YOUNG CHILDREN'S APPRENTICESHIP IN NUMBER

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ABSTRACT

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This thesis investigates young children's appropriation and use of number through social mediative practices which may occur at home or in pre-school playgroups/nurseries. The design and interpretation of this study is drawn from a social constructivist perspective, that is rooted in Vygotskian developmental psychology (Vygotsky, 1978;1986) and leans heavily upon the writings of Wittgenstein (1953) and Vološinov (1973). Number is viewed as an enculturational development, where meaning is appropriated from social use, rather than as an individual cognitive development. Thus it is argued that the acquisition of number stems from mediated social practice. Number meaning is acknowledged to be intrapsychologically structured in the individual through rhetorical-responsive social communication (Shotter 1993). The research data emanates from five different sources, home video recordings, pre-school video recordings, parent interviews, parental diary studies, and nursery teacher interviews. A two dimensional coding schedule, grounded in the research data and based upon theoretical considerations, is developed to analyze transcripts of young children's social interaction involving number utterance. The coding schedule enables an examination of number:

(1) mediation practices (Adult/social other; Child performance; Self-regulation)

(2) aspects of 'use-meaning' being mediated to young children.

The coded analysis of data also enables measures of quantity and quality of mediated numerical interaction from different settings to be compared. A taxonomy of activities that are employed at home, and at pre-school playgroups/nurseries, to mediate aspects of number to young children are also developed.

The results indicate that although some homes have higher quantity and quality rates than some pre-school playgroups/nurseries, on average a young child will receive more mediated numerical interaction at pre-school/nursery, hour for hour, than at home. The highest quality and quantity rates were measured in a primary school nursery classroom, and these were almost three times as high as the average home.

The thesis contributes to our knowledge about how aspects of number 'use-meaning' are socially mediated to individual young children through rhetorical-responsive communication.

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I dedicate this thesis to my parents, who provided me with an early apprenticeship in number, and by so doing, shaped my future life.

CONTENTS

Page

Page

APPENDICES

INTRODUCTION

INTRODUCTION

This thesis has evolved from spending 15 years teaching school mathematics. During that period it became increasingly obvious to me that many children were not achieving as well in the mathematics classroom as they were in most other subjects. I began to suspect that this was not due to any deficiency in their mental development, but possibly due to social expectations. Some children appeared to do well at mathematics, and when questioned about their past performances, it was usually noted that they had always been good at mathematics. Children who described themselves as being 'bad' at mathematics usually indicated that they had always been 'bad'. These ideas about their own mathematical ability may have reinforced their own expectations of themselves in terms of mathematical competence. Children did not appear to suddenly develop mathematical insight, nor did they expect this to come from school teaching, if anything, school teaching appeared to exaggerate mathematical 'self worth'. Good marks and bad marks were expected by different children, - and they would usually appear surprised if their expectations were not borne out. It seemed as though children had appropriated the mathematical competence labels that others, and the school system, had assigned to them, and they lived up to these expectations. In my experience, often a child who had been told by others that they were 'good' at mathematics, usually appeared to make that little bit of extra effort to ensure that their 'reputation' was maintained. A child who was 'bad' at mathematics rarely surprised everyone by achieving a top mark, and it was quite usual for some to 'give up' before they had even made an effort. It was as if children were writing their own destiny as far as mathematical development and competence was concerned. In the case of some children, my classroom efforts, as a teacher, were often ineffective. For some children, it appeared as if there was a psychological barrier to learning mathematics, but not of the form of a mental developmental barrier, it appeared to me to be more of a socio-historical barrier. I began to look deeper into the reasons why some children failed to perform well at mathematics. I certainly was not willing to accept that it was due to some mental failing on the part of the children, or on my ability as a teacher, something else had to be controlling the mathematical development of the children. To me, the children who were not achieving well in the mathematics classroom were not backward in terms of psychological mathematical development, but had simply not appropriated mathematical competence for one reason or another. Their lack of competence in performing routine mathematical algorithms appeared to me to be an historical development, it grew over years, each year compounding the other. Eventually a situation arose where the mathematical competence of some 16 year-olds was seen to be no greater than that of clever 11-year olds - and the National Curriculum takes account of this situation. Possibly, mathematical expectation (the words of others) and achievement were tied up together, the one influenced the other in the form of a dialectical interaction. If teachers and others only expected some 16-year old children to achieve the mathematical competence of some 11-year olds, then possibly that situation was bound to arise.

However, the mathematical expectations of 16-year old children, are not individual expectations by the children, these are social expectations. The National Curriculum is a social instigation, it promotes and sets the mathematical expectations, and it is designed to ensure broad social competence in mathematics.

These insights led me to the view that much of what our young children achieve in terms of mathematical competence, are not so much determined by considerations of mental ability, but by social mathematical expectations. It seemed that individual children usually achieved what was socially expected of them. The children who were 'good' at mathematics, and the children who were 'bad', gained their labels from social expectations, and these appeared to be the motivating or non-motivating factors. Consequently, it seemed that mathematical competence was a socially instigated development, it was structured by social expectation (the words of others), and had very little to do with individual mental competence or mental development.

This being the case, I began to consider where this individual appropriation of 'social expectation' of mathematical achievement originated from (not the National Curriculum). It was quite clear to me that the mathematical destiny of secondary pupils had already been socially decided, but who had influenced their appropriation of any social decision about their own competence and when?

It seemed logical to search for the answer in the children's mathematical socio-historical development, to see where failings and successes first emerged, because these would without doubt influence other peoples' expectations of their mathematical ability and start the dialectical interplay between social expectation and achievement. In other words, numerical competence in early childhood could be a determining factor, and the research in this thesis has been designed to examine early numerical competence.

Past research (Saxe, 1979; Fuson & Hall, 1983; Durkin et al, 1986; Saxe et al, 1987; Sophian, 1988; and others) has often suggested that young children's understanding of number evolves as a direct result of counting experience. According to these viewpoints, pre-school children first learn to use numbers mechanically, in social context, and then gradually develop or construct deeper and deeper meanings of number and counting through physical and social interaction. It has therefore been suggested that much of this early number development takes place before children enter school, resulting from numerical interaction and childhood games with parents and caregivers.

If a child has been 'tutored' in number at home prior to entering school, then that child may be expected to be in a much stronger position than another child who has not been tutored, and this may set the 'expectation-achievement' dialectic in motion. Thus it seemed to me that early caregiver mediation of cultural number use may influence and possibly pre-determine eventual mathematical achievement at school.

Early numerical competence, or the lack of competence, could be expected to be the focus of comment by school teachers and social others. The presence or absence of numerical competence in young children may also be expected to be noticed by the children themselves. In the social situation of young children in a classroom, a laugh at the lack of numerical competence (even that of another child) may be sufficient to make a child aware of his/her lack of competence; and praise from the teacher sufficient to raise the ego of another child who has displayed competence. These early classroom experiences may begin to structure the social expectation-achievement dialectic that eventually leads a child to implicitly appropriate, from the behaviour of others, notions about their own numerical, and eventually mathematical, competence. School may simply provide the stage that reinforces and exploits the socially constructed expectation-achievement dialectic.

Speaking from personal experience, as a young child, I was often singled out by teachers and praised for numerical competence, and I took pride in both teacher and peer praise. It was not long before other children began copying my answers to sums, and this happened even at the age of 5-years old. Consequently, from a very young age I strived to meet the social expectations of me in regard to number competence, both from teachers and peers, and eventually their expectations became my own expectations. I was successful at mathematics, and I always expected to be a success. Being good at mathematics became part of my make-up, and it followed me all the way through to university where I gained 100% in one test of mathematics during my first year, (the university lecturer made a joke of it in front of a lecture theatre full of students, but I was used to that) and afterwards other students wanted me to tutor them in mathematics and I did. Slowly I embarked along the road to becoming a teacher of mathematics. You could say I had written my own destiny in terms of career, but in fact it was the social expectations of others that had led me there. I do not believe that my success at mathematics was due to mental development or mathematical prowess, but that it was due to the mathematical expectations of me by social others. My mathematical knowledge was not self-constructed, but socially constructed. I merely played a role in appropriating its use by others and I had practised those uses with the mediated help and assistance of others. My mathematical competence was interactively developed with social others, my competence was due in part to what others had given me.

If this was true of me, then it may be true of others. We are all what others make us, some are made good at mathematics, others not so good, but our psychological mathematical capability should not be in question, it is not an individual mental development, it is a social development and a social accomplishment.

Mathematics must be viewed as a cultural tool. It has been socially developed, and it is socially mediated in social context, in which case it should not be interpreted in terms of individual mental constructions or mental development:

> The basic tenet of a sociocultural approach to mind is that human mental functioning is inherently situated in social interactional, cultural, institutional, and historical context. Such a tenet contrasts with approaches that assume, implicitly or explicitly, that it is possible to examine mental processes such as thinking or memory independently of the sociocultural setting in which individuals and groups function (Wertsch, 1991b, p86).

I hope that this thesis will show that mathematics, and in particular, numeracy, should be viewed as a social construction, where young children serve a social apprenticeship in number. I suggest that within this apprenticeship paradigm it no longer makes sense to talk of discrete individual mental development. I believe that this early apprenticeship sets a pattern for future school mathematical achievement, it certainly did for me.

CHAPTER 1

THE PHILOSOPHICAL/PSYCHOLOGICAL/LINGUISTIC FOUNDATIONS FOR A SOCIAL CONSTRUCTIVIST ENQUIRY

1.1 THE NATURE AND SOURCE OF COGNITIVE GROWTH

During the last two decades, a steadily increasing body of research indicating the importance of social context in children's cognitive functioning has led to a gradual change in theorizing about the nature of cognition. The research in this thesis will argue that our system of number use does not develop in the child as a mental abstraction from concrete activity, but evolves as a social meaning appropriation, developed linguistically by social mediation and through social contextual application/use. Here, the epistemology of number is viewed as a social development, not a cognitive development.

In Piagetian based studies concerning the cognitive structuration of knowledge, children's cognitive development is often separated from the social, linguistically interactive aspects that are supposedly contingent upon development.

Situational context in a cultural or social sense played a secondary role in Piaget's (1972) individualistic conception of epistemological cognitive development. Piaget acknowledged the influence of the social context on cognitive development as supportive or otherwise to an internal personal cognitive development of logico-mathematical principles. In Piaget's view, the contextual situation is a physically real situation, it is not defined by the interpretations of the participants in terms of social and cultural symbolic signification, eg. language. The symbolic structures of logico-mathematical mental representations are not seen to arise out of a social contextual situation, but are acknowledged to develop as individual constructions derived from individual experiential activity on a physically determined real world. In other words the symbolic mental structures are seen to arise from physical concrete action, not mediated social ideological language usage. The ideological social system of language usage is therefore not recognized by Piaget as the source of cognitive development. For Piaget, cognition does not develop from language, but rather language develops from cognition. Language is seen by Piaget as a system of cognitive representation, it simply reflects cognition, it does not structure it. Piaget is therefore able to justify to himself (and some others) that clinical cognitive investigations of young children's abstract knowledge are valid outside of social context or language usage. However, educational researchers now widely recognize that social contextual agents such as parents, peers, school and societal norms, can have a profound mediational influence on children's cognition and cognitive growth. A Piagetian model of cognitive performance ignores both the role of social context and the ideological structure through which that context is defined, language. It may have seemed 'logical' to Piaget to view individual cognitive development as a process of 'individual abstraction' from the physical environment or cognitive conflict in the social environment, but it is not logical when the nature of cognition is taken to be social. Cognition need not be accepted as a mental function structured by the activity of an individual being, such an entrenched view is simply an ideological psychological inheritance. Cognition can be interpreted as a function of communication, in the sense that human activity is regulated through communication. In which case, cognition is socially determined, seen to exist only between people. From birth, individual life activities are communicatively controlled and directed by social others. Therefore, human social cognition penetrates the individual, and it permeates humanity, it is socially developed, and it is communicatively dissipated. Research by Walkerdine and Sinha (1978) questioned the Piagetian cognitive model and spurred the development of a social constructivist model:

> The kind of data reported in this paper leads the authors to suggest that cognitive development may be considered as a complex interaction of the individual with the social context in which he exists, in which the medium of language plays a central and strategic role
> (Walkerdine and Sinha, 1978, p173-4).

Edwards, (1978); Ernest, (1991); and Shotter (1993) also support the movement towards a social constructivist perspective where meaning must be seen to psychologically develop through language:

> Even those utterances spoken in monologues (Piaget 1926) are ones whose form and meaning are learned in and derived from social interaction
> (Edwards, 1978, p68);

> In this chapter I propose a new philosophy of mathematics called 'social constructivism'. ..... It draws on conventionalism, in accepting that human language, rules and agreement play a key role in establishing and justifying the truths of mathematics (Ernest, 1991, p42);

> The aim of social constructivist argumentation, is to bring about yet another change in psychology's research agenda (Shotter, 1993, p182).

Substantial research has already been reported world wide to support a social constructivist perspective (Rogoff & Lave, 1984; Tizard & Hughes, 1984; Wertsch, 1985; Saxe et al, 1987; Walkerdine, 1988; Rogoff, 1990; Rogoff et al, 1993).

While the developmental causes of cognitive growth have always been a contentious feature of developmental psychology, there is now widespread recognition of the importance of cognitive studies carried out by social anthropological interactionalists. This thesis rejects outright the individualistic foundation of Piaget's theory of the source of cognitive development, and instead will pursue a socio-historical perspective which recognizes that cognitive development arises out of the meanings enveloped in the language of social interactive communication (Shotter, 1993). Cognition will be interpreted as social communicative interaction, it will be analyzed and measured in terms of social communication.

The evolution of cognitive theory to accommodate research evidence of social contextual influence has now reached a point where several prominent researchers [Wertsch, Cole, Rogoff, Resnick, Lave, Ernest, and others] have concluded that a fundamental shift in the nature of epistemology is required. They have all explored a Vygotskian epistemological theory that adopts the perspective that social interaction is fundamental to the individual, acknowledging that cognitive knowledge is culturally entrenched, and developed through social mediational interaction.

The move towards a social constructivist theory has probably evolved as psychological researchers have become more able, and more willing, to undertake non-clinical observational studies of children operating within their normal social environments. Research approaches by social constructivists have become observational rather than testing, research results are often reported and interpreted qualitatively, and in terms of socio-historically accounting for cognitive presence or absence, rather than heuristically attempting to record and measure abstract cognitive functioning. Social constructivist naturalistic studies are often intensely detailed, a consequence of using new technology in the form of video recording equipment:

> Subtle conceptual dimensions of human performance and its interdependency with environmental context emerged under the focus of these 'behavioral microscopes' (Zimmerman, 1983, p17).

Echoing a Vygotskian psychological perspective, Fodor (1972), has argued that children's cognition differs from that of adults only in the range of activities to which it is applied, in other words the difference is seen to be quantitative in terms of the mediation of human activity and not qualitative in terms of stages of mental maturity. Garton (1984) has explored the possible role of linguistic processes as causal mechanisms in seeking to explain cognitive development through social processes. Vygotskian theory question assumptions about the existence of a fixed, unchangeable, positivistic real world that may be said to be 'knowable'. Instead, Vygotskians assume that reality is dynamic and structured through language use, that it is developed by social relations operating in social contexts. In his book, Thought and Language, Vygotsky states:

> In our conception, the true direction of the development of thinking is not from the individual to the social, but from the social to the individual"
>
> (Vygotsky, 1986, p36).

Knowledge is seen to be an accumulative socio-historical product, a semiotically structured relation, that is dialectically developed by human action on a physically constrained world.

1.2 THE PHILOSOPHICAL FOUNDATIONS OF A THEORY OF CULTURAL COGNITION

> The human race is a myriad of refractive surfaces staining the white radiance of eternity. Each surface refracts the refraction of refractions of refractions. Each self refracts the refractions of others' refractions of self's refractions of others' refractions (Laing, Phillipson, & Lee, 1966, p3).

The development of a theory of cultural cognition is rooted in the Marxist philosophical theory of social activity and material dialectical logic. This theory of cultural cognition asserts that the genesis and structure of higher mental processes are historically developed by humanity through communicative mediation. Socially developed knowledge, cultural knowledge, must be mediated if an individual is to function within a socially constructed world, since an individual cannot construct socially constructed knowledge for him or herself. Social mediated knowledge defines the parameters within which an individual is integrated into society. Cultural knowledge, while materially influenced, cannot be simply or mechanically reduced to objective material relations, it is socially and linguistically constructed, and must be socially and linguistically disseminated. According to Berger & Luckman, an individual cannot personally construct a reality that has been transformed and constructed by previous generations, and which embodies their multifaceted experiences:

> The sociology of knowledge understands human reality as socially constructed reality (Berger & Luckman, 1967, p210-11).

The reality of cultural knowledge, while necessarily located within material contexts, may be reduced to social dialogue (Shotter, 1993). For Shotter, an individual's 'reality' is historically mediated by relationships with other people through the dialogical conversations that develop from these interpersonal relationships.

There is an implicit assumption in this theory of cultural cognition, namely, that higher mental processes are socially regulated and ideologically framed through the social activity of *'language-games'* (Wittgenstein, 1953), and this is the hinge-pin of the theory of cultural cognition.

The language-game position requires explication, and this is what I shall attempt here by examining the role of language as an interpsychological meaning mediating tool. Language will not be viewed as simply a means of communication, but as a 'tool' that is used by society to construct individual social-cognitive development or social consciousness.

I shall explore the philosophical views of Vološinov/Bakhtin and Wittgenstein on the relationship between meaning and the practice of everyday language, and I will relate these views to Vygotsky's conception of a socio-historical, materialistic, developmental psychology.

It is my aim to merge together their independent perspectives on language activity and social/individual dialectical consciousness and to demonstrate that their social realist positions are all grounded in Marx's praxis-interactionist thesis.

I shall then show how the application of their fused philosophies has implications for our understanding of how young children appropriate number through 'linguistic social practice'.

> If everyone has been brain-washed then it is by the very forms of social reality itself (Mephan, 1979, p168).

1.3 A brief overview of Marxist Philosophy

Marx contended that the human person and human consciousness is a product of society since, in his view, there was a dialectical relationship between self and society. For Marx, human intelligence is social communication, it exists in and is inseparable from, language:

> Language is as old as consciousness, language is practical consciousness, as it exists for other men, and for that reason is really beginning to exist for me personally as well; for language, like consciousness, only arises from the need, the necessity, of intercourse with other men ...... Consciousness is therefore from the very beginning a social product, .. (Marx & Engels, 1965, p41-2).

According to Marx, humans detect object reality through interaction with social others, and consequently the material properties of world objects are perceived by humans in terms of social significance. Hence, in the view of Marx, the higher mental consciousness of children, their psychological development, is structured by language through social appropriation.

Marx's recognition that the conscious human mind is a product of social experience, led Marx to appreciate the active character of mind, and this is reflected in his epistemology of materialism. In Marx's view, mind is a dialectical creation, both a product and a tool of language activity.

In Marx's view, individual sensory experiences are transformed into mental perceptions through social language experience. Marx insists that what we see and hear in a material world is mediated and shaped relative to social and historical contexts:

> Even the objects of the simplest 'sensuous certainty' are only given him through social development, industry and commercial intercourse
> (Marx & Engels, 1965, p51).

For Marx, sense experience emerges from a dialectical interaction between human society and the physical world.

From the perspective of Marx's philosophy, if children are to become conscious of number and counting practices, then it is practical social uses and social processes that will mediate that consciousness through language.

1.4 The Influence of Marxist Philosophy on Vygotsky

Vygotsky sought to develop a Marxist psychology which would consider human beings as active participants in their interaction within a social environment. To this end, Vygotsky emphasised an historical view of psychological developmental processes (Vygotsky, 1978, 1986). In developing his thinking about the units of analysis in psychology, Vygotsky was without doubt influenced by the dialectical and materialistic philosophy of Marx.

Vygotsky was dissatisfied with empirical psychological practices and he sought revolution (F.Newman & L.Holzman (1993) call Vygotsky "Revolutionary Scientist"). Marxist theory inspired Vygotsky and he revolted against the ideological substance that constituted the form and content of scientific psychology:

> I don't want to discover the nature of mind by patching together a lot of quotations. I want to find out how science has to be built, to approach the study of mind having learned the whole of Marx's method
>
> (Vygotsky, 1978, p8).

Vygotsky (1978), maintained that psychology should be able to account for and explain the complex phenomena of individual human mental achievement from a socio-historical, materialistic, perspective (Newman & Holzman, 1993). Vygotsky introduced psychology to a methodology that was entrenched in a socio-historical theoretical approach to the understanding of human mental development, and based his own study of children's mental development upon Marxist ideology. Vygotsky was one of the first Soviet psychologists who recognized the influence of a social materialistic psychology on mental awareness or consciousness (Holowinsky, 1988). Vygotsky pointed out that by ignoring the materialistic contribution, through socially mediated consciousness (language), to mental development, psychology ignored the real formulational complex of human behaviour. Vygotsky described his psychological theory as cultural-historical, viewing development of all higher mental functions within the context of human social evolution. According to Vygotsky, it is indisputable that society in one way or another determines individual development and behaviour. Man is seen as a social being, not an individual being, he is socially developed, not individually developed, and so for the child.

In Marxist dialectical philosophy, the thought of society is 'shaped' and 'constructed' through words, and in turn, our words 'shape' and 'construct' our thoughts. Vygotsky's psychological perspective of the development of higher mental functions is thus firmly entrenched in Marxist theory.

According to Vygotsky, an individual's specifically human qualities, eg. the developed higher mental functions (and that includes number), are acknowledged to be a product of the society in which that human lives, and consequently it is from the social environment that the individual is seen to develop higher mental functions.

In Vygotsky's view, intellectual development consists of a progression from the social to the individual, from interpsychological to intrapsychological functioning:

> In our conception, the true direction of the development of thinking is not from the individual to the social, but from the social to the individual
> (Vygotsky, 1986, p36).

In line with a Marxist view, Vygotsky (1978,1986), regards social interaction as fundamental to the development of individual consciousness, and hence cognition.

The developmental path that Vygotsky outlines is recognizable as a social constructivist developmental process.

1.5 A brief overview of Wittgenstein's Philosophy

Much of Vygotsky's reasoning about psychology and the social foundations of the individual psyche is shared by the eminent philosopher Ludwig Wittgenstein.
Just as Vygotsky revolted against the substance that constituted psychology, Wittgenstein started his own revolution in philosophy, he revolted against the substance that constituted philosophy:

> What is your aim in philosophy? - To show the fly the way out of the fly-bottle (Wittgenstein, 1953, p103).

Wittgenstein's philosophical arguments attempt to undermine conventional acceptance that the properties of mind are individual attributions:

> I have been trying in all this to remove the temptation to think that there 'must be' what is called a mental process of thinking, hoping, wishing, believing, etc., independent of the process of expressing a thought, a hope, a wish, etc.
> (Wittgenstein, 1969b, R41);

> No supposition seems to me more natural than that there is no process in the brain correlated with associating or with thinking
> (Wittgenstein, 1967, p106, R608).

According to Wittgenstein there is nothing mentally going on in us when we express meaning in our talk, rather, our meanings are established by the activity of social process:

> Why can a dog feel fear but not remorse? Would it be right to say "Because he can't talk"? (Wittgenstein, 1967, p91, R518).

Wittgenstein argues that the thinking properties of mind cannot be separated from action, that 'consciousness' of mind is human activity:

> What determines our judgment, our concepts and reactions, is not what *one* man is doing *now*, an individual action, but the whole hurley-burly of human actions, the background against which we see any action
> (Wittgenstein, 1967, p99, R567);

> This activity [thinking] is performed by the hand, when we think by writing; by the mouth and larynx, when we think by speaking
> (Wittgenstein, 1969b, p6).

In line with Marxist thought, Wittgenstein acknowledges that while nature does not determine what we say about it, nature does set limits to what we can say. For Wittgenstein, all our perceptions are linguistically constituted through a dialectical interaction between human subject and physical object. For example, in Wittgenstein's view, perceptual discrimination is made *usable* through language description:

> He learns to call 'red' *what we too* call 'red'?
> (Wittgenstein, 1967, p75, R412).

For Wittgenstein, our colour labelling is not just a perceptual recognition, it is a mediated social recognition, and it is my thesis that the same applies to number. A child may learn to call 'three' *what we,* social others, call 'three'.

For Wittgenstein, 'looking' and 'seeing' are quite different activities. A person can look at a tree but will not see a tree; to 'see' a tree the 'look' must be interpreted, - through social training. A child learns to discriminate between a dog and a cat through contextually based social mediative discourse. The same is true in the case of a child's perceptual discrimination of colours or numbers. A child could 'look' at four items, but will not 'see' four items until that child has been socially trained to do so. Psychological perception or 'seeing' is a function of social mediative interpretation. 'Seeing' is not a matter of cognitive or mental development, but a social interpretation where meaning is appropriated through linguistic mediative practices:

> We see, not change of aspect, but change of interpretation;
> You see it conformably, not to an interpretation, but to an act of interpreting
> (Wittgenstein, 1967, p39);
>
> But an interpretation is something that is given in signs
> (Wittgenstein, 1967, p41, R229);
>
> I learn the concept 'seeing' along with the description of what I see. I learn to observe and to describe what I observe (Wittgenstein, 1967, p111, R637).

According to Wittgenstein the meaning of a word or sentence is to be found only in its use in language, that is in the context of social activity. For Wittgenstein, language can only be understood within the cultural context in which it appears. In Wittgenstein's view, language and social life dialectically create one another. Language expresses social life, and social life develops language:

> We talk, we utter words, and only *later* get a picture of their life
> (Wittgenstein, 1953, p207).

Wittgenstein is saying that it is not language per se that mediates our experiences of the physical world but our ideological social life. It is our ideological framework that creates language meaning, and hence our way of interpreting number sense:

> But being guided is surely a particular experience! (Wittgenstein, 1953, p70);
>
> This is how these words are used (1953, p73);
>
> To obey a rule, to make a report, to give an order, to play a game of chess, are customs (uses, institutions) (1953, p81);
>
> When I obey a rule, I do not choose. I obey blindly (1953, p85).

The social embeddedness of linguistically mediated meaning was recognized by Wittgenstein as a *"language game"*:

> Here the term "language game" is meant to bring into prominence the fact that the speaking of language is part of an activity, or a form of life
> (Wittgenstein, 1953, p11);
> Language, I should like to say, relates to a way of living
> (Wittgenstein, 1978, p335).

Rubinstein (1981) acknowledges that Wittgenstein's remarks on language expresses a view that is very similar to that of Marx:

> For both men, the social level of explanation is irreducible
> (Rubinstein, 1981, p150).

The writings of both Marx and Wittgenstein reject the idea that socially conscious meaning could develop from within an individual mind. Both Marx and Wittgenstein do not acknowledge the existence of 'individual' mind. In both their views, 'individual' mind is an accumulation of socially communicated meaning, it is a product of social development, rather than of internal individual consciousness. They both advocated that it is human language within a system of social practices that gives rise to conscious meaning. For both men, meaning is a social product it cannot develop 'mentally', or individually, it must be socially appropriated through language:

> Hence it would be stupid to call meaning a 'mental activity' because that would encourage a false picture of the function of the word
> (Wittgenstein, 1967, p5, R20);

> A meaning of a word is a kind of employment of it. For it is what we learn when the word is incorporated into our language
> (Wittgenstein, 1979, p10, R61).

According to both Marx and Wittgenstein, our interpretations of the physical world are social constructions, mediated through language and formed from socially constructed ideological meaning. Marx and Wittgenstein suggest that all the presupposed properties of mind are social constructions, dialectical products of cultural activity on a perceived physical world, and they both accept that our social practices determine our psychological construction of reality. Consequently, in both of their views, any psychology of number must be rooted in social practices. Both Marx and Wittgenstein would view number consciousness as a human sense activity that has been socially and historically cultivated through language.

The conception of meaning as a property of social context acknowledges a dialectical relationship between individual thought and social thought. In both their views, it is the dialectic of interaction between an individual and socially mediated ideological meaning that determines a level of individual meaning understanding, not mental development or mental activity:

> A person cannot beg, borrow, or steal except in society. Neither can he buy or sell, give or take, borrow or lend, insult, vote, promise, bet, betray, teach, command, or obey apart from others (Rubinstein, 1981, p163);

and I suspect that a person could not (would not) count or use numbers apart from a social communicative situation.

In other words an individual must be socially engaged to socially appropriate, and understanding can only be measured in terms of social engagement, not mental development. Rubinstein (1981) sums up Marx's and Wittgenstein's arguments with the following sentence:

> If human intelligence is possible only with language, and if language is possible only in society, it is not possible to speak of 'mind' apart from a social life (Rubinstein, 1981, p164).

In this philosophical line of reasoning, Marx's and Wittgenstein's views deviate from conventional psychological notions of mental development, but are in line with Vygotskian psychological development.

1.6 LANGUAGE AND THE SOCIAL CONSTRUCTION OF MEANING

Wittgenstein's philosophy of language mirrors Vygotsky's psychological perspective of meaning as an appropriation from social contextual use of words:

> The children are brought up to perform *these* actions, to use *these* words as they do so, and to react in *this* way to the words of others
> (Wittgenstein, 1953, p4);
>
> In the practice of the use of language(2) one party calls out the words, the other acts on them (Wittgenstein, 1953, p5).

Like Vygotsky, Wittgenstein recognizes that any analysis of language must also take account of the sociohistorical context:

> On the other hand a language-game does change with time
> (Wittgenstein, 1979, p47, R256).

For Wittgenstein, understanding language requires an understanding of the social context in which the language appears. The account of the nature of mind that emerges from the work of Wittgenstein is perfectly matched to a social constructivist view of mental development:

> Let the use of words teach you their meaning
> (Wittgenstein, 1953, p220, RII,XI).

For Wittgenstein then, as for Vygotsky, linguistic meaning is socially conceived and socially mediated in context. Individual appropriation is perceived to develop through social activity, *'meaning-use'*, and is socially co-authored. The employment of a word is to be seen as having been regulated by the linguistic conventions of a particular community. For Wittgenstein, *meaning* is not just *use,* it is clearly identified with social practice, "this language game is played" (Wittgenstein, 1953, p167).
Wittgenstein perceives of meaning as an element embedded within the contextual discourse of the language game:

> Only in the practice of a language can a word have meaning
> (Wittgenstein, 1978, p344).

In Wittgenstein's Philosophical Investigations, remarks of this nature are employed to suggest that language games are not founded upon logic (grammatical illusion), but are constructed from the human *essence* of language, and, "the essence is hidden from us" (Wittgenstein, 1953, p43).

For Wittgenstein, human 'essence' is probably a hybrid representation of "use" and "sense", it is "expressed by grammar" (Wittgenstein, 1953, p116). In trying to grasp essence, Wittgenstein states:

> What we do is to bring words back from their metaphysical to their everyday use (Wittgenstein, 1953, p48).

Wittgenstein asserts that the meaning of a sign lies in its usage, *"the use-the meaning"* (Wittgenstein, 1953, p14, R30), and if it has more than one usage it has more than one meaning (Wittgenstein, 1953, p148). Wittgenstein (1953, p6), views words as "tools" in a language "tool-box" where the activity of using the tools produces a language game that expresses meaning, but he asserts that it is the social activity of toolmaking that creates meaning. The "finding and inventing intermediate cases" (1953, p49) is Wittgenstein's way of saying that the activity of toolmaking is practised before "tools" from a "tool-box" are used. The activity of toolmaking is "seeing connections" (1953, p49), an explicit association between social contextual meaning and word use that might be called *linguistic understanding*.

Wittgenstein's view of linguistic understanding as words as tools in use, consisting of "seeing connections" or "family resemblance", is very similar to the idea of linguistic mediation in Vygotsky's ZPD. The use of language as a 'tool' to develop number consciousness may be interpreted from these philosophies.

For Wittgenstein, Mathematics is simply another "language-game", a discourse without foundation nor in need of philosophical justification (Wittgenstein, 1953, p49-50, R167). Wittgenstein attempts only to clarify and understand mathematics as it is actually practised:

> And why is it evidently mathematics? - Because it is a game with signs according to rules? (Wittgenstein, 1978, p265).

An important aspect of Wittgenstein's philosophy of mathematics is that he regards it as *grammatical* - rules constructed by social convention:

> The mathematician is an inventor, not a discoverer
> (Wittgenstein, 1978, p99).

In other words, Wittgenstein recognizes mathematics as a rule entrenched human discourse created by social activity:

> Of course, in one sense mathematics is a branch of knowledge, -but still it is also an activity (Wittgenstein, 1953, p227);

> Once you have got hold of the rule, you have the route traced for you
> (Wittgenstein, 1978, p333).

This relationship between activity and meaning has much in common with Marx's perspective of the activity relationship between social ideology and meaning that was remarked upon earlier. Wittgenstein's view is essentially that the activity of mathematics constitutes mathematical meaning:

> Mathematics - I want to say - teaches you, not just the answer to a question, but a whole language-game with questions and answers.
> Are we to say that mathematics teaches us to count?
> (Wittgenstein, 1978, p381);

> We take it much too much for granted that we ask "how many?" and thereupon count and calculate.
> Do we count because it is practical to count? We count! - And in the same way we calculate (Wittgenstein, 1978, p389);

> we assume that children learn counting and the simple kinds of sum by means of imitation, encouragement and correction (Wittgenstein, 1978, p390).

1.7 A Vygotskian Perspective of Higher Mental Functioning

Vygotsky recognized higher mental functioning as being qualitatively different from biological psychological development in that, "this new activity is mediated by signs" (Vygotsky, 1986, p109).

Vygotsky's human developmental psychology has already been noted to be rooted in the philosophy of Marx, by recognizing a dialectical material relationship exists between individual thought and social communication. A Vygotskian interpretation of the social functions of language are twofold, firstly as a speech system of social meaning expression, and secondly as a mediational tool in social meaning appropriation:

> The problem is that thought is mediated by signs externally, but is also mediated internally, this time by word meanings. Direct communication between minds is impossible, not only physically but psychologically. Communication can be achieved only in a roundabout way. Thought must first pass through meanings and only then through words
> (Vygotsky, 1986, p252).

For Vygotsky, words are associated with linguistic communication, but words are not synonymous with the social communication of meaning. According to Vygotsky, meaning is developed through the social activity of mediation, by using words. It is not the words but the mediation through words that enables an individual to self-regulate the socially-regulated meanings of society:

> Behind words, there is the independent grammar of thought, the syntax of word meanings. The simplest utterance, far from reflecting a constant, rigid correspondence between sound and meaning, is really a process
> (Vygotsky, 1986, p222);

> But word meanings evolve. When a new word has been learned by the child, its development is barely starting; (Vygotsky, 1986, p149).

Vygotsky is suggesting that, initially, young children do not differentiate between word meaning and object, or between meaning and the sound of a word. According to Vygotsky, the differentiation only occurs during the mediated processes of generalization development, through social interactional influences such as societal norms, rules and uses of language:

> Thought is not only mediated externally by signs. It is mediated internally by meanings. The crux of the matter is that the immediate communication of consciousness is impossible not only physically but psychologically. The communication of consciousness can be accomplished only indirectly, through a mediated path. This path consists in the internal mediation of thought first by meanings and then by words. Therefore, thought is never the direct equivalent of word meanings. Meaning mediates thought in its path to verbal expression. The path from thought to word is indirect and internally mediated
> (Vygotsky, 1987, p282).

For Vygotsky, human "speech capacity" is both a social and a psychological phenomenon, it dynamically structures the human mind. Vygotsky viewed linguistic communication as a social-individual dialectical process where meaning is expressed through words, not in words.

Like Wittgenstein, Vygotsky saw language as a tool that is used to design, shape, and develop social meaning:

> we attempted to study experimentally the dialectics of transition from perception to thinking, and to show that a generalized reflection of reality is the basic characteristic of words.......
> ..consciousness is reflected in a word as the sun in a drop of water. A word relates to consciousness as a living cell relates to whole organism, as an atom relates to the universe. A word is a microcosm of human consciousness
> (Vygotsky, 1986, p255-6).

Vygotsky's historical tool-and-result analysis of word meaning led him to disagree with much of the psychology of his day, especially when it was assumed that words were simply a means of social interaction. Vygotsky recognized that social interaction was only possible through the use of words, but that 'use' was grounded in the social intentional human meaning. Vygotsky insisted that social interaction was dialectically generated, constituted by an interplay between words and intentional meaning, to achieve social generalization.

Thus, one difficulty facing young children in their attempts to engage in social interaction is their low level of already socially appropriated generalization of intentional meaning, ie their level of social thought, - which is socially mediated through words. Therefore, mediated meaning, has important developmental significance in terms of promoting further social interaction, by virtue of socially raising the child's level of meaning generalization. Vygotsky implies that word meaning is not only a unity of thought and speech, it is also:

> a unity of generalization and social interaction, a unity of thinking and communication (Vygotsky, 1987, p49).

This unity of generalization with social interaction-word meaning, is seen to be a process of social construction of meaning in the individual, and the process is, for Vygotsky, the connection between cognitive and social development.

Newman & Holzman (1993), acknowledge that it is the unity between thought and word that lies at the heart of Vygotsky's social constructivist psychology:

> This notion of completing (thought completed in the word) is both an extraordinary discovery in itself and a magnificent example of what Vygotsky means by unity; it is a concept of unity that is distinctly anti-metaphysical and dialectically, historically materialistic
> (Newman & Holzman, 1993 p132).

Vygotsky's ideas concerning the social relationship between language and mind has inspired many other followers, all echoing the same perspective, namely that language is not simply a means of communication, it determines the thought of social consciousness:

> Language embodying socially accumulated and generalized experience reflects the phenomena of the surrounding world in the human mind in the form of consciousness. Thus consciousness is a form of reflection which is social by nature. It is inconceivable without the mastery of language
> (Leontiev, A.N. & Leontiev, A.A. 1959, p193).

Language is a key to understanding meaning because it is the tool by which human beings interpret divergent understandings of meaning, and construct shared social realities. Language is the tool used by 'others' to shape children's social reality, and children themselves practice the use of this tool with 'others'. It is through the use of language that children gain entry into the interpretive frameworks of their culture (Lucy & Wertsch, 1987). All social meaning interpretations are seen to be linguistic mediated appropriations, and that includes number.

1.8 INDIVIDUAL CONSCIOUSNESS AS A SOCIALLY REFRACTED CREATION THROUGH UTTERANCE

It has already been noted that for Wittgenstein, language use is discursive practice, it creates meaning between people, where that meaning is characterized by what is accomplished by an utterance. However, meaning must be 'fine tuned', because all sorts of different things may be accomplished by the same utterance, and according to Wittgenstein an utterance achieves a particular meaning because "This is how these words are used" (Wittgenstein, 1953, p73, R180).
The writings of Vološinov (1973) and Bakhtin (1986) are of some relevance here. According to Bakhtin/Vološinov, the individual may create "acts of speech", but their creations are socially formulated, the logic of language rules is social, the context of use is social, and the mode of expression is socially oriented towards another, "The utterance is a social phenomenon" (Vološinov, 1973, p82).

Utterance is not simply viewed as language exchange, it is recognized as human discourse whose constitution is social activity:

> The immediate social situation and the broader social milieu wholly determine - and determine from within, so to speak - the structure of an utterance
> (Vološinov, 1973, p86).

Both Vološinov and Bakhtin view the individual psyche as a socio-historical mediated phenomenon developed through the ideological material of sign. Bakhtin/Vološinov do not recognize the individual as the real unit of psychological development, for they argue that individual consciousness is a function of social consciousness.
Their views are captured in the following poetical quotation:

> The self is created by its apprehension of an other. The other is created by its distinction from a self. They create each other and sustain each other's existence. Each makes the other what it is (McEvilley, 1992, p147).

For both of them, Vološinov and Bakhtin, the real unit of psychological development is *utterance*, the product of the speech act.

1.9 The importance of Utterance to Social-Individual Psychic Development

Vološinov's linguistic philosophy concerning the psychological development of the self was also rooted in Marx's philosophy, and like Vygotsky, he advocated a sociological introspection and pursued a socio-ideological interpretation, "The individual consciousness is a social-ideological fact" (Vološinov, 1973, p12); and:

> The processes that basically define the content of the psyche occur not inside but outside the individual organism, although they involve its participation (Vološinov, 1973, p25).

Vološinov recognizes the existence of individual consciousness, but only in terms of a social ideological formulation, not as an individual cognitive construction. For Vološinov, the individual consciousness is seen to be a dialectical social product arising out of social communication, and not from individual cognitive development. Vološinov's perspective of the individual psyche and consciousness is entirely sociological in character, where psychic content is seen to be ideologically determined by verbal content. For Vološinov, any psychology of the individual must be concerned with the social psychology of the individual:

> In the present context, we should prefer to avoid the word 'psychology', since we are concerned exclusively with the content of the psyche and the consciousness. That content is ideological through and through, determined not by individual, organismic (biological or physiological) factors, but by factors of a purely sociological character. The individual, organismic factor is completely irrelevant to an understanding of the basic creative and living lineaments of the content of consciousness (Vološinov, 1973, p90).

It is from this philosophical insight of Vološinov's that I will pursue my argument that numerical consciousness among children is a sociological contextual development, a product of social ideology, and not an individual mental development.

> The individual consciousness not only cannot be used to explain any thing, but, on the contrary, is itself in need of explanation from the vantage point of the social, ideological medium (Vološinov, 1973, p12).

> Consciousness takes shape and being in the material of signs created by an organized group in the process of its social intercourse ....The only possible objective definition of consciousness is a sociological one........The individual consciousness is nurtured on signs; it derives its growth from them; it reflects their logic and laws (Vološinov, 1973, p13).

Vološinov recognizes that individual consciousness is linked to social ideological conditions and forms of social communication. Vološinov is suggesting that it is through the material of social communication that individual consciousness is ideologically formed and shaped:

> ..... by having at its disposal material that was pliable and expressible by bodily means. And the word was exactly that kind of material
> (Vološinov, 1973, p14).

Vološinov views the word as a semiotically pure and *neutral sign*, that is ideologically used in social communication, and which acts as the semiotic material of consciousness:

> This has determined the role of word as the semiotic material of inner life - of consciousness (inner speech) (Vološinov, 1973, p14).

This recognition by Vološinov, of individual consciousness as *inner* word, is identical to the view expressed by Vygotsky, and places language firmly at the centre of any study of young children's development of numerical consciousness.

The child's consciousness of number must be seen to be sociologically controlled, and to be sociologically developed through the child's active participation in the social dialectical co-construction of numerical signification.

For Vološinov, all social processes of cultural expression and understanding depend upon the word as the medium of human consciousness:

> All manifestations of ideological creativity ..... - are bathed by, suspended in, and cannot be entirely segregated or divorced from the element of speech
> (Vološinov, 1973, p15);

and it is my thesis that this philosophy applies to the cultural development of 'number' use.

1.10 The Relationship between Individual Utterance and Social Meaning

For Vološinov, like Wittgenstein, there is no such thing as linguistic meaning. Meaning is seen to be a social creation, uniquely developed in particular, social situations, through utterances, and is not simply an aspect of normative linguistic forms that are abstracted and applied.

This dialogical nature of the utterance-word arises because meaning and expression are social in origin, although the physiological implementation of these is an individual act. Yet even this individual implementation is seen by Vološinov to be socially influenced:

> Aside from the fact that word as sign is a borrowing on the speaker's part from the social stock of available signs, the very individual manipulation of this social sign in a concrete utterance is wholly determined by social relations
> (Vološinov, 1973, p86).

According to Vološinov, there is no such thing as an individually constructed utterance, nor an individually constructed consciousness. For Vološinov, ideological signification in the form of social utterance permeates the being of all individuals. In other words, the verbal whole of individual consciousness is socially determined through individual participation in social speech utterance, and consequently individual participation is socially determined:

> Thus the personality of the speaker, taken from within, so to speak, turns out to be wholly a product of social interrelations. Not only its outward expression but also its inner experience are social territory (Vološinov, 1973, p90).

For Vološinov, individual utterance is not an expression of a speaker's inner psychological world, it is wholly a product of social interaction:

> The structure of the utterance and of the very experience being expressed is a *social structure*. The stylistic shaping of an utterance is shaping of a social kind, and the very verbal steam of utterances, which is what the reality of language actually amounts to, is a social stream. Each drop of that stream is social and the entire dynamics of its generation are social
> (Vološinov, 1973, p93).

According to Vološinov, it is the reality of speech as verbal interaction in social context that gives utterance meaning, and not the linguistic forms of language per se:

> The actual reality of language-speech is not the abstract system of linguistic forms, not the isolated monologic utterance, and not the psychophysiological act of its implementation, but the social event of verbal interaction implemented in an utterance or utterances (Vološinov, 1973, p94).

It is this social formulational nature of the utterance, and its role in shaping the inner speech of consciousness that led Vološinov to reject an individualistic theory of experience and expression. Vološinov effectively adopts a theory of cultural cognition, where all meaningful expressions are socially constituted and ideologically framed. All meaning is socially formulated and socially appropriated *through* language, not *in* language. The individual is dialogically involved in this interactive process of social construction of meaning through language, and so the individual verbal consciousness is a dialogic construction between an individual and his/her social community:

> Language acquires life and historically evolves precisely here, in concrete verbal communication, and not in the abstract linguistic system of language forms, nor in the individual psyche of speakers (Vološinov, 1973, p95).

For Vološinov, (and Garfinkel 1967), the process of meaning understanding is quite distinct from that of linguistic recognition. Semiotic signals are linguistic fixtures, they may be linguistically recognized, but they do not reflect or refract meaning. To understand the meaning of a signal involves an 'appropriation' of social meaning, where social context has to be taken into consideration, therefore to understand meaning is to be *attuned* to the social situation, not the linguistic form. Meaning is socially formulated, not linguistically formulated, and can only be socially understood, not linguistically understood.

In the case of number words being used or directed towards young children, the numerical meaning of these words are not developed from the words, but developed from the social *'situational use'* of the words. In Vološinov's view, social consciousness (and that would include number consciousness), is verbally developed in social practice, through the contextual usage of particular linguistic forms. Vološinov asserts that the verbal consciousness of speakers is not created by linguistic form nor by language as such, but in the social usage of particular utterances in social context:

> Words are always filled with content and meaning drawn from behaviour or ideology (Vološinov, 1973, p70).

1.11 The Notion of Addressivity

Vološinov recognizes that language-speech and its linguistic forms is inseparable from its ideological or behavioural implementation. It is the social implementation of language as speech which converts the language signal into a speech sign. Vološinov recognizes the *real mode* of language as the real-life practice of *social communication,* and the *real units* of language as *utterance in the stream of speech.*

Vološinov recognizes that meaning, developed within a contextually situated utterance, is not simply a creation of a speaker for no one to hear, there has to be a social other, a listener, someone to understand. There can be no meaning without understanding.

For Vološinov, utterances are dialogical formulations, they are jointly and creatively developed between at least two people, a speaker and a listener. The listener does not understand the meaning of an utterance by recognizing the language form, but instead appropriates and correlates meaning from within the social situation in which the utterance has been formulated:

> In other words, the understander, belonging to the same language community, also is attuned to the linguistic form not as a fixed, self-identical signal, but as a changeable and adaptable sign (Vološinov, 1973, p68).

For Vološinov, inner psychic experience is a personal embodiment of social meaning and it originates and develops from social communicative mediation of the material of outer ideology. Therefore, Vološinov asserts that there is no fundamental qualitative difference between inner and outer experiential expression of meaning. Expression in the form of outer ideological utterance is seen to structure inner psychic experiential expression.

According to Vološinov, utterance is social expression, it is 'constructed between two socially organized persons', a speaker and an addressee. Vološinov recognizes all utterance-expression as being constructed for, and addressed to, a real or imaginary addressee:

> The *word is oriented toward an addressee*, toward *who* that addressee might be (Vološinov, 1973, p85).

Vološinov recognizes that our utterance-expressions filter "through the prism of the concrete social milieu surrounding us", and that the prism opacity is determined by a "certain typical and stabilized *social purview*". It is this social purview that leads Vološinov to assert that our individuality is socially created through the expressive sign utterance of our immediate social group:

> Each person's inner world and thought has its stabilized *social audience* that comprises the environment in which reasons, motives, values, and so on are fashioned. The more cultured a person, the more closely his inner audience will approximate the normal audience of ideological creativity; but, in any case, specific class and specific era are limits that the ideal of addressee cannot go beyond (Vološinov, 1973, p86).

In Vološinov's view, the word is a two sided act, the individual enters into a reciprocal relationship with the surrounding language community through utterance:

> It is determined equally by *whose* word it is and *for whom* it is meant. .... Each and every word expresses the 'one' in relation to the 'other'. I give myself verbal shape from another's point of view, ultimately, from the point of view of the community to which I belong (Vološinov, 1973, p86).

The utterance-word is seen by Vološinov as a social creation, it is only partly an individual creation:

> A word is territory shared by both addresser and addressee, by speaker and his interlocutor (Vološinov, 1973, p86).

This view has also been expressed by Bakhtin (1986).

1.12 The Relationship between Speech Genres and Meaning Consciousness

Bakhtin's philosophy of language also took a course that led to a suggestion that the self is a social product, constituted by the language of others. For Bakhtin, "self" is viewed as a social "relation", and the very capacity to possess consciousness is based on otherness, communicated through utterance.

According to Bakhtin, the construction of an utterance is not determined by linguistic form but rather by the social sphere in which it will be used:

> Two people waiting at a bus stop are very likely not only to discuss the topic of the weather but to do so in utterances shaped by conventions of the genre "talking about the weather" (Clark & Holquist, 1984, p216).

Bakhtin asserts that in any utterance the listener dialogically imagines what the speaker wishes to say, and the listener is also able to determine when an utterance is completed. In other words, conversational participants learn to recognize 'speech patterns', which Bakhtin labels '*speech genres*':

> Utterances and their types, that is, speech genres, are the drive belts from the history of society to the history of language (Bakhtin, 1986, p65).

The unsystematic features of language usage, in terms of varied meanings of words, is resolved, in the view of Bakhtin, by recognizing that actual conversations exist between specific speakers in particular situations. Bakhtin's concept of speech genres suggests that although utterances are always formed for social reasons, utterance meanings is seen to be bound to social context, and since social contexts are seen to be boundless, particular utterances are seen to possess boundless meanings. Bakhtin names this boundlessness of contextual utterance meaning *"heteroglossia"*. Advances in the study of discourse pragmatics, promoted by the insight of Bakhtin (1984;1986), have led researchers to a new appreciation that there are complex levels of organization beyond the sentence and that linguistic signs systematically index features of their linguistic and non-linguistic contexts of use. By virtue of these properties, the process of discourse, rather than words themselves, generates and constitutes meaning (Miller & Hoogstra, 1992).

The 'fine tuning' of utterance meaning is seen to be socially determined, and individually appropriated through generic stylistic use:

> In essence, language, or functional, styles are nothing other than generic styles for certain spheres of human activity and communication. Each sphere has and applies its own genres that correspond to its own specific conditions. There are also particular styles that correspond to these genres. A particular function (scientific, technical, commentarial, business, everyday) and the particular conditions of speech communication specific for each sphere give rise to particular genres, that is, certain relatively stable thematic, compositional, and stylistic types of utterances (Bakhtin, 1986, p64).

Bakhtin criticized linguistic analysts who failed to recognize that the 'whole' living utterance was the proper unit of study. For Bakhtin, dialogue is constituted through "otherness", implying that utterances are always socially constructed. Utterances are seen to embody social meaning, they are not created by individual users, but appropriated from social use for the purpose of further social use:

> Any concrete utterance is a link in the chain of speech communication of a particular sphere. The very boundaries of the utterance are determined by a change of speech subjects. Utterances are not indifferent to one another, and are not self-sufficient; they are aware of and mutually reflect one another. .....
> ..... Every utterance must be regarded as primarily a *response* to preceding utterances of the given sphere (we understand the word 'response' here in the broadest sense). Each utterance refutes, affirms, supplements, and relies upon the others, presupposes them to be known, and somehow takes them into account. ....
> .... Therefore, each kind of utterance is filled with various kinds of responsive reactions to other utterances of the given sphere of speech communication
> (Bakhtin, 1986, p91).

1.13 THE DEVELOPMENT OF MEANING IN THE STREAM OF COMMUNICATION

Marx, Vygotsky, Wittgenstein, Vološinov and Bakhtin all attribute the perceived features of individual consciousness of mind to the linguistic development of mind within an ideologically framed society. They all suggest that meaning is not an individual construction nor a feature of individual mind, but ideologically and socially constructed through language (and socially appropriated through language). It appears that Wittgenstein, Bakhtin/Vološinov, and Vygotsky are all saying that meaning is developed in social communication, and that the individual psyche is a product of that communication in terms of social experiential practice and social response. Therefore, counting practices and the use of number by young children, may be viewed as socially constructed processes and not 'individual' features of mind.

For example, what does the statement, *"Count them"* really mean to a child?

According to Wittgenstein the child must appropriate the meaning from social practice:

> Let the use of words teach you their meaning (1953, p220);
>
> In saying,'When I heard this word, it meant ...... to me' one refers to a *point of time* and to a *way of using the word*" (1953, p175);
>
> Only in the practice of a language can a word have meaning (1978, R41, p344);
>
> And nothing is more wrong-headed than calling meaning a mental activity! (1953, p172).

In Wittgenstein's view, meaning lies in human social activity implementation, in its practice or use, only contextual use gives it social meaning. Learning to count or apply the idea of sequential number is not a mental activity but a contextual social 'using' activity.

Only when a child is able to demonstrate *'in practice'* the social process of counting do we socially accept that the child has appropriated the social meaning of the verbal statement "Count them". Meaning is communicated socially, 'in the stream of life', through the practical contextual use of words and expressions, through rhetorical-responsive social interactional expression. In order for a child to appreciate what the statement, "Count them", means in a particular social encounter the child must pay attention not only to the words of the utterance, but to the subtle sensuous social meaning embedded in the communication and which are contextually dependant. This kind of sensitivity can only be gained from 'within' our social environment, through a multiplicity of social interactional participation. The principle achievement of all verbal and nonverbal communication between people is to socially exchange meaning, but words must be seen as being only tools in the ideological social process of constructing and shaping meaning. Social meanings are contextually dependant, they are like pieces of a social jigsaw puzzle that are fitted together by participants in the co-construction of a conversation. Each and every conversation is unique (Bakhtin), it represents a shared social exchange, and it influences us socio-historically to a greater or lesser extent, directly or indirectly. Such joint conversation is governed by social conversational rules, and these must be adhered to if 'meaning' is to be exchanged (Garfinkel, 1967).

According to Garfinkel, what is being 'talked about' in a conversation can often be far from clear (and this would include counting), and he suggests that it is only through reciprocal rhetorical-responsive exchanges that meaning is negotiated. For Garfinkel, constructive, meaningful conversation can only develop when the interlocutors are all afforded the opportunity in 'making' meaning and in turn reciprocally acknowledge the other's meaning. Only through such shared dialogue, does "the matter talked about" develop. For Garfinkel, 'making sense' from within the flow of oral conversation, and thereby appropriating what is being 'talked about' from 'specifically vague' words, involves the interlocutors in conversational activity and other implicit contextual "seen but unnoticed" background features of everyday uses:

> a complex back-and-forth process of negotiation between speakers and listeners, and between what has already been said and what is currently being said (Garfinkel,1967, p36).

Garfinkel (1967, p40), views conversational meaning as a "developed and developing event" in which meaning becomes "known by both parties from within this development". Consequently, in Garfinkel's view, the development of meaning from conversation does not happen by a process of abstraction of meanings from words, but by "catching the drift of conversation".

Meaning is seen to develop out of the process of conversation where the participants negotiate intentional meaning through socially accepted, familiar, intimate and contextual word usages. Conversational meaning is seen by Garfinkel as an interpsychological development, not a personal abstraction from socially assigned meanings of words. Garfinkel's view of conversational meaning is very much in line with the ideas of Wittgenstein. For according to Wittgenstein, conversational participants *use* words as a means of socially making meaning, and the meaning lies in their use, not in their sound.

1.14 THE RHETORICAL-RESPONSIVE DEVELOPMENT OF MIND

For Bakhtin/Vološinov, 'understanding' is bound-up with the relationship between *'theme'* and *'meaning'*. According to Bakhtin/Vološinov, genuine understanding is "active understanding" and this involves individual response, a grasping of 'theme':

> To understand another person's utterance means to orient oneself with respect to it, to find the proper place for it in the corresponding context (Vološinov, 1973, p102).

Theme represents the social historical element of understanding, whereas *meaning* is situational, encompassing the individual active, responsive element:

> Any true understanding is dialogic in nature (Vološinov, 1973, p102);
>
> From the very beginning, the speaker expects a response from them, an active responsive understanding. The entire utterance is constructed, as it were, in anticipation of encountering this response (Bakhtin, 1986, p94).

Thus, for Bakhtin/Vološinov, the elements of "theme" and "meaning" are interrelated in an *"active"* and *"responsive"* social context during all generative processes related to 'understanding'.

Expanding on the views of Wittgenstein, Bakhtin/Vološinov, and others, Shotter (1993), has outlined a *rhetorical-responsive* conception of the 'development of mind', and it satisfactorily accommodates the interpsychological nature of mind as expressed by the ideas of Vygotsky.

Shotter's rhetorical-responsive 'development of mind' recognizes the unique and 'social developmental' nature of conversational dialogue in relation to 'mind' development as:

> The move from a referential-representational view of language to a rhetorical -responsive view, entails also the move from a decontextualized concern with a theoretically-explanatory 'psychology of mind', to a "situated" concern with a practical-descriptive 'psychology of socio-moral relations' ....
> .... For 'mind' as such, ceases to be something to be explained, and becomes instead a rhetorical device, something we talk of at various different times for various different purposes (Shotter, 1993, p28-29).

Like Bakhtin/Vološinov, Shotter (1993), points out that our daily lives are 'rooted' in oral conversational encounters, and by implication, so are our 'minds'. This social interactive 'rooting', through conversational participation, is seen by Shotter as the means by which we develop our *"common sense"*.

According to Shotter, this social rooting is also the means by which ethical sensibility is regulated to prevent an 'anything goes' chaos (Garfinkel, 1967). For Shotter, the roots or foundations of our actions are to be found within our ordinary everyday conversational activities, and not within certain, predetermined structures of mind. According to Shotter, it is from such conversational activities that human ideas develop, not from 'the mind'. Conversational activities are seen to be both the initiator and the product of all our social constructions:

> The rhetorical-responsive social constructivist stance I shall take then, marks a radical departure from the 'analytic' aims of the Enlightenment: the dream of discovering the 'real', already existing, orderly principles underlying our behaviour, either in the 'minds' of individuals, or, in the 'rules' regulating a systematic, social order (Shotter, 1993, p30).

Shotter echoes Vygotsky, in suggesting that attempts to explain language and thought in ways which divorce them from their social origins confuses and distorts our views of how we learn to think, and how we learn to speak, - and hence how we learn to use numerical terminology. For Shotter, like Wittgenstein, conversational dialogue is a means, an instrument, a tool, it is seen to socially determine its users into ways of thinking, ways of living. According to Shotter, human individuals are socially engineered, or socially constructed, in thought, through talk; and this point is also made by Vygotsky (1986, p218) in his statement, "Thought is not merely expressed in words; it comes into existence through them".

In Shotter's social constructivist, functional view of language, the conversational and other communicative exchanges in which children become engaged, 'roots' and 'socially regulates' their learning. Such 'learning' is seen to exist only to the extent that it represents meaning, defined socially, and developed interpsychologically within a conversation. For Shotter, the social 'tradition of argumentation' brings into existence, through the usage of words, a certain form of human being, and in the words of Wittgenstein, "to imagine a language is to imagine a form of life" (Wittgenstein, 1953, p8, R19). In Shotter's view, it is only through our use of words to develop conversational reality that we humans sustain and manage our social reality.

Like Vygotsky, Wittgenstein, Bakhtin/Vološinov, Shotter suggests that language is central to the process of cognition. For all of them, psychological cognition is a socially developed phenomenon, rhetorically-responsively shaped and structured through language.

The aim of the research in this thesis will be to investigate how a historically developed cultural system of number may be rhetorically-responsively developed, through socially mediated numerical language, to become an appropriated feature of individual cognitive consciousness.

1.15 CHAPTER SUMMARY

Working from within a Marxist ideological framework, Vygotsky (1978;1986), emphasised that the psychological development of the child is primarily social and that it takes place within a socially developed and developing culture. Vygotsky believed that the child's higher mental development evolved through mediated interaction with the sign systems of a culture, especially speech activity. Vygotsky (1986) argued that the psychological regulative function of speech manifests itself through children's dialogues with adults. For Vološinov (1973) and Bakhtin (1984;1986), speech activity, included all the various nuances associated with utterance, not just words. And for Wittgenstein (1953) speech activity embodied meaning in use, not in word.

Vygotsky's view of the social origins of higher mental functions, together with Vološinov/Bakhtin's dialogic view of the social generation of meaningful speech genres through utterance, and Wittgenstein's view of linguistic meaning as a social development derived from practical use, all point towards a theory of cultural cognition.

According to Marx, Vygotsky, Wittgenstein, Vološinov and Bakhtin, all 'individual' features of mind are social products in the sense that ideological activity, language and thought, constitute the building blocks of mind, and are mediated by the social language of others.

A theory of Cultural Cognition would suggest that young children's appropriation and use of number is influenced by the social communication of number to young children. The attributes of a theory of Cultural Cognition for number appropriation and use may be stated as follows:

1. Number appropriation is an historical development linked to dialogic social mediation. There is no absolute division between the individual number psyche and social number use.
2. Numerical consciousness is reflected and refracted through social number use. It develops through an individual embodiment of linguistic sign.
3. Numerical utterance is a purely sociological structure, possessing both contextual social theme as well as socially determined technical meaning.

CHAPTER 2

THE MEDIATIONAL FRAMEWORK

2.1 RHETORICAL-RESPONSIVE SOCIAL CONSTRUCTIVISM

> To see culture, to make the invisible visible, we have to examine the role language plays in its workings (Schieffelin, 1990, p249).

In this interpsychological research study, there is a realisation that it is important to provide a descriptive account of the interactional processes that are deemed to mediate cognitive development. These interactional processes are part of sociocultural order, they are contextually situated and linguistically structured. Socially motivated cognitive appropriation is acknowledged to be socially co-constructed and mediated semiotically through language (Vološinov, 1973).

During the process of conversational exchange the participating interlocutors become 'locked' in meaning, so that when a 'speaker' rhetorically constructs situational meaning, the construction is for an 'addressee', and that 'addressee' acts responsively towards that construction of meaning:

> Thus the rhetorical-responsive version of social constructivism proposed here is not only directed towards an understanding of how we constitute (make) and reconstitute (remake) that common sense, or ethos, but also towards how we make and remake ourselves in the process. It is this dialectical emphasis upon *both* our making of, *and* being made by, our own social realities, that is, I think, common to social constructivism in all its versions
> (Shotter, 1993, p34).

In Shotter's view our cultural knowledge is not primarily derived from a "person-world, referential-representational, dimensions of interaction", but emanates from a socially derived secondary source, "emerging out of the everyday, conversational background to our lives" (Shotter, 1993, p8). At the heart of this social-conversational dimension of interaction, lies the assertion that the conversational reality of our cultural knowledge is no more than a rhetorical-responsive construction. By altering and redirecting the social conversation of psychology, Shotter (1993, p9), believes that it is possible to release psychology from its 'colonization':

> My aim .... is to try to release psychology from its 'colonization' by an ahistorical, asocial, instrumental, individualistic 'cognitivism'

According to Shotter, our social conversational reality can be accounted for by using 'verbal resources' such as, "joint action; knowing of the third kind ('from within conversational situations'); rational-invisibility and illusions of discourse; the 'sensuous' nature of responsive forms of talk; our ways of talking (genres) as formulative forms etc". For Shotter these verbal resources act as "conceptual prosthetics", they support our mental sense, and "this undermines (enlightenment inspired) systematic, unsituated or decontextualized approaches to the study of 'mind' " (Shotter, 1993, p11).

In Shotter's view, conversational realities are dialogical products of argumentation, they constitute a common sense and act as a practical resource, a tool to be used, in the continuous process of human cultural development:

> As I see it, there are no pre-established orders of things in the world; what orders there are, are humanly constructed and sustained ones;
> .....In rejecting realism, I reject the idea that there are discoverable, indisputable 'foundations', or 'standards', or 'limits' in terms of which claims to truth can be judged (Shotter, 1993, p12-13).

In Shotter's social constructivist world (constituted through conversational reality) the development of cultural knowledge is not just a matter of prediction and control, but a matter of how those embedded within it are rhetorically-responsively involved in producing it:

> It is not theoretical knowledge (a 'knowing-that' in Ryle's (1949) terminology) for it is joint knowledge, knowledge-held-in-common with others. It is a third kind of knowledge, *sui generis,* that cannot be reduced to either of the other two, the kind of knowledge one has *from within* a situation, a group, social institution, or society; it is what we might call a 'knowing from'. Bernstein (1983) has called it 'practical-moral knowledge' (Shotter, 1993, p19).

Like Wittgenstein, Shotter rejects outright the referential-representational view of language, "as a systematic object of thought, structured as if according to rules". And like Vološinov, Shotter's interest lies in, "the contested activity of words in their speaking", not in "already spoken words" (Vološinov, 1973). According to Vološinov it is in the pragmatic use of words as tools to form and shape dialogue that enables meaning to be rhetorically-responsively negotiated and realized:

> The word is a two-sided act. It is determined equally by *whose* word it is and *for whom* it is meant. ....it is precisely the product of the reciprocal relationship between speaker and listener, addresser and addressee. Each and every word expresses the 'one' in relation to the 'other'. I give myself verbal shape from another's point of view, ultimately, from the point of view of the community to which I belong (Vološinov, 1973, p86);

This social-constructivist rhetorical-responsive view of cognition must be seen to apply even in the realm of developing numerical practices.

In my research, I shall be giving account of the everyday processes of spontaneous, responsive, pragmatic, verbal interactions through which society mediates aspects of number to young children.

The theory behind this social constructivist thesis gains support from the views of Shotter, since, from Shotter's writings it can be argued that, young children may be *'talked into'* the supposed reality of numbers.
And, from the work of Rogoff and Gardner (1984), it has been suggested that the cognitive development of number is socially situated and socially mediated by adults:

> In order to understand cognitive development, it is necessary to consider the everyday contexts in which children are provided guidance by adults in approaching and solving novel problems. Illustrations of mother-child instruction support the idea that adults assist children with new problems by guiding the transfer of knowledge and skills from more familiar contexts, thereby guiding the child in making connections
> (Rogoff & Gardner, 1984, p115).

Over the decades there has been a steadily growing body of research (Clarke-Stewart 1973; Elardo et al 1975; Gauvin & Rogoff, 1989; Rogoff, 1990; Rogoff et al, 1993) which demonstrates that interactive social and linguistic associations between young children and adults influences the rate of cognitive or mental development of the child.

2.2 Mathematical Cognitive Development through Social Mediation

Vygotsky's (1978;1986) has argued that it is the social interactive activity of human beings that represents culture and it is social communication that determines cultural meaning. Vygotsky interpreted intrapsychological functioning as a social ↔ individual dialectic of cultural inter ↔ intra psychological functioning. Here, intrapsychological functioning is being interpreted as a mediated appropriation of cultural interpsychological functioning. Mediation is being recognized as a socialization process involving linguistic activity, and this includes self-regulated activity as well as social-regulated activity. Social mediation is directly linked to forms of social activity, and so without some form of language activity the mediation of cultural meaning would not take place. Consequently, language must be viewed as a fundamental axiom of social mediation, representing shared communication through social ↔ individual interaction.

For Vygotsky, individual human cognition is shaped by social interactive processes, ie. intrapsychological functioning is developed from society, from cultural interpsychological functioning. Vygotsky's position is based on the premise that shared cultural meaning involves linguistic communication, and language is fundamentally a dynamic social construction. Learning through social interaction is interpreted by Vygotsky as being caused by the raising of an individual's level of awareness to a point of conscious sensitivity to interpsychological thought (Vygotsky, 1986, p168). According to Vygotsky (1986, p186), social instruction influences and leads cognitive development. Instruction may be considered to be a form of social mediation, it is after all an interlocutory dialectical psychological process.

individual perception of mathematical knowledge (intrapsychological thought)	↔	shared communication interactive emotion motivation interest	↔	the social construction of mathematical knowledge (interpsychological meaning)

The diagram above may represent an interactive social constructivist framework for mathematical cognitive development, where the proportions formed on either side depend upon the shared communication, emotion and motive. Using this model. shared communication could be interpreted as the factor that mediates the development individual meaning or expands social cognition. Either gives rise to a social interactive interpretation of mathematical cognitive development. Without any shared communication there would be no relationship between individual mathematical knowledge and the cultural construction of mathematics. A certain minimum quantity of social interaction and shared mathematical communication must be present before any individual mathematical knowledge could be socially recognizable. If mathematical knowledge is viewed as a form of interpsychological cultural functioning, then its socially regulated meanings must be interactively communicated to children before such mathematical thought can be expected to become a personal intrapsychological function. Language is seen as the medium of interpsychological functioning, consequently, mathematical language must be shared with children if they are to develop mathematical knowledge through a rhetorical-responsive social process. A child's growth in language is accompanied by a growth in shared interpsychological functioning and cultural integration. Physical and social experience gives rise to children's questions, and they are always answered from a cultural perspective. Even when children are limited in language and unable to ask questions, sensitive adults will often ask the culturally important questions for the child and supply the culturally acceptable answers. This would imply that individual development may be influenced by social communicative interaction.

Young children may be able to see differences in size, shape, quantity, time, direction etc., but they may not be aware of the cultural significance of these differences until social interaction communicates the 'cultural sense' of these differences through language. Individual experience cannot develop or give rise to 'cultural sense' because such 'sense' is embedded in cultural meaning not individual meaning, consequently cultural meaning must be socially communicated. It may be hypothesized that young children will only develop the socially accepted form of 'sense' if they appropriate ' cultural sense' through language. In this regard, a child's cognitive development may be viewed as always being culturally interpreted and related to measures of social 'sense' developed through interactive communication.

Such a social $\leftrightarrow$ individual analysis would suggests that individual mathematical development is linked to the social communication of cultural mathematical ideas and meanings through language. In other words, children may appropriate cultural mathematical ideas and meanings only through socially mediated oral and written language. If children are to become party to social mathematical discourse, it is essential that mathematical language use and symbolism, be mediated in practice by society to children.

Vygotsky has drawn attention to the effect that writing has had upon human cultural development:

> We need only try to imagine the enormous changes in the cultural development of children that occur as a result of mastery of written language and the ability to read - and of thus becoming aware of everything that human genius has created in the realm of the written word (Vygotsky, 1978, p116).

Vygotsky's perception that written symbolism should be distinguished from spoken language can also be applied to mathematics. Interpsychological mathematical thought may be separated into pre-literate communication, mainly verbal labelling, and post-literate symbolic representation. The everyday social practice of mathematics, pragmatic mathematics, is confined to a large extent, to pre-literate mathematics (concepts that can be expressed in language), and pre-literate mathematical discourse, such as number assignation and counting, is often within the grasp of most pre-school children (in the same way that linguistic description and labelling is). The written symbolism of mathematics is taught mainly at school, and this makes mathematics more readily contextualized as a school subject, maybe more so than writing.

Learning the rules and language of mathematics may be viewed as a socio-cultural construction of the individual. Applying mathematics to solve a problem requires individual use of socially developed mathematical knowledge, and consequently, an interrelationship could be expected to exist between individual mathematical performance and the social-individual co-construction of mathematical knowledge.

It has been argued elsewhere that the social-individual interrelationship is *'hot'*. Where the shared mathematical communication involves more than the mediation of meaning:

> Our exploratory research points to a few general conclusions. One is that, at least in the case of individual's suffering from learning difficulties, mathematical thinking is clearly 'hot': it is bound up with emotions, beliefs, styles, motives, and identity (Ginsburg & Asmussen, 1988, p107).

In other words, the social construction of individual mathematical knowledge must take account of the shared communication developed in the context of human emotion and motive. It is also through shared communication involving emotion and motive that social mathematical constructions, interpretations and syntheses contribute to the ever expanding social construction of mathematical knowledge. Emotion, interest and motivation need not necessarily be interpreted as individual attributes either, since social interaction may be viewed as being responsible for promoting these individual developments, for example:

a child who observes another child playing with a toy may develop a certain amount of motivational interest, and may decide to try the toy out by grabbing, or picking the toy up after it has been put down. The length of time that the toy is played with often depends upon external interest shown in it, by other children or an adult. If an adult assists a child in its play *with a toy, then that toy is often long lasting - unless the* adult is too possessive with the 'assistance' the child becomes an observer (later, the child may be seen playing with the toy alone).

Emotion, interest and motivation in mathematics may also be socially appropriated from others in an imitative responsive manner, and so be seen to originate not from within individuals, but from others. In the case of mathematics Fuson (1991) writes:

> Children can be best prepared for school maths by having preschool teachers, parents and caretakers who help children take joy and pride in their noticing and labelling numerical aspects of their environment and in their learning of the number sequence and who facilitate children's enthusiastic counting of all sorts of things in many different situations (Fuson, 1991, p35).

Social interaction is undeniably responsible for communicatively mediating any social development of numerical cognition.

2.3 Vygotsky's Zone of Proximal Development (ZPD)

The social interactive minimum in the eyes of Vygotsky is *imitation*:

> Children can imitate a variety of actions that go well beyond the limits of their own capabilities. Using imitation, children are capable of doing much more in collective activity or under the guidance of adults (Vygotsky, 1978, p88).

Imitation does not depend upon language construction or interpretation, and from this point of view it can be considered to be a very effective form of human communication in the context of social interaction. Baldwin (1894), recognised imitation as the principle means by which knowledge is socially disseminated. Baldwin (1913), sensed the individual's active contribution in the imitation process by particularising (constructing?) social generalizations. Under these conditions, certain aspects of Piaget's theory of individual cognitive development could be understood in terms of individual reciprocal interaction with social cognition. In building up a picture of learning through social interaction, Clementson-Mohr (1982), recognizes imitation as a cornerstone:

> When imitation, its development, and precise relationship to the tutoring process are well understood, psychology will have taken a giant step towards a comprehensive explanation of mind and its relation to culture
> (Clementson-Mohr, 1982, p71).

According to Clementson-Mohr, the contribution of imitation in the context of learning through social interaction is worthy of serious naturalistic investigation.
When very young children first begin to count using number words they are possibly imitating an observed social practice, and according to Vygotsky, individual cognitive development is one of shared meaning achieved through social interaction:

> In the child's development...., imitation and instruction play a major role
> (Vygotsky, 1986, p188).

Related to imitation and instruction is Vygotsky's Zone of Proximal Development. The idea of a Zone of Proximal Development was coined by Vygotsky (1978, p86) to account for observed differences between children's lone and adult assisted achievements during problem solving performances.
This gives rise to the notion of learning as being a dynamic socializational process

within a cultural framework (Tharp, & Gallimore, 1988, p58).
The zone of proximal development may be thought of as the quantity of social interaction or communication required to effect individual intrapsychological functioning from social interpsychological functioning.

intrapsychological functioning ——— ZPD ——— interpsychological functioning

Vygotsky's ZPD can be considered to be a measure of an individual's sensitivity to conceptual communication through social interaction, effectively, the ZPD is the gap between interpsychological and intrapsychological functioning:. In this respect the ZPD is related to learning, and Vygotsky (1978, p90) acknowledges this by stating, "an essential feature of learning is that it creates the zone of proximal development".
The differences in children's achievements may be partly explained by the differences in interaction and mediational input. The lone problem solver is entirely dependent upon being able to self mediate previously appropriated socially regulated knowledge, whereas the adult assisted problem solver's performance receives additional social regulation in the form of interactive mediation.
Although Vygotsky (1978, p86; 1986, p187) appeared to consider his postulate of a zone of proximal development as being the difference between assisted and unassisted mental competence, this is an oversimplification. Zones of proximal development are not static, they are constantly changing in response to social dialogic interaction in the "process of living". Zones of proximal development are not attributes of an individual's past or present mental state, zones are instantaneously formed within social discursive activity. Vygotsky's Zone may be thought of as a measure of adult sensitivity to a child's mediative practices of cultural appropriation. In every day situations of real life, and for the young child that includes play, socialization actions and activity enable a subtle appropriation of social and cultural values.
Newman, Griffin and Cole (1989) conducted a study of how school children's cognitive processes change as they interact with teachers and other pupils. For

Newman et al, the social context of assisted performance involves *"activity settings"*, contexts in which collaborative interaction, intersubjectivity and assisted performance take place. Newman et al have put forward the idea of a *"Construction Zone"* by merging Vygotsky's ZPD with Leontiev's (1981) concept of appropriation.

The Construction Zone is a Neo-Vygotskian perspective of cognition, being viewed as a function of culture. In order to explain cognitive development, the CZ takes into consideration the social context of human interaction, it does not focus exclusively on the psychological aspect of adult-child interaction, since this would distort the "social reality" of human life. According to Newman et al, children and adults become dialogically involved psychologically within social contexts:

> Taking the context seriously means treating the ZPD as more than a psychological phenomenon. For a ZPD to be created, there must be a joint activity that creates a context for teacher and student interaction
> (Newman, D., Griffin, P. & Cole, M. 1989, p71).

This Neo-Vygotskian perspective of Newman et al tends to interpret learning in a CZ as a cognitive change that is socially developed within activity settings, a developmental product of contextual joint activity. This Neo-Vygotskian perspective has been recognized by Newman, F. & Holzman, L. (1993) as a distortion of Vygotsky's radical perspective on the relationship between learning and development through interactional activity.

For Vygotsky, all perceived reality is interpreted within a socially regulated reality, and the social interpretation of cultural activity was learning. Orthodox Vygotskians such as Newman, F. & Holzman, L. (1993), recognize *"mediated activity"* as the learning that leads and promotes cognitive development (an internalization of social reality). Neo-Vygotskian perspectives, such as Newman et al, fail to emphasise the importance of the "mediated activity", and many others focus on the contextual 'activity setting' as a developmental influence:

> For any domain of skill, a ZPD can be created .... Boys in Micronesia, where sailing a canoe is a fundamental skill, will have a ZPD for the skills of navigation, created in interaction with the sailing masters
> (Tharp & Gallimore, 1988, p31).

For the Neo-Vygotskians learning appears to be viewed as a developmental product of social communicative interaction in contextual situations. Neo-Vygotskians such as Tharp & Gallimore, and D. Newman., Griffin & Cole have extended, and in the process deviated from Vygotsky's original insight into the cultural development of higher mental processes.

For orthodox Vygotskians the social context is not the significant factor, it is the unity of the historical interaction between *social mediation* and subsequent *social appropriation* of cognitive processes that forms and shapes a pattern of cognitive development. Vygotsky writes:

> ...our own approach focuses on this interaction (Vygotsky, 1986, p207).

Vygotsky was not so much interested in the developmental product, cultural cognition or higher mental functioning, but in the *social psychological processes*, the social activity, that historically predated and led cognitive development.

The social environment or culture may appear as a 'generator' of development to neo-Vygotskians, but in reality this only provides a context for development. For Vygotsky, the intrinsic power which drove the cognitive generator was social linguistic activity.

For orthodox Vygotskians, it is the power of social interaction which sets in motion the, "dynamics of intellectual progress" (Vygotsky, 1986, p187), and not the social contextual situation. The Vygotskian causal explanation for the development of a cultural skill is social, not contextual.

My intention here has been to re-emphasise Vygotsky's views on the direction of cognitive development, which is from the social to the individual through the dynamics of dialogic communication, *mediation*.

Vygotsky recognized an interactive dialectical relationship between learning and cultural cognitive development, with learning being appropriated through social situations, and discourse leading development. In this respect, Vygotsky's simple measurement of a ZPD, is misleading:

> The discrepancy between a child's actual mental age and the level he reaches in solving problems with assistance indicates the zone of his proximal development; in our example this zone is four for the first child and one for the second. Can we truly say that their mental development is the same?
> (Vygotsky, 1986, p187).

The answer to Vygotsky's question is irrelevant, since the question is logically insecure in the first instance. The perceived inequality of their mental development with assistance is based upon a measurement that Vygotsky does not accept in the first place as a true measurement.

	_____ mental age with assistance(12)
_____ mental age with assistance(9)	↑
↑	ZPD (4)
ZPD (1)	↓
_ ↓___ mental age(8)	______ mental age(8)

Vygotsky's crude measurement of a ZPD has an invalid base measurement, 'mental age', by his own admission. Vygotsky recognized it as an invalid measurement, and he even argued against using mental age:

> This measure (ZPD) gives a more helpful clue than mental age does to the dynamics of intellectual progress (Vygotsky, 1986, p187).

Vygotsky's measurement of a child's ZPD, to emphasize the difference between that child's mental age and mental accomplishment with external assistance, is inconsistent with his own theoretical considerations of socio-cultural development. In Vygotskian theory there should be no talk of mental age, only a measurement of socio-historical cultural participation. Vygotsky's definition and explanation of measurements of a ZPD appear to be distorted within his own socio-historical theory of cognitive development, but the nature of the explanation may be understood to illustrate his argument against maturational theories of cognitive development:

> Studying child thought apart from the influence of instruction, as Piaget did, excludes a very important source of change and bars the researcher from posing the question of the interaction of development and instruction peculiar to each age level (Vygotsky, 1986, p207).

Vygotsky's socio-historical foundation of a ZPD is based upon an observation that learning is both socially mediated and individually appropriated. Theoretically, Vygotsky's ZPD is a two dimensional intangible measurement of social-individual interaction, and it should only be recognized by the rate at which socially mediated learning influences and leads individual cultural cognitive development. The ZPD may be viewed as a socio-historical interactive communicative gap, a cultural cognitive gap, which can be represented by the *"dynamics of intellectual progress"*, but it cannot be represented in only one dimension, it is a social-individual dialectic. The ZPD is not just an individual cognitive attribute.

No arbitrary measurement label can be attached to a social-individual dialectical function such as a person's ZPD, since its twin components interact to influence each other. Under these circumstances, individual zones of proximal development cannot be compared relatively with one another to explain differences in rates of cultural cognitive development. The explanations for the differences in cognitive development rates lie in a separate comparisons of the *socio-historical* and *mediative* ZPD components, and in recognizing their interactive relationship.

Brown & Ferrara (1985), compared Zones of Proximal Development in their experimental studies on the dynamics of teaching potential by measuring the quantity of prompts given to aid a child to solve a series of related problems:

> The assessment of the width of a child's zone of proximal development empirically translates into the assessment of how many prompts she needs to solve problem 1, versus problem 2, versus problem 3, and so on (ie. how quickly she learns and how far she transfers). A child judged to have a wide zone of proximal development is one who reduces the number of prompts needed from trial to trial, that is, who shows effective transfer of a new solution across similar problems (Brown & Ferrara, 1985 p284).

The progressive measurements of prompts enabled Brown & Ferrara to use an assessment of a mediative component of the ZPD to probe the socio-historical component. However, the total socio-historical component can never be completely assessed, since it is the sum total of all previous socially mediated activity.

In this thesis I suggest that young children's numerical competence is a socio-historical development where numerical meaning is structured by the effect of social linguistic mediation and determined by the quantity and quality rates of social numerical use related to numerical interaction.

2.4 QUASI DIALOGIC PRACTICES

Vygotsky (1978) defines learning as an internalization of meaningful societal process, regulated through language and socially developed in a zone of proximal development. In this Vygotskian model, individual cognitive development is seen to be a function of social interaction, where social knowledge and practices are socially regulated in the individual through language. Vygotsky (1986) considered language to be as important as activity, in the transformation of social processes into psychological processes. Both language and activity are seen as forms of social functioning, only qualitatively different.

According to Vygotsky, speech that accompanies action regulates action, even egocentric speech. According to Vygotskian theory, language is a powerful mediational tool, it is used to regulate social interaction, and it can determine the nature of the interaction as well as the roles adopted by the interlocutors. Young children unable to solve a problem, or achieve a goal on their own, often direct their speech to a more competent peer or adult to attain the solution ('tool use' of language). In time, the need for the 'other person' becomes less, and the child can deal with the problem and its solution on an intrapersonal level, using internalized self-regulated speech. Such interpersonal interaction, through language use, is also seen to structure the process of self-regulation, which eventually leads to individual intrapersonal functioning (the individual psyche derived from the social psyche).

Vygotsky argues that development lags behind learning, and that children can carry out cognitive tasks in interaction, through language use, that otherwise they could not accomplish independently.

Research into the functioning of Vygotsky's theory of mental development, as quasi dialogical practice, regulated by language use, that progresses from the social to the individual, has usually focused on problem solving. This is not my aim, but it is worth noting the results of such previous research. For example, in a study by Wertsch et al (1980), mother-child pairs (in which the children were 2½, 3½, and 4½ years old) were asked to complete a jigsaw puzzle, and they were provided with a model.

In Wertsch et al.'s interpretation of the dyad behaviour, when the younger children looked at the model (regardless of whether this behaviour was self- or other-regulated), the mothers' appeared to presume that the young children were unable to extract the relevant information from the model, or were unable to put extracted information to use in their puzzle construction, hence the mothers intervened appropriately (linguistically or through action). Older children, however, were presumed by their mother's to have perfected, and self-regulated, certain social-regulated 'interpretive skills' and were given some leeway to act independently and insert the relevant puzzle piece in the correct location. Wertsch et al (1980) concluded from their study that, in the process of joining jigsaw puzzle pieces together, the regulatory practice of visually checking from a model, was taken over by the children from their mothers as they became aware of the functional significance of the activity.

Cooper (1980) and Cooper et al (1982) examined the communicative behaviours of young children (aged between 3½ and 4½ years) who were engaged in mutual problem-solving activities. They found a developmental trend of better interactional skills with older children, they being more successful, more efficient, and more effective in their use of language, especially when focusing attention by showing and pointing, and in giving and interpreting linguistic information. In their observational study, Cooper et al (1982, p186) noted that:

> Peer learning occurs in the context of a network of social or friendship relations. How much contact children have, and the nature of these contacts, will provide the context within which peer learning will develop

Recent investigations of learning by Rogoff (1991) challenge the idea of abstract cognitive functioning, the separating of what is learned from how it is learned through language and use in social context. The social activity, including the language, in which knowledge is developed and deployed, is acknowledged to be an integral part of what is learned. Learning and cognition are fundamentally socially situated and socially shared through language, social situations are co-produced through dialogue (Rogoff et al, 1993; Lave & Wenger, 1992; Rogoff, 1991; Lave, 1988b; Mertinez, 1987; Rogoff & Wertsch, 1984).

Learning to participate in dialogue appears to be fundamental to the process of appropriating knowledge and becoming an integrated family and cultural member.

It has been argued elsewhere that it is within the context of dialogue, assisted by a regulatory parental role in an apprenticeship relationship, that children learn conversational and linguistic skills along with the social development of mind that is already entrenched in the cultural minds of adults (Bain, 1983; Kaye, 1982; Kaye & Charney, 1981; Bruner, 1975).

Brown et al (1989) suggest that the contextual situation of social activity is part of human cognition and learning, stating that:

> We suggest that, by ignoring the situated nature of cognition, education defeats its own goal of providing useable, robust knowledge. And conversely, we argue that approaches such as *cognitive apprenticeship* (Collins, Brown, & Newman, 1989) that embed learning in activity and make deliberate use of the social and physical context are more in line with the understanding of learning and cognition that is emerging from research (Brown et al, 1989, p32).

A recent study by Rogoff et al (1993), demonstrates how children socially participate in adult activities, and learn from their participation, through a combination of observation and instruction, that is managed by adults. The results of Rogoff et al's (1993) world-wide cultural studies of adult-child participation in social activities establishes important commonalities and differences in the processes of guided participation in varying cultural communities. The differences were culturally embedded, and mainly affected the goals set for development and the nature of involvement between children and adults, but there was a thread of commonality in terms of the interdependence of children and adults during instructional interaction. Rogoff et al (1993, p150) state that:

> The interdependence of children and their social partners in valued and routine cultural activities may account for children's rapid development as participants in the practices and understandings of their community, whether this involves learning to weave or to read, to tend livestock or young children, or to do schoolwork.

Cognitive apprenticeship methods (Collins, Brown, & Newman, 1989) attempt to account for children's developing cognitive enculturation through the activity and social interaction of everyday learning practices, in a similar way to the skill development of craft apprenticeship.

Interactive cognitive apprenticeship is accepted by Collins et al (1989) as a natural form of learning. It is seen to characterize learning before there were schools, "from learning one's language to learning how to run an empire" (p491). In distinguishing cognitive apprenticeship from traditional craft apprenticeship, Collins et al emphasise the importance of *generalization in use* to achieve a form of decontextualized knowledge:

> We propose that cognitive apprenticeship should extend situated learning to diverse settings so that students learn how to apply their skills in varied contexts. Moreover, the abstract principles underlying the application of knowledge and skills in different settings should be articulated as fully as possible by the teacher, whenever they arise in different contexts
>
> (Collins et al, 1989, p459).

This thesis advocates that the way in which young children conceptually achieve an understanding of number, is through such an enculturational process, *a numerical apprenticeship*, where the cultural tool of number must be used, 'acting together in social context', to socially bind young children to the linguistic (utterance) use of number.

CHAPTER 3

A CULTURAL VIEW OF NUMERICAL THOUGHT RELATED TO PREVIOUS RESEARCH ON COUNTING AND NUMBER APPROPRIATION

3.1 NUMERICAL THOUGHT AND LANGUAGE

Cardinal numbers cannot be seen or touched, they have no physical perceptive reality, they are a rhetorical-responsive construction of cultural thought and they do not exist independently of the human mind. Children cannot "see" numbers, consequently, they cannot self-construct a sense of number through physical experiential activity, but must appropriate numerical meaning through a rhetorical-responsive mind enculturation process.

Bully (1990, p46-7) echoes this Wittgenstienian view of number, noting that: "There is certainly a temptation to regard numbers as having a sort of reality independent of us", but "Number seems to me a bit like grammar, since grammar is not part of what it describes and does not itself require to be defined; it is just an idea for describing things, namely words, sentences and so forth, from a particular point of view"; in which case Bully continues, "Number, likewise, is not part of any group of objects, but an idea for talking about them from a certain angle; number, therefore, does not need to be described as having intrinsic characteristics".

Bully suggests that cardinal numbers are a cultural tool akin to grammar, where meaning is socially structured in use. Children are introduced by social others, through mediative practices, into numerical language and figurative or symbolic representations. Children may appropriate number by being placed in situations that enable them to see number from the positions of social others, and assuming the perspective of these social others. In my opinion, children's episodic thought structures of number develops from an explicit association of language and numerical figurative/symbolic representation, not from a tacit creation of units (Von Glasersfeld & Richards, 1983), or counting principles (Gelman & Gallistel, 1978) or even counting activities (Isaacs, 1960).

The culturally transmitted practice of counting involves numerical language usage, and as such, it is a practice that initiates children into the use of a number grammar, and this mediated language may structure number thought through socially regulated responsive feedback. In my opinion, it is not the counting activity that leads the child to appropriate cardinal numerosity, but the associated social mediative language and grammar that regulates numerical thought. Counting out loud promotes interactive numerical communication and the child is able to relate such language to figurative/symbolic representations.

To the young child, cardinal number descriptions are just words, they can be compared to abstract linguistic descriptive words such as "expensive" or "cute". The meaning of words are conveyed to children through contextual social usage, and children imitate this usage (Wittgenstein, 1953, p37). As a result of practice (use), children develop rhetorical-responsive mental models of the meaning of these words because adults mediate their own meaning by correcting or praising the child's usage. For Wittgenstein (1958, p344), "only in the practice of a language can a word have meaning", and by this argument, only in the practice (use) of number language can number develop meaning. Piaget dismisses such learning as being "verbal", but I suggest that all cultural learning (including number) is socially transmitted and therefore verbally transmitted; it is mediated through language, it is constituted by language, and meaning is dependent upon linguistic usage.

A child does not learn to construct an operational structure for eighty-nine by actively counting eighty-nine objects and appropriating physical 'real' knowledge. No, it is the language of number use, or its symbolic representation, that structures meaning, and this is even more evident with cultural word usage such as "dozen", "score" or "gross". Customary *'usage'* gives rise to meaning, and this meaning is associated with the grammar of number language. Consequently it makes no sense then, to talk about meaning belonging to individual cardinal number words, since these words are just the symbolic expressions of social meaning:

> When I think in language, there aren't "meanings" going through my mind in addition to the verbal expressions: the language is itself the vehicle of thought (Wittgenstein, 1953, p107).

It is not the language per se that conveys the meaning, but meaning is socially encoded in language, and the social code is deciphered through language:

> A child learning his mother tongue is learning how to mean; he is building up a meaning potential in respect of a limited number of functions. These functions constitute the semiotic environment of a very small child, and may be thought of as universals of human culture (Halliday, 1994, p36).

If cardinal numbers are considered to be abstract verbal descriptions, then their meaning to the child (thought), can be expected to change and develop as the child participates in social communication involving number use. Vygotsky (1986), recognises a dynamic relationship between thought and word:

> The relation of thought to word is not a thing but a process, a continual movement back and forth from thought to word and from word to thought .... Thought is not merely expressed in words; it comes into existence through them (Vygotsky, 1986, p218).

This dynamic relationship of word and meaning constitutes linguistic development and, in the eyes of Vygotsky, this is related to a cognitive development. Words such as "furniture" represent a higher level of generalization than "chair". It could be hypothesised that if linguistic development is considered to be less to do with individual attributes and more to do with social interactive experience (SIE), then any episodic model of number appropriation, based upon verbal mediation, may be related to individual SIE.

SIE is defined here as being discursive situations that involve children in contextual activities which are socially regulated through linguistic communication. From a Vygotskian perspective on the development of linguistic meaning, the child may initially possess an undifferentiated meaningful complex in regard to the verbal usage of cardinal numbers, and that through SIE, cardinal number usage may become personally meaningful.

Vygotsky (1986, p218), distinguishes between two planes of language, the inner (meaningful) and the external (phonetic). Vygotsky hypothesised that thought and word have separate roots in these separate planes, and that from these thought and word unite, developing dialectically from opposing directions:

Meaningful Plane		SIE		Phonetic Plane
	⟷	unification of	⟷	
Inner thought		thought & word		external language

From an external phonetic plane (a social plane), the child's inner subjective meanings (an intrapsychological plane), are dynamically regulated through SIE.

If number words are treated as linguistic descriptions which grammatically represent socially defined meaning, then these same two planes may be used to account for a dialectical development of cardinal number understanding in the child. The process that leads the child to develop cardinal number understanding may be the same as the process that leads the child to all other linguistic understandings, namely "use" (Wittgenstein, 1953, p53-54).

For Vygotsky, the development of linguistic meaning involves a bidirectional interpsychological process:

> In mastering external speech, the child starts from one word, then connects two or three words; a little later, he advances from simple sentences to more complicated ones, and finally to coherent speech made up of series of such sentences; in other words, he proceeds from a part to the whole ...... semantically, the child starts from the whole, from a meaningful complex, and only later begins to matter the separate semantic units, the meanings of words, and to divide his formerly undifferentiated thought into these units
>
> (Vygotsky, 1986, p218-9).

If this paradigm is considered as a developmental framework applicable to the development of children's cardinal number appropriations, then it should be possible to observe adults verbally regulating children's use of cardinal number words, and later observe the children progress towards self-regulation of meaning through usage. It may also be possible to observe the development of a sense of numerical grammar in children's usage, this would be expected as a result of generalization, "from a part to the whole".

What is being suggested is that children develop a verbal sense of number by associating numerical thought with language. In this Vygotskian model, young children may be seen to appropriate cardinal number meaning through an explicit association with language, or as a result of social practices that involve linguistic mediation.

This linguistic view of number, and the process of learning number, challenges the constructivist epistemology of Von Glasersfeld et al (1983), who view the creation of units by 'reflective abstraction' as a prerequisite for number acquisition. The Von Glasersfeld et al position draws support from Euclid, who defines a number as, "a multitude composed of units", (book VII of The Elements), and Piaget (1952, p161) who states, "since a number is an additive union of units".

Despite these powerful 'personal construct' insights, I suggest that young children do not initially appropriate numerical meanings by de- and re-constructing cardinal numbers through unitary compositions, but by relating thought and word through rhetorical-responsive SIE involving numerical mediative practices (and this includes counting).

This is not to say that ostensive definitions of cardinal numbers are adequate, since according to Wittgenstein, (1953, p14), "an ostensive definition can be variously interpreted in every case". Wittgenstein draws our attention to the difficulties associated with ostensive definitions, namely that the, "overall role of the word in language" must be "clear", essentially:

> But this means that the word "number" must be explained before the ostensive definition can be understood (Wittgenstein, 1953, p14).

However, by Wittgenstein's own philosophy, words cannot be explained:

> One cannot guess how a word functions. One has to look at its use and learn from that" (Wittgenstein, 1953, p109).

Heeding this insight, the word "number" cannot be explained to a child, but its meaning must be appropriated by the child through social linguistic usage, and *"the use - the meaning"* can be *"extended in time"*, (Wittgenstein,L. 1953, p53).

This thesis will suggest that it is not abstracted perceptual unitary compositions that give meaning to the number words, neither is it the number words that communicate meaning, but that it is the social usage of number language which regulates meaning. Wittgenstein notes:

> To obey a rule, to make a report, to give an order, to play are customs (uses, institutions).
> To understand a sentence means to understand a language.
> To understand a language means to be master of a technique"
> (Wittgenstein, 1953, p81).

According to Wittgenstein, meaning is linguistically associated with activity, it is mediated by social others in the context of SIE.

I suggest that children's sense of number does not just develop out of a process of 'reflective abstraction" practised in social isolation, but that the child relates numerical language to social use, and that cardinality and other aspects of number develop in children through social usage. Number is seen to be a rhetorical-responsive social construction.

3.2 The cultural Development of Mathematical Cognition

> Long before computers appeared, technical instruments such as a written language expanded human intelligence to a remarkable extent. I take as axiomatic that intelligence is not a quality of the mind alone, but a product of the relation between mental structures and the tools of the intellect provided by the culture (Pea, 1993, p91).

Present day western mathematical thought has been developed by human civilization over a period of many thousands of years, social need and use being the principle propellant:

> mathematics is certainly not independent of culture and society. All societies on which it was grafted in the course of its history have contributed to shape and enrich this common good of mankind. Each of them has left its mark and, by its cultural style, its often specific centers of interest, its forms of social and scientific organization, has set its own imprint on the development of mathematics (Chevallard, 1990, p15).

In a fundamental historical sense, numbers may signify a human labelling of a perceptual 'quality' of reality. Both the Greek and the Hebrew peoples used their alphabets to represent numerals in their counting systems. And in Roman system there is a 'qualitativeness' about number representation, ie. X, L, M, C and a 'quantitativeness' eg. II, III, IX, XII. These ciphered systems produced not only a 'quantitativeness', but represented the 'quality' of perceived reality by the nature of their exact and brief labelling. It is important to recognize this perceptual 'quality' of number as well as any psychological mental development of 'quantitativeness' (Monbill, & Souyung, 1983). It has been suggested by Monbill & Souyung (1983), that people, including young children, initially understand number in a qualitative manner, not in a quantitative sense. Monbill & Souyung conducted experiments to teach young children number through a qualitative approach. They concluded that there was support for the view that the cognitive psychology of number has a qualitative nature and that young children, "should and can learn number qualitatively", noting that:

> The number concept is indeed a hard task because, in the same way as any other mathematical concept, it is the reflection in our own consciousness of certain relations in reality (Monbill & Souyung, 1983, p351).

Monbill & Souyung argue that the quantitative relations of number by which the real world is reflected in most of its cultures may be a late invention of civilization, and they assert that number may be more fundamentally qualitative to culture than it appears:

> In the beginning, for our ancestors as well as the primitives, to perceive the world is to name the things around them. The number they used often gave a description rather than a quality to the sensible object, an attribute rather than a noun of a number sequence, a qualitative indicator rather than a quantitative difference to express the numerical property of the object
>
> (Monbill & Souyung, 1983, p359).

Just an mankind as a whole may have first began to recognize number as a perceptual quality, it appears that it is the perceptual 'quality' of number that young children first seem to notice. Starkey and Cooper (1980) showed that elementary forms of 'quality' discrimination may be exhibited in early infancy. They reported that infants 16 to 30 weeks of age were capable of discriminating between numerosities in the case of visual arrays containing two and three objects. Antell and Keating (1983) replicated the findings of Starkey and Cooper with babies 21 to 144 hours old. In addition to age irrelevance, there are no clear limits to the number of elements that can be discriminated. Strauss & Curtis (1981) report that under some circumstances, infants 10 to 12 months of age can discriminate between three and four element displays, but that this discrimination breaks down with displays containing four or more elements. Such data on infant numerical discrimination has added fuel to the debate concerning the role of perceptual preverbal cognition in the development of numerical reasoning. From a social constructivist perspective, these infant's perceptions do not amount to a dėmonstration of an intuitive cognitive ability to 'abstract' numerosity since these infants are only demonstrating that they are perceptually responsive to activity within their micro-environment. Direct perception and subsequent reasoning of numerosity is impossible from set quantity if number is recognized as a socio-cultural development:

> Many aspects of human learning that we have traditionally regarded as 'cognitive' development are specializations of 'social' development. The central issues are not so much about how the child develops knowledge, but rather, about how he develops shared or cooperative knowledge
>
> (White & Siegel, 1976, p430).

Mathematical cognition must be recognized for what it is, a socio-psychological appropriation, a development of individual social enculturation, achieved through mediated social interaction with the mathematical knowledge constructed by society. This is also the view of Bishop (1989) who writes:

> the thesis is therefore developing that mathematics must now be understood as a kind of cultural knowledge, which all cultures generate but which need not necessarily look the same from one cultural group to another. Just as all human cultures generate language, religious beliefs, rituals, food-producing techniques, etc., so it seems that all human cultures generate mathematics. Mathematics is a pan-human phenomenon. Moreover, just as each cultural group generates its own language, religious belief, etc., so it seems that each cultural group is capable of generating its own mathematics (Bishop, 1989, p86).

Mankind has not always existed within a number active society. Primitive societies have in the past had little need for extensive reckoning systems. Zaslavsky (1973, p7) notes:

> The development of a number system depends upon need. In a small, self-contained economy in which all or most of the necessities of life are produced within the community - typical of large sections of Africa - there is little need for an extensive reckoning system. The names of numbers are frequently connected with the objects to be counted, just as we have special names for certain sets, - flock, herd, brace, etc., dating back from a pastoral or agricultural society. ...... A characteristic of African counting is a standardized system of gestures to accompany, or even replace, the number words.

According to Zaslavsky, the social interactive indoctrination of young children into the numerical ways of their culture is as prevalent in Africa as it is in other societies:

> Children in Africa, as in other parts of the world, learn finger counting rhymes even before they are aware of the number sequence. Some rhymes go only to five, while others continue as far as twenty. Most stop at ten, corresponding to the number of fingers. In some areas the rhymes are based on a twelve system or give special emphasis to multiples of three or four. ..... Counting songs are among the first item of the Venda children's musical repertory. They, too, accompany the words by counting on the fingers. Using their right index finger, they first tap the little finger of the left hand, then each consecutive finger until the thumb is reached. Counting on the right hand starts with the thumb and proceeds to the little finger, each in turn being grasped by the thumb and first finger of the left hand. Sometimes the child claps his hands when he reaches ten. The actual number words embrace several languages besides Venda - Thonga, Sotho, Afrikaans, English
>
> (Zaslavsky, 1973, p102).

Karl Menninger's Number Words and Number Symbols, published in 1969 in an English translation of the 1958 revised German edition, deals extensively with the development of numeration systems throughout the world.

Cohen (1983) defines numeracy as, "ability with knowledge of numbers", and suggests the use of *innumerate* to express a parallel meaning to illiterate. Cohen (1983) has shown how the Anglo-American culture shifted from prenumerate to numerate over three centuries, 17th -19th, as a consequence of the growth in the application of number to a variety of human endeavour. Cohen's (1983) text gives examples of how the use of numbers was pursued in the context of cultural developments in science, economics, navigation, surveying and gunnery. These examples constituted the beginnings of *"political arithmetic"* (Walkerdine, 1988, p214), and further entrenched social numerical intercourse through the formation of mathematical-scientific organizations and clubs, and their subsequent issue of academic publications. Cohen estimates that the number of *"mathematically minded"* men in 16th century England was fewer than 400. It is only from the 16th century that social forces have pushed general society towards an expanded public consciousness of number, and this may be linked to the rise of capitalism and national economies, spurred along by Adam Smith's 18th century publication of *The Wealth of Nations* which enshrined the idea of promoting the growth of overseas trading and the entrenchment of a money economy. Cohen suggests that there were additional social upheavals that promoted the social growth of numeracy, the Protestant Reformation and its accompanying breakup of monastery landholdings, the demise of aristocratic land holdings, and the rise of science. Cohen has thus shown how socio-historical events are linked to our cultural developmental use of numbers in our present society.

In early human civilization, mathematical knowledge would mainly have been communicated through society by oral means, and this would suggest the beginnings of a linguistic construction of mathematical knowledge. Prior to the onset of mass literacy, pre-literate mathematical knowledge, as defined by society, would have consisted of concepts that could be expressed in oral language (or drawings), eg. numbers, arithmetical operations shapes, fractions, measurements of length, area, volume, etc.. Social mathematical knowledge would have been constrained by the knowledge that could be constructed, interpreted, and analyzed through oral language.

Consequently, the social regulation of mathematical meanings would have become embedded in language, through the development of a linguistic 'mathematical register':

> we can refer to a 'mathematics register', in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is used for mathematical purposes (Halliday, 1975, p65).

Present-day mathematical thought has evolved beyond the confides of oral language, and has become to a certain extent, a symbolic language, eg. $f(x)=4x-2x+3$, e, i, $\int t^2 dt$, and although these may be orally expressed, their mathematical meaning is reached through their symbolism. Such symbolically entrenched mathematical meaning could not be socially communicated as mathematical thought to a pre-literate society. Mathematical thought may be seen to be limited by symbolism, and developments in symbolic representation enable the communication of mathematical thought. The appropriation of mathematical thought may be viewed as an appropriation of meaning embedded in symbolic representation. Mathematical thought would be highly restricted if it had to rely on oral communication alone. The very development of human mathematical thought or mathematical interpsychological functioning is directly related to the representation and interpretation of symbolic meaning. Socially defined mathematical competence involves mastering the socially constructed symbolic code and rules associated with present-day mathematical discourse.

Hughes (1986), has pointed out the difficulties that young children experience in learning this written symbolism associated with literate mathematics, and at the same time pointing out their cognitive competence through linguistic performance. The mode of mathematical communication, written or verbal, appears to determine performance, but not competence. Competence would appear to be determined by the quantity and quality of social-individual interactive communication. For most young children, social-interactive communication is mainly speech. Under these circumstances, it is not surprising that children can usually speak much more fluently than they can write coherently. Speech is very effectively mediated in the home, but not writing, and children often struggle with writing at school. Indeed, Vygotsky (1978, p116), makes a case for transferring writing to pre-school.

Mathematical enculturation may be perceived in terms of social interaction, where the language associated with mathematical discourse conveys shared meaning through a 'mathematics register' (Pimm, 1987):

> Learning to speak, and more subtly, learning to mean like a mathematician, involves acquiring the forms and the meanings and ways of seeing enshrined in the mathematics register (Pimm, 1987, p207).

Thus, mathematical language may be considered to be a subset of social language, a distinctive cultural discourse that is used to signify certain specific meanings enshrined in a 'mathematics register'. It is inconceivable that it should be considered possible for a child to develop aspects of cultural mathematical cognition, or abstraction, without help of such a socially constructed mathematical discourse. Damon (1979), supports this position by suggesting that all knowledge is "co-authored" and never occurs in social isolation. A social determinist position implies a dialectical relationship between the social and personal constructions of knowledge:

> To claim that mathematics is a social construction, rather than, say, a representation of reality, is no longer contentious as it once was
> (Noss, 1994, p2).

Sinclair (1989, p58) also notes:

> the subtle, but powerful interaction between the societal presentation of objects which allows a great number of children nowadays to master scientific concepts only geniuses could construct in the past cries out for detailed study.

A child's appropriation of meaning from mathematical discourse must be understood to be partly a social constructive process and not just an individual constructive process. A dialectical social constructivist position does not exclude individualistic contribution, but it does emphasize that individual contribution should be interpreted in socio-historical terms. Vygotsky's theory concerning the existence of human thought would suggest that the mechanism through which mathematical functioning comes into being is social in origin:

> human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them
> (Vygotsky, 1978, p88).

3.3 A Critique of Gelman & Gallistel's (1978) model of Counting

Gelman & Gallistel, (1978, p204), advanced the thesis:

> A knowledge of counting principles forms the basis for the acquisition of counting skill

It is my intention to argue against this perspective, and I will offer an alternative view, a social constructivist view, that suggests interactive social mediative practices may dialogically structure a child's appropriation of counting, through numerical discourse and activity.

Fifteen years ago, Gelman & Gallistel (1978) suggested that counting is the key to a child's development of an *'understanding'* of number. But is 'understanding' really important, is it the cornerstone to usage that we all think it is? Must a child 'understand' the logic of number in order to develop number skills such as counting? Surely it is imitative usage that comes first, not 'understanding'. We all use words, but we do not 'understand' our words prior to use, we learn to 'understand' *the use* of our words from social practice. Usage is the activity that ultimately produces 'understanding'. Usage is not a mental process, and neither is 'understanding', it is a social practice:

> Try not to think of understanding as a 'mental process' at all. - For that is the expression which confuses you. But ask yourself: in what sort of case, in what kind of circumstances, do we say, "Now I know how to go on," when, that is, the formula has occurred to me? -
> In the sense in which there are processes (including mental processes) which are characteristic of understanding, understanding is not a mental process.
> (A pain's growing more or less; the hearing of a tune or a sentence: these are mental processes.) (Wittgenstein, 1953, p61, Rk.154).

Gelman & Gallistel (1978, p73-4) argued that the numerical domain of the young child is firmly rooted in logical counting principles which are related to staged mental development. The developmental model of counting ability in young children that is suggested by Gelman & Gallistel was influenced by a study of cognitive attainment in young children carried out by Mehler & Bever (1967). Gelman and Gallistel's (1978) "counting procedures" are inferred from experimental observations of young children's counting procedures.

In defining "counting", Gelman & Gallistel insist that the child's ability to count should not be measured against the pattern of conventional adult criteria of what "counting" means, - ie. the acceptable (correct) use of the standard number sequence. Gelman & Gallistel (1978, p77) suggest that "matching" is the basis of all counting methods, human and non-human. For Gelman & Gallistel, "matching" does not limit counting to the use of conventional count words.

Gelman & Gallistel only acknowledge the usefulness of language and count words as a numerical matching process, they do not recognize counting as a social practice, structured by utterances and language usage, indeed they write:

> The point should be made now: There is no reason to require a child to use conventional count words in a conventional order
>
> (Gelman & Gallistel, 1978, p76).

Gelman & Gallistel, appear to perceive the counting process as being founded upon scientific logical principles. They outline a general "How-to Principle" based upon three steps:

1. The one-one principle
2. The stable-order principle
3. The cardinal principle

What Gelman & Gallistel have failed to recognize is that scientific logic is itself founded upon socially acceptable practices and mentally structured through language usage. By not recognizing the social embeddedness of perceived logical counting principles, Gelman & Gallistel do not answer the question, "Why does a young child learn to count?".

Gelman & Gallistel's one-one principle requires the child to develop control over the rhythmic tagging practice by assigning or matching numerical labels (eg. count words) to the individually partitioned elements of a set. This one-to-one correspondence practice is mistakenly assumed by Gelman & Gallistel to be a mental skill that is structured by perceptual experience on object reality. It is not so, we see only what we are socially trained to see, object reality is socially presented and interpreted through language usage:

> Now think of the following use of language: I send someone shopping. I give him a slip marked "five red apples". He takes the slip to the shopkeeper, who opens the drawer marked "apples"; then he looks up the word "red" in a table and finds a colour sample opposite it; then he says the series of cardinal numbers - I assume that he knows them by heart - up to the word "five" and for each number he takes an apple of the same colour as the sample out of the drawer. - It is in this and similar ways that one operates with words. - "But how does he know where and how he is to look up the word 'red' and what he is to do with the word 'five'? " - Well, I assume that he acts as I have described. Explanations come to an end somewhere. - But what is the meaning of the word "five"? - No such thing was in question here, only how the word "five" is used (Wittgenstein, 1953, p2-3, Rk 1).

The child's understanding of number should not be seen as an internal mental development of logical principles, scientifically derived through experience of object reality, but must be seen to be a social skill structured by linguistic usage and developed through experience of social reality. Only under these latter circumstances can we understand why a young child should ask, "What is one and one?". The child's understanding of number is represented by experience of those social practices involving the *use* of number language. The child's understanding is a social measurement of the level of appropriation of socially constructed knowledge. A child asks, "What is one and one?" in order to appropriate social knowledge. The question would never be asked if its answer could mentally develop through logical principles. Numerical processing is a socially developed skill, not a mental skill, it is developed through rhetorical-responsive social communication, not mentally developed.

There is always some external social input or influence that aids or assists a young child to mentally represent and partition a set of items into individual components, - and this must happen before tagging can begin. This external social input, often verbal, influences the young child's way of interpreting the perceived information associated with a set of items. Mental interpretation of perceived reality is socially determined through linguistic communication. To a young child, a set of items are seen as just that, a set of items, they cannot be counted and they are not counted. My research shows that a young child who "sees" individual items within a set has been socially trained to do so (Wittgenstein).

The one-to-one tagging of partitioned items with sequential number words may be seen to involve social training. My research shows that adults initially hold and move a child's pointing finger from item to item during this training process. The child's mental representations are encultured through rhetorical-responsive communication. The adult partitions a set of items through verbal utterances which accompany and structure the physical activity of pointing/touching.

Putting into action Gelman & Gallistel's (1978) one-one principle is very much a social process, it involves social dialogic activity, requiring interpsychological communication not mental development. The mental developments associated with the procedures of counting are not a sudden or even a gradual development of logical principles, they are an appropriation of meaning, a socio-historical development of mind through linguistically mediated activity.

From an early age, less than 2yrs from my data, adults involve children in counting rituals through verbal questioning and answering, eg: "How many? .....one, two, three, four, ...". Even when adults do all the talking, they are structuring the minds of their children. By verbally reciting the counting word sequence adults are externally regulating a cultural activity from a social perspective. The child's intrinsic motivation to count is initially socially promoted through interactive verbal activity, number rhyming. Adults impart to counting a ritualistic value which socially motivates an imitative counting action by the child.

Not only do adults subtly introduce children into counting activity, they also interpsychologically superimpose the form of counting on children. Joint counting activity is always socially regulated by adults through verbal feedback on performance. Adults direct children to "count properly" or "try again" when a counting or tagging error has occurred, in addition, adults often reinforce a child's counting performance by repeating a correct count themselves. Praise is usually given to the child when a correct performance has been accurately executed.

The nature and structure of counting, including the various sub-skills such as the one-one principle, the stable order principle and the cardinal principle, outlined by Gelman & Gallistel are all socially mediated. Logical principles and social reality are not opposed to each other, logical principles are part of social discursive reality. Gelman & Gallistel's cardinal principle is not just a logical principle, it is a socially defined counting rule. Young children engaged in counting activity quickly note that the size of the set is determined by the last number in the count (Frye et al, 1989). For Frye et al adherence to the cardinal rule is not a consequence of individual cognitive development of an understanding of cardinal meaning, it is simply an imitative use of the cardinal principle. The cardinal principle appears to be socially appropriated by young children through rhetorical-responsive use.

To be able to count meaningfully is a social determinant, young children must be seen by others to have mastered the socially constructed rules of counting. Young children are not observed waiting for some internal cognitive development that will enable them to mentally process the logical principles associated with counting, they are observed to socially practice and participate in counting activity. Counting is not some cognitive skill that is developed in social isolation, learning to count is a social skill, it is mediated through language usage, it involves social others. I suggest that there is no such thing as "the child's *understanding* of number", there is only the child's *use* of number. Young children appropriate counting rules through active involvement in counting practices and counting discourse mediated by more experienced social others, the counting rules are not self constructed, they are socially constructed:

> And hence also 'obeying a rule' is a practice. And to think one is obeying a rule is not to obey a rule. Hence it is not possible to obey a rule 'privately': otherwise thinking one was obeying a rule would be the same thing as obeying it
> (Wittgenstein, 1953, p81, Rk.202).

The socio-historical extent of counting experience and use of counting practices is the only valid measurement of a child's numerical understanding. Learning to count meaningfully is not a mental accomplishment, but a social accomplishment.

Gelman & Gallistel (1978, p135) write:

> What have we learned about 2-year-olds? To be sure, they are not skilled counters. Nevertheless, they do use some components of the counting procedure. They attempt to tag items, they point (albeit in a less-than-systematic fashion), and they appear to be guided by the stable-order principle. They have much to learn. But they will not be without help, for they seem to have available counting principles, principles that guide them in their efforts to achieve performance mastery. Perhaps now we understand why young children seem to be so caught up in counting rituals and so very interested in numbers.

I am not sure that Gelman & Gallistel (1978) have researched why young children are "caught up in counting rituals" since they place great faith in their defined counting principles, suggesting that these will "guide" young children, "in their efforts to achieve performance mastery". As for being "so very interested in numbers", this is hard to justify under controlled experimental conditions.

My own ethnographic data does suggest that some young children are "caught up" and "very interested in numbers", but not all children, it is their prevalent social and affective environment that plays an important role in fostering numerical interest and ritual. Following rules, or principles is to conform to a social practice, consequently performance mastery is socially determined and not cognitively determined (see Wittgenstein's quote above).

Gelman & Gallistel state that 2-year-olds, "are not skilled counters" and "They have much to learn", but is this surprising? Counting is neither a need nor a desire for most 2-year olds. How many 2-year old's wish to be a skilled counter? Why should a 2-year old be a skilled counter? Above all, why should 2-year olds be "interested in numbers"? The 2-year old's need for counting just does not arise. The need has to be socially generated in the context of everyday social use.

My research data demonstrates that under certain micro-environmental circumstances many 2-year olds *have already* learned to count and the*y are skilled.* Young children regularly engage in 'counting play' if their social micro-environment initiates and promotes counting activity. The limitations are not cognitive, but social interactional, based upon social need, social value, social activity, and social discourse.

In daily routine, in the course of living, adult activities regularly involve them in contextual counting activities, (eg. using money, setting the table, etc.), but 2-year old's play activities rarely require or involve them in needing to count, - unless the situation is artificially created by an adult to test and stretch the child's numerical appropriation. As a 2-year old grows older, needs and desires change, counting becomes more relevant and important eg. the child develops a liking for sweets and takes an interest in the numerical quantity of sweets given to him/her.

Gelman & Gallistel's adherence to the overall importance of counting principles is a limited view of how a child acquires counting skills. It is not enough to say, "Children as young as 2½ years use the how-to-count principles" (p203), and quote experimental data to back up the discovery. Counting is first and foremost a social skill. The how-to-count principle has both a social mediational and an appropriation dimension.

3.4 The Social Context of Number Appropriation

In the past, research attention on early number development has been mainly concerned with how children learn to count and the use of counting practices to further develop numerical meaning. Such research has originated from various psychological disciplines including: developmental, educational, cognitive, experimental. It is only more recently the social discipline has taken an interest.

It has been claimed that the development of number provides an ideal domain for a Vygotskian investigation of the relationship of social and cultural communicative tools to aspects of personal cognition (Saxe et al, 1984).

Perhaps the most frequent experience that a young child has with number is in the context of counting. Although some adults may think of counting and the skills involved in comparing two quantities as simple or basic, their efficient application in *social context* represents an important accomplishment for all young children. Walkerdine and Sinha (1981, p187) note that it is, "Impossible to understand the children's responses without reference to their active categorization of the context"; and that, "the same context signifies differently for different children depending on their existing category systems".

If the notion of context is deemed important to communication, then context will become, "a critical feature of signification itself" in any analysis of numerical communicative development:

> By examining utilization of numbers and arithmetic operations in the home practices it should be possible to see how far the signifiers, signs, and discourse are similar and different (Walkerdine, 1988, p97).

Walkerdine has shown that relational terms such as 'more' and 'less', commonly taken to be important for any learning of comparative number or sequential ordination, are used in specific home practices, "so that very specific signifiers are used within particular relations in practice" (Walkerdine, 1988, p98).

Fuson and colleagues (eg. Fuson, 1988; Fuson & Hall, 1983; Fuson, Richards & Briars, 1982) have argued that the number words have different meanings in different contexts, and that children sequentially acquire these different meanings, learning each number word at first as several different context-dependent words. These different meanings gradually become interrelated and extend to sequence, counting, and cardinal "meanings", or contexts, of number words.

Walkerdine (1988) has illustrated the variety of ways in which counting is taught *informally in everyday situations.* For instance, parents rarely appear to count objects aloud unless for the specific purpose of introducing their children to the language use of number, but count out aloud they do. Children are also observed to play with this language of number in games, rhymes and songs (Opie & Opie, 1959). The social world of young children is one in which the language of numbers is verbally embedded in fixed sequence, for example:

'one, two three, four, five, once I caught a fish alive ....', and 'one, two, buckle my shoe, three, four, open the door ......', etc.

The sequential arrangement of number words is socially facilitated in the context of ritual play is often overseen and regulated by many parents, or older children (see the research of this thesis).

Daniels (1990) suggests that children who have limited experience of the language of number and number play may find the idea of fixed sequential ordination novel and difficult to put into practice quickly, especially if they become aware that their performance is intended to expose aspects of number competence.

Daniels (1990) suggests that irrespective of whether children acquire competence in cardination or numerical ordination, that knowledge may not be so much a function of 'natural development' but more of a development from active social participation in numerical aspects within the child's cultural experience:

> Children acquire elements of number competence before they engage in formal schooling (Daniels, 1990, p51).

It is therefore not unreasonable to argue that the patterns of communication and interaction in which the young child is socially involved bear some relation to the way in which the child comes to appropriate aspects of our number system.

3.5 Cognition and Verbal Counting

The pioneering work of Binet (1890), and of Piaget (1952), on number reasoning began a tradition of playing down (and in some cases ignoring) the social role of counting in the cognitive development of number concepts. Counting was perceived as a skill developed independently from individual understanding of the concept of number. The *individual understanding* was deemed the all important facet of number cognition. Binet (1890), for example, when studying his 4-year old daughter's understanding of relative numerosity commented that she:

> fortunately does not know how to ... count, and her parents were wise in postponing the beginning of her education as much as possible
> (Binet, 1890/1969, p86).

This tradition of considering the social practice of counting as irrelevant to numerical reasoning was continued by Piaget (1952), whose principle concern was an analysis of possible underlying logical concepts related to an individual's understanding of number. Piaget (1952) argued that counting cannot become a 'symbolic tool' for the child until a logico-mathematical mental structure had been developed, and that occurred only after the child had learned number conservation from concrete experience. Piaget believed that individual development of number 'concepts' could only be understood in terms of more general cognitive structures and he argued that:

> there is no connection between the acquired ability to count and the actual operations of which the child is capable (Piaget, 1952, p61).

To support this view, Piaget pointed to children who could verbally recite the number word sequence at a very young age but who failed his number reasoning/conservation tasks.

Pollio & Whitacre (1970), reported that the length of preschoolers counting strings is an excellent predictor of their ability to establish one-to-one correspondence, to divide objects into equally numerous sets, to insert the missing number in a series and to count on from an arbitrary chosen point within the number string. Pollio & Whitacre's study was designed to determine how far various numerical skills had developed in children ranging in ages from 3½ to 6½ years. Although their primary concern was with testing children's development of counting, other tests were included to determine how counting ability interacted with other aspects of set enumeration. Pollio & Whitacre's study was not specifically undertaken to test Piaget's (1952) stage-hypothesis of number development, but their test data was interpreted with respect to supporting Piaget's view:

> In general, the tests used here may be ordered in accord with Piaget's analysis and the data they generated seem to support a stage-hypothesis of numerical development (Pollio & Whitacre, 1970, p174).

Klahr and Wallace (1973) suggested that counting ability developed in a hierarchical fashion and that gradually, through practice, counting becomes automatic. As simple skills are mastered in context, they are supposedly integrated into a network to perform more complex numerical skills. More specifically, Schaeffer et al (1974), suggested a hierarchical integration of counting skills to account for number conservation development. Schaeffer et al's explanation of number conservation could be viewed as a *social-interactive* account. They emphasized that the most basic skill is the learning of the number words. This is followed by the skill of "enumeration" which involves the ability to coordinate these number words with each object in a set, so as to create one-to-one correspondence. This pairing of words and countable items is often accomplished by a pointing action. Thirdly, as a result of repeated exposure to counting quantities "and possibly adult instruction", children learn that the last number in the set represents the number of items in that set. Finally, Schaeffer et al report that children begin to realize that counting can be useful in comparing sets, and they suggest that only when this stage has been reached should a child be expected to conserve number.

An alternative analysis of number development has begun to emerge, according to which number concepts and meaningful counting interact as development progresses (Fuson & Hall, 1983; Wagner & Walters, 1982). According to these viewpoints, preshoolers first learn to use numbers mechanically and then gradually discover or construct deeper meanings of number and counting. It is suggested that through the application of increasingly more efficient counting procedures (from counting-all to counting-on), children supposedly discover or construct number concepts. Much of this number application and use takes place before children attend school, it happens in the home through parental interaction (Durkin et al, 1986) and childhood games (Fuson and Hall, 1983).

The relevance of counting and one-to-one correspondence to the formation of number 'concepts' has been the focus of a great deal of recent research attention.

Gelman and colleagues (eg. Gelman & Gallistel, 1978; Gelman & Greeno, 1989; Gelman & Meck, 1983; Gelman, Meck & Merkin, 1986) have proposed that young children possess an innate concept of number consisting of a set of counting principles that define an exposition of counting (see previous chapter for outline and critique). However, contrary to what would be expected from this view, there is evidence that children learn to count, and associate meanings with some of the number words, before learning that counting determines the numerosity of a set, or before connecting counting with the process for determining set numerosity (Frye, Braisby, Lowe, Maroudas & Nicholls, 1989; Fuson, 1988; Wynn, 1990).

With regard to the 'Counting Principles' theory, Fuson (1991, 34) writes:

> No support was found for the Gelman and Gallistel relationship except for very small sets.

It would appear then that young children may not start out with unlearned counting principles that lead them to the meanings of the number words and guide their acquisition of counting skill. Rather, children must learn how to count, and must learn the meanings of the number words by some other process, other than mechanistic correspondence association with a set of mental counting tags. That other process may be social communicative interaction:

> Children can best be prepared for school maths by having preschool teachers, parents and caretakers who help children take joy and pride in their noticing and labelling numerical aspects of their environment and in their learning of the number-word sequence and who facilitate children's enthusiastic counting of all sorts of things in many different situations (Fuson, 1991, 34).

According to Fuson et al (1982), knowledge of the standard counting sequence develops in two phases. During the initial 'acquisition' phase, children learn the conventional number words as a relatively meaningless sequence. At this stage, the sequence functions as a single connected whole, from which words cannot be independently isolated, eg. onetwothreefourfivesix etc. An 'elaboration' phase follows this 'acquisition', and during this second phase the number sequence is decomposed into separate number words. Gradually children learn to produce the words with little effort and the number words become objects of thought, used for counting things. This 'elaboration' phase is demonstrated by the child's ability to count backwards, count on, count in tens, and so on. According to Fuson et al (1983), it takes a child several years to 'acquire' and 'elaborate' the whole number word sequence, and she suggest that parts of the number word sequence may be in different phases of development at the same time.

3.6 Young Children's Acquisition of Number Words

Infants and young children have been reported to demonstrate considerable knowledge and expertise in the use of small numbers. Very young infants can discriminate between visual arrays containing small numbers of elements (Starkey and Cooper, 1980; Strauss and Curtis, 1981; Treiber and Wilcox, 1984), and by the age of two years, children are often reported to be making use of the first number words (Fuson et al, 1982; Wagner and Walters, 1982). The acquisition of the standard sequence of counting words up to 100 has often been reported to begin soon after the age of two years. The age of acquisition does not appear to be a determining factor, with some 3-year olds producing longer correct sequences than some five year olds. However, most young children aged 3½ years or older, can produce sequences to 10, and children between 4½ and 6-years are often reported to be acquiring the 'teen' part of the sequence (14-20), and children aged 4½ to 6½ are also reported to be learning the decade sequence between 20 and 90 (McEvoy, 1989). Fuson et al (1982), reported the mean length of sequences of correct number words increased from 13 at age 3½ - 4 years, to 51 at age 5½ years, but with a wide range within each age group. On average, children appreciate that 'three' is greater than 'two' by the age of 3½ (Schaeffer et al, 1974), and it has been reported that by the age of 4-5½ years, children are quite accurate in determining which of two numbers is the larger, at least up to the number '5' (Resnick, 1983).

In a longitudinal study, Durkin et al (1986) reported that children's early experiences with number are predominantly with the words 'two' and 'three'. Durkin et al reported that both mothers and children used 'two' more frequently than 'three', and 'three' much more frequently than 'four'. Durkin et al also reported that 60% of mother's usages of number words took place in the context of nursery rhymes, stories, songs, reciting the sequence of number words with the child, and counting objects together. In other words, the child's use of number was developed mainly through social practice and interaction. Such number acquisitions and skills by young children has prompted some researchers to assume a less 'intuitive' approach and adopt a more 'social' approach:

> This seems to indicate that some young children already know a lot about mathematical communication, the forms it takes, and the kinds of things it is used for, in much the same way as they know a lot about what writing looks like

> and what it is used for, before they understand it fully. And some children, given half a chance, demonstrate a readiness to try out their knowledge of mathematical convention (Gifford, 1990, p70).

This point has been taken up in a series of studies by Wynn (1992a,b). In a 7-month longitudinal study of 2- and 3-year children by Wynn (1992a), it was found that at an early age children already knew that count words referred to a distinct, unique numerosity, although that numerosity remained vaguely defined in terms of exactitude. Wynn suggests that it is possible that children learn numerosity party from the syntax application of number words:

> In order to understand the counting system - that is, to know how counting encodes numerosity - children must know the meanings of (some of) the number words (Wynn, 1992a, p220).

Nonetheless, Wynn continues to focus her attention on the counting system as the meaningful constructor as opposed to the human mediators of number language:

> Despite this early knowledge, however, it takes children a long time (on the order of a year) to learn how the counting system represents numerosity. This suggests that our initial concept of number is represented quite differently from the way the counting system represents number, making it a difficult task for children to map the one onto the other (Wynn, 1992a, p220).

The "difficult task" that Wynn speculatively envisages for young children learning to count lies in the practical process of counting a set. Wynn suggests that when a child observes the counting practice of apparently assigning a number word to a particular item, the child will associate the number word with that item, while the count word is unknowingly to the child, being used as an accumulation descriptor:

> Yet when we count, we assign a number word to each item, so the child sees an individual item labelled 'one' another 'two', another 'three' etc. Given children's tendency in such situations to take novel words as names for kinds of individual objects or their properties (eg. Markman, 1989), it would seen an especially difficult hurdle for children to learn that the number words refer to properties of sets of entities (Wynn, 1992a, p221).

Wynn, argues that understanding the meaning of a given number does not enable a child to understand how counting determines which number word applies to any given set. Wynn is in effect arguing that counting is a secondary and separately learned process from that of appropriating number word meaning:

> Thus children's developing knowledge of the meanings of the number words is a central part of their understanding of the counting system
> (Wynn, 1992a, p221).

To support this view, Wynn explains that young children are able to correctly pick up 'one', 'two', or 'three' items when asked, and "virtually never use counting to do so", before they can pick up higher numbers which may require an application of the process of counting. Wynn suggests that young children directly map small numerosities onto the appropriate number word, and so usually succeed at identifying these numerosities, but have not yet learned to apply the counting system to determine the numerosity of a set:

> Once they learn the way in which counting determines the numerosity of a set of items (the cardinal word principle), they acquire the cardinal meanings of the rest of the number words within their counting range, and so can give any number of items they are asked for (Wynn, 1992a, p227).

Wynn notes that research data on the time span taken by young children from the initial learning of the number word meanings to mastery of the 'cardinal word principle', varies from child to child:

> because the data obtained so far are cross sectional and there is much individual variation - some children have acquired the cardinal word principle before their third birthday, while others nearing their fourth have yet to learn it
> (Wynn, 1992a, p227);

yet the social constructive factors that may account for such variation are not proposed, rather, the variation is accounted for by a postulation of "task difficulty", and an innate counting 'accumulator theory' (Wynn, 1992b).

Wynn has researched young children's acquisition of number words and their use in a counting system from an individualistic perspective that does not take into account social matutinal factors that may assist or hinder children's appropriation. The research is still basically focused on observing, measuring and reporting individual children's numerical aptitudes and skills. The human socio-historical contribution to children's number word meanings and their employment in a counting system culturally constructed has been ignored by Wynn's studies.

In a study of children's use of counting, by Michie (1984b), it was found that:

> out of 60 children who counted readily when asked to do so, only four counted spontaneously without being asked to do so (Michie, 1984b, p352).

Michie (1984b) suggests that young children do not readily use counting procedures to solve problems concerned with perceptual quality, not because they are not able to do so, but because they are not used to doing so:

> In their own experience, young children may not have been presented with situations that require counting and may have found length to be a reliable cue. Their preference for using length cues rather than counting may not, therefore, reflect a lack of understanding of number (see Michie, 1984a)
> (Michie, 1984b, p357).

Michie (1984b), found that the only intervention which had a significant effect on children's tendency to count was feedback concerning the reliability of the counting. The use of alternative verbal instructions or use of alternative counting problems appeared to have no effect. Michie (1984b) concluded that the use of counting by children to solve problems can only be promoted through adult intervention, and the most effective intervention was that which provided feedback.

3.7 <u>Saxe et al's (1987) Model of Children's Developing Understandings of Number</u>

Ginsburg & Russell (1981) reported that the mean lengths of number word sequence recitals for middle-class and poor inner city 4-year olds attending preschool or day centres, to be 19.9 and 15.5 respectively. Wang et al (1971), found that 13% of kindergarten children from families labelled as being of low Social and Economic Status appeared unable to produce a sequence to 'five', and 32% failed to produce a sequence to 'ten'. If the differences in SES are taken as implying differences in a child's social interactive micro-environment, then it may appear that socio-cultural micro-environment does influence a child's acquisition or elaboration of the standard number word sequence.

Saxe et al (1987) studied and reported upon a possible relation between social class and measures of young children's numerical competencies. As part of their research they investigated the numerical activity situated in the everyday environments of children in middle- and working-class homes. Consistent with Vygotsky's ZPD hypothesis, Saxe et al (1987) characterize social interaction in number tasks as meaning negotiations between adult and child, where adults adjust their interaction with children in the process of solving a numerical task in relation to the child's cognitive needs, and where children responsively adjust their goal-directed behaviour in relation to adult instruction. Saxe et al's model of the development of number understanding in young children is analytic, rather than interpretive, in character. It entails systematic investigations of *goal-directed adaptations* related to children's emerging numerical abilities and the shifting *socio-cultural organization* of children's numerical environments in response to those emerging abilities. Saxe et al use "setting the table" as an example of a joint parent-child goal-directed activity within the social environment in which the child might develop and use numerical skills:

> The plates, knives, forks and spoons have no inherent numerical properties, and no numerical relations involving equalities or inequalities inherently exist between these items. Numerical properties of these items and numerical relations between sets of items are generated only through the child's goal-directed activities of conceptualizing the items as countable and numerically comparable (Saxe et al, 1987, p5).

Saxe et al argue that an analysis of children's abilities to perform numerical goals in the environment in which the child participates is necessary to gain insight into the understandings and strategies that are inherently generated in goal-directed numerical activity.

Some of the more interesting findings of Saxe et al involve the relation between the children's number understandings, the mother's attempts to assist, and the mother's reports of the number activities in which children are involved on an everyday basis at home (ie. the socio-cultural level of analysis).

Saxe et al's findings regarding socio-cultural influences on number learning show that both middle- and working-class pre-schoolers are heavily involved in number games and activities. This is consistent with my own data, and it challenges assertions by some that children enter school with a *'natural'* understanding of number that derives from their own individual efforts to assimilate the logical sense of number independent of social influences, eg. Ginsburg & Allardice, (1984):

> System 1 knowledge develops outside the formal school setting, it is termed "informal". Cultural influences, such as parental training, books, and television, do not appear to be major determinants of the development of System 1 skills, such as the Piagetian operations on the concept of more. Indeed, most parents are surprised to find that children possess such skills. It is conceivable that System 1 knowledge is tied to a biological component and thus is 'natural'
> (Ginsburg & Allardice, 1984, p196).

The "spontaneous concepts" or "informal knowledge" of System 1 that Ginsburg and Allardice consider to be 'natural' may be socio-culturally endowed upon young children, and yet not classified as such. Long before the onset of formal schooling, 1- and 2-year old children are involved in spontaneous parental didactic instruction and adult/child guided participation in socially structured activities involving relational number word use (Saxe et al, 1987; Walkerdine, 1988; and the research in this thesis).

The main aim of Saxe et al (1987) was to examine the social class differences in children's number skills, and report on possible class differences in social interaction and social arrangements for pre-school children's number learning. However, Rogoff (1987) criticizes Saxe et al for failing to provide case study dialogue that would have provided a dynamic account and *"given life"* to the extensive research data gathered on mother-child interaction. I hope that the dialogue presented within this thesis will give life to similar exchanges of numerical social interaction as is reported by Saxe et al, and thereby satisfy the research demands of B.Rogoff.

Saxe et al reported some differences between middle- and working-class children's understanding of number:

1) 4-year olds from middle-class homes displayed greater competence on tasks with more complex numerical goals than did their working-class counterparts;
2) Middle-class mothers' aspirations for their children's educational attainment were usually higher, often requiring children to work toward a more complex goal with more instruction

Despite Saxe et al's assertions that there were social class differences resulting from the analyses of their research data, Rogoff (1987, p156) comments that there were in fact very few social class differences, and argues that on most analyses there were no social class differences at all. The interpretations placed upon Saxe et al's research data is obviously open to question, but from my own point of view, the individual differences within any particular social class is likely to be just as great as any across class difference. Numerical language usage is seen to be cultural, and may be expected to permeate all social classes embodying similar culture more or less to the same extent. All social classes operate with number in routine everyday ways, any measurable differences in social class usage and interaction may be offset by other considerations, such as the number of people in the home.

The study carried out by Saxe et al shows how children adjust their numerical goals to those that are required of them during social interaction, and in this respect, the research data contained within this thesis supports Saxe et al's findings.

3.8 The socially created world of Number

In order to gain insight into the development of young children's number appropriations as being a mediated social process, children's social worlds in terms of interaction must be observed. Early studies, eg, Piaget (1952), of children's developing numerical abilities focused on their already developed abilities, and the unit of analysis was normally number cognition. This unit ignored the socio-historical processes that led to a development of number cognition. Many other research studies of young children's development of number have continued this practice, focusing on number cognition as the unit of analysis.

In this thesis, the process of becoming numerate is viewed from a social constructivist position, (influenced by Vygotskian perspectives on culture, communication and cognition), where social others are seen to mediate the elements of our cultural number system in social contexts. The basic unit of analysis is not number, but mediated language, the social use of language to mediate and describe a particular situation in numerical terms. What is being researched is the nature and extent of social interactive processes that enable children to participate in culturally valued numerical activities, and to historically monitor and report the changes in children's numerical competence in relation to their participation in socially mediated numerical activity.

Account will be taken of historical experiential utterance, linguistic and mathematical, and the social interactive contexts that create and generate these. I intend to focus the research on how the process of verbal interaction impinges upon the child's appropriation, and subsequent usage, of social utterance to effect cultural meaning, especially number constructs. *Utterance* is being acknowledged as the unit by which mental cognition is socially regulated (Vološinov, 1973), and numerical utterance will therefore form the units of analysis. Interactive dialogue amongst children and adults will be used as a source of research data through which to probe the role of utterance in the social construction of numerical meaning in young children.

A possible relationship between the social use of numerical language and the development of a numerical consciousness in the young child will be examined through a descriptive analysis of the child's social interactive 'ventriloquation' (Wertsch, 1991) of numerical language. The contextual source of the research data will be everyday living contexts, the social habitat of the child. It will not be a laboratory, it may, for a fraction of a day, be a playgroup, nursery school, or creche, but for most of the time it will be home. It is at home where a young child is most likely to first come into contact with numerical descriptive language, and to be socially introduced to the counting sequence, and most of all, where counting practices will be first observed (Tizard & Hughes, 1984). It is through social interactive experience of these numerical practices at home that the young child's consciousness of number arises, and develops, and this has been recognized by previous researchers, including Walkerdine (1988), and Tizard & Hughes (1984). It is my intention to expand the 'social path' begun by these pioneering 'social situational' researchers by classifying the linguistic social practices that lead a young child to 'ventriloquate' and subsequently 'appropriate' cultural numerical descriptive language.

Walkerdine (1988), has examined the use of certain 'mathematical' relational language, words such as 'big', 'little', 'large', 'small', 'heavy', 'more', in children's spontaneous speech data (recorded in the children's homes). Walkerdine's argument was that the children's use of such mathematical relational terminology developed from aspects of the linguistic regulation of social practices in which children's daily lives were embedded.

The study by Tizard and Hughes (1984), was more broadly based and it touched only briefly on number appropriation, it revealed differences between the linguistic interactions of children at home and those that took place in a nursery school. Despite a dearth of numerical language in the conversational material collected by Tizard and Hughes, the importance of social dialogue as an "aid for the child's intellectual growth" was very evident (Tizard & Hughes, 1984, p14).

Count words may be viewed as part of everyday descriptive language, and young children may become party to the common cultural practice of having numerical utterances socially mediated to a greater or lesser extent in social contexts. Recognizing the extent and limitations of preschool children's numerical experiences is important to any understanding of how young children will be expected to perform and participate in formal pedagogical mathematical education:

> Preschoolers who exhibit a weakness in basic number concepts and counting skills may be at risk of failure when, at a later age, they are required to master school arithmetic; for example, children whose knowledge of the counting words

> is deficient and those who fail to appreciate the concept of 'more' will find basic addition and subtraction difficult and confusing (McEvoy, 1989, p110).

Fuson (1991) has also noted that:

> Young children in all parts of the world learn to say the number-word sequence used in their own culture.
> .... However, many children entering school do not even know the first five ordinal words (Fuson, 1991, p27).

3.9 CHAPTER SUMMARY

Number consciousness need not be viewed as a mental development, it may be viewed as a social development. Number consciousness may develop through social interaction, through social usage, and through the rhetorical-responsive communication of meaning. The more times a child interactively participates with a social other in a numerical task or activity, the more culturally competent and socially integrated the child may become in terms of appropriating socially constructed numerical meaning through mediational practice. Numerical skill performance may be interpreted as a socially developed skill, and not just an individual cognitive development. This social constructivist approach to young children's number learning opposes the positivist *'referential-representational'* view which commonly asserts that language is perceptually related to an object world, and this thesis suggests that it is the social system which determines numerical meaning through *'rhetorical-responsive'* social communication.

CHAPTER 4

RESEARCH METHODOLOGY

RESEARCH METHODS:A FIELDWORK DESIGN

4.1 Research Outline

My research is designed to study the social contexts in which young children may be involved by adults or other children in rhetorical-responsive mediation of number language usage.

The objects of study are everyday examples of numerical discourse in which young children's numerical meanings are being socially mediated. The numerical discursive practices may involve:

a) adult/parent mediation

b) child/child mediation

c) self-mediation by child

My interpretive study of these social interactive discursive practices which may influence young children's numerical cognition has been theoretically framed within the socio-historical method expounded by Vygotsky (1978). Although Vygotsky may have intended to link discursive practices to interpsychological socialization processes, his own work focused on individual children's cognitive achievements through their usage of language as a tool, and through instructive interaction with an adult. The focus of this present research is to study the interactive practices that are dialogically structured through language usage, and socially imparted (mediated) to young children. My task is to interpret young children's situated cognition of number as 'meaning' mediated in social practice through language, and within the context of social usage, describe the nature and character of any regular patterns of activity that may permeate and accompany young children's mediated numerical meanings. The research has been organized in an attempt to provide possible answers to the following questions:

1) Do the mediative practices of parents, nursery teachers or other children act to enable young children to reciprocally self-mediate numerical meaning and produce skilled numerical performances?

2) Are there any discernible relationships between a child's spontaneous use of number language and number skills and the quality/quantity of external mediation concerning numerical matters?

3) Is numerical mediation culturally visible only in the sense that practice is influenced by socio-cultural need and usefulness, and hence laden with socio-cultural value?

4) Can successful numerical mediation be defined? If so, what are its characteristics?

In order to be methodologically secure my research encompasses various data-gathering techniques:

1. Ethnographic Case Study of the mediated numerical activity of two children at home (researcher's) - 20 months duration, participant & nonparticipant observation, data collected through transcription of video recordings and diary notes;
2. Diary Studies of other children's home activity - 3 months each (6 cases), parent written reports of their numerical mediative practices with young children;
3. Interviews of parents about their children's numerical skills and parental mediated practices at home (approx. 20 minutes in length, and 40 in total, written and audio records), parental testing of their children at home - 6 parent mediated numerical activities performed by children;
4. Case studies of mediated activity within pre-school playgroups/nursery school, participant & non-participant observation involving transcribed video recordings - 9 months duration (5 different sources);
5. Interviews with nursery teachers (approx. 20 minutes in length, and 6 in total), - concerning their views on parental involvement in mediating young children's number skills, the number competencies that they have observed young children display, questions were also designed to characterize the nature and type of numerical practices that may be instigated within nursery classrooms.

My qualitative inquiries are firmly entrenched within the broad label of ethnographic practice. Historically, qualitative research data has been gathered through ethnographic fieldwork. Spindler and Spindler (1992) define eleven criteria associated with good ethnography, Criterion V reads:

> Sociocultural knowledge held by social participants makes social behaviour and communication sensible. Therefore, a major part of the ethnographic task is to elicit that knowledge from informant participants
>
> (Spindler & Spindler, 1992, p74).

Hammersley and Atkinson (1983), note that ethnography is both a process and a product. The process is flexible and it evolves contextually, it undoubtedly influences the product, - the research, and subsequent knowledge interpreted from the data.

My data analysis focuses on reporting and describing the rhetorical-responsive dialogues with adults and other children that may shape and structure young children's numerical thought through interpsychological appropriation from others. A rhetorical-responsive dialogue is defined as an exchange sequence in which an utterance, with appropriate non-verbal behaviour, elicits a response by another interactant (Shotter, 1993). I shall not attempt to argue a rhetorical-responsive version of a theory of social constructivism, but rather will deliver an account of its use in social context as a tool, in explaining and accounting for, and indeed for making sense of, young children's everyday conversational activities involving number, and young children's appropriation of number ideas.

One consequence of my social constructivist theoretical perspective is that the research focus, of young children's developing number meanings, is being shifted from a description focusing upon aspects of individual number cognition to an interpretation of social interpsychological mediational aspects of the number learning process. Number meaning is not being located or interpreted as a cognitive burden within an individual child, but the process of cognitive appropriation is seen as dialectically embedded within the child's socio-cultural environment. It is that social mediational process of cognitive appropriation that is being interpreted and analyzed, in terms of the discourse of number present in a child's socio-cultural environment. An adequate account of how young children appropriate number may be seen to depend more upon social application and usage of number language, where meaning is being mediated in a social context, than the child's personal and individual cognitive construction of number denotation from concrete activity. Young children's number comprehension is thus being interpreted from the theoretical perspective of socio-cultural usage.

Adherence to a routine of observing and reporting, video-recording, and transcribing texts, all within socially framed episodes is expected to instill objectivity and rigour into a research process designed to compile a data bank of social mediative practices involving number use. Examples of the social practices involving numerical rhetorical-responsive mediation will then be interpreted and analyzed from a social constructivist dialectical perspective, 'from within' (Shotter, 1993).

In the view of Watson-Gegeo (1992), an ethnographic study of the influences and interactions of both the micro and macro contextual levels are necessary to achieve adequate analysis, holism and *thick explanation*:

> A thick explanation takes into account all relevant and theoretically salient micro- and macro-contextual influences that stand in a *systematic relationship* to the behaviour or events that one is attempting to explain
> (Watson-Gegeo, 1992, p54).

My social constructivist perspective recognizes that children are influenced by a multilayered social system composed of both micro and macro contextual levels, and my research field has been planned accordingly. It has been argued by Bronfenbrenner (1979), that when the subject of a research enquiry is human development, a broad sampling of settings should be undertaken:

> The understanding of human development ..... requires examination of multi-personal systems of interactions not limited to a single setting and must take into account aspects of the environment beyond the immediate situation
> (Bronfenbrenner, 1979, p21).

My research of young children's apprenticeship in number will include an examination of some macro contextual influences outside the family, such as institutional pre-school playgroups or nursery school, within which a child may become a social participant prior to formally entering school. These institutions may be expected to frame, inform, constrain or expand the numerical socializing interactions of young children's everyday life. By examining these settings as well as home life, I will be able to integrate the micro and some of the macro levels of young children's socialization processes, and so achieve a *thick explanation* and a more holistic understanding of young children's socialized interactions with number.

4.2 The research field:

1. An Ethnographic Case Study of Number Activity and Discursive Interaction at Home

The field of my ethnographic research is limited by real access. It is intrusive to enter the homes of total strangers, or even friends, for long periods of time. Even if this were possible, it would not be representative of a normal situation. A trusting rapport between researcher and subjects is important in ethnography and this takes time to develop. Methodologically this means 'being in communication' with the participants an 'insider' privileged to all the special vocabulary and pronunciations, all the nuances, gestures, looks, actions and virtually the whole area of 'body language' which conveys meaning to others. Such close communication could not be effectively 'set-up' for research, nor would it be totally practical, it has to be "lived" as Wittgenstein would say. My home observation of children has therefore been restricted to my own home, because only in this setting can a normal, unobtrusive situation, be sustained.

The family unit in my home, comprises myself (father), mother and two male young children: Kirk (born 24/9/90) & Ashley (born 21/8/91). This field enables a detailed holistic ethnography of mediated numerical interactions to be continuously monitored on the basis of:

1. Participatory observation (parental)
2. Non-participatory observation (child-child, mother-child, child with self)
3. Parental contribution, both structured and spontaneous, and temporal extent

Home observations (Tizard & Hughes, 1984) and interventions (eg. Tins game) (Hughes, 1986), have identified numerical activity and skill amongst many young children. But how does numerical activity come into being for young children? Does the child create for his or herself situational contexts which give rise to a practice of numerical activity, or is such activity always or partly socially created and mediated? In order to put young children's numerical activity into an historical perspective and gain insight into the situations which promote its development, it is necessary to record a child's numerical development as close as possible, in the depth of all of its manifestations.

For a period of 20-months, from January 1993 to September 1994 inclusive, Kirk and Ashley's daily activities, and their interactions with each other and their parents both inside and outside the home were systematically monitored. Notes were written about their numerical language usage and parental mediation in that usage. Kirk and Ashley's activities and interactions with parents were recorded during the 20-month period by using a video camera as a matter of almost daily routine. The video camera was switched on and placed in locations where there may have been some likelihood of capturing 'live' Kirk and Ashley using number language to communicate meaning, either to themselves, each other, or their parents; or where their parents were likely to communicate numerical meaning to Kirk or Ashley. This often entailed leaving the video-camera switched on in the livingroom, both during the daytime and evening, but it also involved the video-camera being placed in the bathroom, bedroom, diningroom, kitchen, in the garden, while walking along streets, and in a playpark The video-recordings were subsequently edited to develop a permanent record of Kirk and Ashley's numerical mediational interaction, in different contextual situations. The editing process involved identifying and selecting those episodes that directly involved some of the parties in the use of number words to communicate numerical meaning. This video diary of Kirk and Ashley's progressively developing use of numerical language has focused on maintaining episodes of numerical activity developed in social context, where numerical mediation and appropriation of meaning has apparently taken place. This video diary extends to approximately 56 hours, and all numerically relevant episodes have been reviewed and transcribed in full. Detailed transcripts exist of all relevant linguistically framed rhetorical-responsive interactions involving the social (parental) mediation of number meaning as well as number word use or application of appropriated meaning by Kirk and Ashley.

The home environment of Kirk and Ashley will furnish me with episodic examples of numerical activity particular to their own spatial, temporal and personal situation. This data will represent a unique insight into the social developmental course of their numerical knowledge, and the activities, mediational or otherwise, that dressed their knowledge in meaning.

My ethnographic case study of Kirk and Ashley aims to qualitatively describe how our cognitively entrenched cultural model of number is interpsychologically communicated through mediation. I hope to be able to show how the guiding words of others come to be appropriated by Kirk and Ashley in their own self-regulating practices of number thought. The home data is expected to shed light on the mechanisms by which meanings emerge interpsychologically through the social interactive process of rhetorical-responsive linguistic dialogue. The data may produce examples where these meanings have become intrapsychologically self-regulating for Kirk and Ashley through a process of social appropriation. The ethnographically accumulated data will be sampled across time to draw attention to the socio-historical development of meaning as a dynamic social process. It is anticipated that an examination of similar numerical activity in different contexts or situations may demonstrate an entrenchment or generalization of meaning in terms of mediational input. Kirk and Ashley are expected to continuously question and interpret any linguistically framed meanings imparted to them by others, and in this regard their process of appropriation will be acknowledged as having a social discursive component, involving the rhetorical-responsive development of meaning.

Steps have been taken to triangulate this 'home' data with further sources of other 'home' data, by asking six parents of young children to keep diary accounts of numerical activity in their homes, and by interviewing a much wider cohort of parents in relation to their home practices.

2. Diary Studies of the Numerical Activity and Interactions of other Young Children at Home

In a recent research study into young children's literacy and number interactions by Munn & Schaffer (1993) it was reported that:

> Studies of children in home settings tell us that early learning is an ad-hoc affair, with adults using opportunities to extend learning as they present themselves in the course of daily routines (Munn, & Schaffer, 1993, p64).

But what is the nature and character of these *ad-hoc affairs* with regard to number? Is the learning instructive in a mediational sense? Is it largely rhetorical-responsive in nature? Is it structured in any way by parents?

The uniqueness of Kirk and Ashley's numerical experiences at home is insufficient to answer such questions in any more generalized way. Consequently, the home data of Kirk and Ashley will be partly triangulated by unobtrusive sampling of the nature of numerical activity in other children's homes, through the compilation of diary reports involving the cooperation of parents.

In this study six parents have monitored and recorded in a diary notebook those numerical practices in which their children have independently or jointly been engaged in. Parents were asked to observe and report on all events at home involving their children in number usages. Parents were free to report on anything that happened during their child's daily routine or play. It was emphasized to parents that they were not being asked to deliberately 'teach' or do any 'additional' number activities with their child, but to report the activity that takes place in the course of living. Parents were asked to indicate the age and sex of their child and record their observations over a three month period. These diary reports imposed an additional chore on parents, and this duty required a certain amount of good faith, rigorous reporting could not be expected. Indeed, twelve parents originally agreed to keep a diary record of their child's numerical activity, but in the event only six parents maintained records. However, the number of diary reports compiled is sufficient to indicate if there are comparisons with the case of Kirk and Ashley in relation to the nature and extent of parental involvement in mediating young children's numerical activities through language. These diary records will be closely scrutinized in order to identify any commonality of scenes or practices, mediational or otherwise, or gross disparities in relation to other children's numerical experiences at home, compared to those monitored in the case of Kirk and Ashley. A sense of validity will be determined through multiple comparison of the reports with each other and by comparing reported practices with answers given during private interviews with other parents. These diary reports are expected to shed further light on the nature, character and extent of social practices in which adults involve young children in number.

3. Interviews with Parent/adult Caregivers

Forty interviews with parents/caregivers were conducted on a one-to-one basis, usually on the premises of preschool playgroups. The parents/caregivers of young children aged between 1- and 4- years old were individually approached, usually when they appeared to have some free time, ie. when their child was busy playing, when they were sitting alone, having a cup of tea, or showing some interest in the research activity, etc.. The interviews lasted approximately 20 minutes and were usually audio recorded (but a few were not for various reasons). Parents/caregivers were asked a series of pre-prepared semi-structured questions designed to elicit information concerning their young child's number skills, for example: extent of reciting the standard number word sequence, counting items in one-to-one correspondence, cardinal labelling, and recognition of written/printed numerical figures; and questions were also asked about the contextual nature of the activities that the children and adults engage in together, or the children individually, in their 'use' of numbers (see Appendix C). This interview data will be interpreted qualitatively, but it will also be analyzed in a quantitative manner to provide a statistical analysis of children's numerical competencies in relation to parental/caregiver mediative practices. In order to determine measures of reliability and validity, comparisons will be made between interviews and parental testing of children. Parents were asked to mediate at home a series of activities that required their young children to use number (see Appendix C). Results of these number based, linguistically mediated, activities may or may not support parental/caregiver interview answers. Although all parents were asked to mediate these brief tests of their child's number skills, only a small proportion of parents returned results. Nonetheless, those parents who did so provided additional data in regard to their child's already developed number skills and this will be related to reported parental/caregiver number practices.

4 Case studies of Adult-child and Child-Child Mediation within Preschool Playgroups & Nursery School

In the light of recent research carried out by Munn & Schaffer (1993), it would appear that the incidence of numeracy events in preschool playgroups and nursery classrooms is rare:

> The latter [numeracy events] were relatively infrequent; when they did occur they tended more often to be embedded in literacy events such as songs, stories and rhymes. ... Very few activities dealing explicitly with quantity or comparison were observed, and there was also very little talk specifically about number or quantity (Munn & Schaffer, 1993, p70).

Munn and Schaffer argue that early numeracy experiences are just as important as are early literacy experiences for preparing young children for a schooling culture. In Munn and Schaffer's quantitative analysis of young children's nursery interactions, it was discovered that the majority of literacy/numeracy incidents occurred in preschool playgroups or nursery classes when "adults acted in a supportive capacity", and they imply that from their research, nursery school activities are not meeting young children's needs with respect to providing sufficient interactive numeracy experiences:

> The development of numeracy does not, of course, occur automatically but requires fostering by adults. In the nurseries we investigated such fostering was rarely observed, contrasting sharply with interview and observational data on mothers' activities with their children (Saxe et al, 1987; Tizard & Hughes, 1984) which suggest that games involving numbers are relatively frequent occurrences in the home (Munn & Schaffer, 1993, p76).

Munn & Schaffer suggest that nursery staff do not readily induct young children in number, or place young children in a numerical 'apprenticeship' role:

> Game-like activities involving number were not observed, suggesting that staff did not regard numbers, quantification, or one-to-one correspondence as suitable themes for play. Shared routines such as dishing out food or laying tables for dinner where staff involved the children, the appropriate numerical processes were not observed either (Munn & Schaffer, 1993, p77).

To what extent do adults/nursery staff support and mediate young children's numerical interactions in playgroups or nursery classes? Is support given relatively infrequently as is suggested by the Munn & Schaffer (1993) research? How infrequent? Is this likely to be substantially less than at home? What is the contextual nature and characteristics of numerical interactions in preschool playgroups? These are some of the questions that this research intends to address.

Four preschool playgroups and one primary school nursery classroom were selected for detailed observation of adult mediated numerical practices during daily interactive routine and play. The preschool playgroups/nursery school were selected on the basis of Convenience Sampling, they could all be reached easily and were situated within my home district, making the process of gaining access more acceptable to those in charge. My attendance appeared acceptable, and unobtrusive in the sense that I attended as a parent as much as a researcher, since I was always accompanied by either Kirk or Ashley, or both. However, my 'acceptable' parental attendance must be qualified to the extent that I was often the only male adult in the midst of female adults, and I was constantly video-recording the children's activities. Despite these oddities, my role did not differ much from that of the other parents, I became a playgroup participant. At times I passively observed the children playing and interacting, and at other times I took part in the children's activities, helping, guiding, directing, supervising, and generally acting as any other adult social regulator. The preschool playgroups all differed from one another in terms of the needs of parents/children they were designed to cater for.

The first playgroup was a daily creche set up within an adult education college to look after children of parents attending courses at the college. Usually there were approximately 12-15 children present, and in this creche the only adults constantly present were the creche staff, all trained nursery nurses, usually three in number, but sometimes four if there is a student nursery nurse. I attended this playgroup for three weeks, as a pilot study, to detect any difficulties that I might face in this aspect of my research. I monitored the children's interactions, taking observational notes, and video-recording the activity.

The second playgroup attended was a Parent and Child playgroup which met three times per week to enable local parents and children, usually about twenty, all regular, to associate with one another. It met in a church hall and a token charge was levied on parents attending. Numerous toys of various description were provided for the children to play with while parents were able to sit and chat to one another, usually over a cup of tea/coffee. This second playgroup was registered and operated under the umbrella of Pre-school Playgroup Association. It had a single organizer, qualified and waged, and she was assisted in the day-to-day running of the playgroup by some parents. I attended this playgroup for 12 weeks, constantly monitoring and video-recording the activity, as well as making some written notes.

The third playgroup observed was a local council operated playgroup, with its own premises situated in a sectioned-off area of a park close to a council housing scheme. This playgroup was open on a daily basis Monday to Friday, every afternoon, and it attracted a regular troop of parents from a nearby council housing estate. This playgroup might be described as being as much a 'club' for mums as a playgroup for young children. There were five regular staff members (all female), who worked on a three on, two off, rota basis. They were council appointed under-five play leaders, directly responsible for the daily organization of activities to occupy the young children. This council playgroup was labelled a Play & Stay, as parents had to remain on the playgroup premises with their children. I attended 4 days per week for 12 weeks, and constantly video-recorded the playgroup activity.

The fourth playgroup selected was different in nature yet again, it was a 'drop-in'. This fourth playgroup was privately operated, it opened Monday to Friday every morning, and it catered mainly for working mothers. Parents were not expected to remain at the playgroup with their children, although occasionally one or two did remain There were usually two or three staff present each day (all female), although only the proprietor appeared to be permanent, and they looked after approximately 15-20 regular children. There were always plenty of toys for the children to play with, and the staff constantly participated in the children's play or interacted in their activities. I attended 3 days per week for 10 weeks, and routinely video-recorded the playgroup activity.

The primary school nursery class that was selected for observation, was once again chosen for convenience and easy access. The nursery had admitted my son Kirk, on a mornings only basis in September 1993, when he had attained the age of 3-years. Access was readily available, and the school appeared content for me to carry out some educational research. So I attended Kirk's nursery class complete with video-camera for a period of 3 weeks, 3 days per week. I had intended to spend a longer period video-recording the interactions in the nursery class, however it became apparent to me that the principle nursery teacher felt that a longer period would have been too intrusive. However during my three week period in the nursery I was able to amass sufficient data in the form of video-recorded numerical mediational interaction of child-child, child-teacher and children's self-regulated use of numbers in nursery school, making a prolonged presence unnecessary.

The video-recorded activity among all of the preschool playgroups and the nursery class extends to approximately 124 hours in an unedited form. The average length of each recorded session was 1½ hours. When a preschool playgroup was being visited for the first few times, it was usual for the sessions during the first two weeks not to be video recorded, so as to make my entry appear more normal and acceptable. All video recordings were carried out as discretely as possible with the permission of those in charge. Parents and playgroup staff displayed some interest in my research activity. Although my research appeared to have little effect on normal routine, my presence is expected to have had some effect on adult behaviour when it appeared to them that they were being video recorded. Possibly more effort was made to be seen 'doing number'. This will be taken into account during the analysis of the playgroups/nursery research data.

Much of the playgroups/nursery activity video-recorded was continuous in the respect that once the camera was switched on in a playgroup or nursery, it was rarely switched off, except when batteries expired or when my attention had to be diverted to other matters. All of the activity episodes video-recorded were spontaneous and 'live', and were recorded because of possible numerical language application or use by adults or children, or possible introduction of numerical mediational input by adults or children. In other words the camera was always focused on what appeared to be the most interesting or most fruitful mediational event going on amongst the numerous simultaneous interactions between children and their activities. In any single playgroup there was likely to have been in excess of a dozen happenings at any one instant, and it is acknowledged that my video camera could only capture some of this. Activity sampling decisions were made on the spot and were based on the premise that where number use or mediation was likely between adults and children, or between children, that episodic event should be recorded. And, under these circumstances, what was recorded was expected to be just as likely to contain number word use or mediation of number meaning as what was not recorded. All of the activity that was recorded has been subsequently reviewed and accounts written about the nature of the total activity. In activity where there has been some child use of already appropriated number meaning, or activity in which adult guidance or mediation plays a role, numerical or otherwise, a detailed transcript of the episodic event has been produced. The number of events involving adult mediated number in preschool playgroups has been noted to be rather low in comparison to adult mediation of other activity. This has also been noted in a recent study of young children's literacy and numeracy interactions by Munn and Schaffer (1993):

> We found that relatively few literacy or numeracy incidents were observed when the children were not in the company of an adult; contact with material outside such social interactions produced only infrequent and fleeting contact. Adult-child interaction routines were therefore of fundamental importance in giving children experience of literacy and numeracy at their early age
> (Munn & Schaffer, 1993, p76).

My ethnographic observations, and video-recordings, of preschool playgroups, including the primary school nursery class, is qualitatively interpreted in terms of numerical utterance, but the data also lends itself to detailed quantitative analysis. I will draw out inferential statistical comparisons, regarding the *quality/quantity* of mediated numerical practices by noting the number of numerical interactions in terms of child use of number, adult use of number, adult-child mediation of number, between the different preschool playgroups and nursery. This quantitative data is expected to produce some insight as to the importance or cultural value of number implicitly imparted by adult caregivers in respect to their daily routine of aiding, guiding or mediating children's appropriation of number in social contexts.

Situations for counting and using number do arise in the course of preschool playgroup/nursery activities, and they can be readily created by adults and children during routine play and interaction without too much effort, eg. counting book pages or 'reading' book page numbers, counting the number of bricks in a toy tower construction, counting the wheels on a tricycle or dolls pram, checking the number of pieces in a jigsaw puzzle, counting the number of cars parked in a toy garage, or the number of toy animals in the toy farm, even counting the number of children playing with play dough, or painting, or running.

The questions to be answered are, "Do adults employ the use number words in their linguistic interactions during play with young children?", and consequently mediate number word meanings; and, "Does this occur to the extent that they might claim when interviewed on the subject?"; and, "What is the contextual nature and character of mediated numerical language use to, and by, young children in daily routine at preschool playgroups?".

Answers to these questions are important because a central tenet of Vygotsky's theory is the idea that psychological structures are created through interaction with the social environment (Vygotsky, 1978). Vygotsky points out that for the young child, speech may initially be a means of communication with adults, but that it soon becomes the social tool by which a child learns to regulate his/her own activity. Vygotsky has argued that higher mental functions are cultural developments, interpsychological developments, from social 'tool' use (language), and that they should be interpreted in terms of social mediated activity. Vygotsky's view of cultural development stresses the notion that in order to understand higher mental processes, such as number, researchers must examine their social origins:

> Instruction, after all, does not begin in school (Vygotsky, 1986, 208);
>
> Children begin to use the same forms of behaviour in relation to themselves that others initially used in relation to them (Vygotsky, 1981, p157);
>
> Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane (Vygotsky, 1981, p163).

The social regulational aspect of language is recognized by Bloom (1993), as being an important source of meaning for the child, where conventional, shared, and public meanings are embedded in the social use of linguistic forms:

> Children achieve the power of expression by learning the public, conventional meanings of a language for expressing and articulating the private, personal meanings they have in mind. This happens because of a child's social connectedness with other persons who need or want to know what the child has in mind, and developments in cognition and affect are integrated with one another in the endeavour (Bloom, 1993, p264).

Accordingly, adult verbal expression and use of numerical language as a means of representing adult ways of thinking would be expected to become increasingly part of the child's own self-regulated number thought through the interpsychological process of social mediated use of number:

> As a child learns language, he also learns through language (Halliday, 1994, p40).

Halliday (1994) views language as a social code bound up with culture, where culture is transmitted with the code, linguistic experience reveals both the social code and the culture. In this view, the culture of number and its social code, is only revealed to a child through the linguistic use of number. For Halliday, a child relies heavily on the social system of language to decode meanings in day-to-day life:

> so it is first and foremost through language that the culture is transmitted to the child, in the course of everyday interaction in the key socializing agencies of family and peer group (Halliday, 1994, p41).

If there is evidence for the interpsychological social use and mediation of number and number language in preschool playgroups and nursery classrooms, as well as in young children's homes, prior to young children's intrapsychological use of number and number language, then this would support a Vygotskian view of number appropriation as a higher mental process, developed through socio-cultural mediation. If there is little or no evidence for interpsychological social use or mediation, and young children do not make use of number or number language, this scenario would still be consistent with Vygotskian theory. Only in the case of young children using number and number language in the absence of social numerical mediation would explanations couched within a social constructivist perspective become suspect.

5 Nursery Teacher Interviews

My research observations of number practices and number interactions between adults and children in preschool playgroups and a nursery class will be partly triangulated by ascertaining a 'normal' perspective of the number skills that young children are 'expected' to acquire, and the means by which they are expected to develop these skills, by interviewing a cohort of professional nursery teachers.

As part of their research into young children's literacy and numeracy contextual interactions in nursery schools, Munn & Schaffer (1993) carried out nursery staff interviews, and it is equally important to this study that nursery teacher's observations, nursery practices, and teacher perspectives are represented and fully taken into account. Nursery teachers obviously play a major role in the socialization process of young children, and their input in terms of number use, whether mediational or not, must be viewed as instrumental in promoting young children's numerical cognition.

Six nursery teachers attending an INSET evening course at the university (UNL), agreed to be interviewed about their experiences of young children's number skills and their classroom practices. Each individual interview lasted approximately 20 minutes and each interview was audio recorded. The questions put to these nursery teachers (see Appendix E) were designed to shed light on three things:

1) Teacher/school expectations of parents in regard to prior fostering of number ideas in young children;
2) classroom practices related to the fostering of number in young children;
3) the variable extent of young children's number skills on entry to primary school;

In regard to the first point, Greenberg (1993) has argued that parents are not very effective at teaching their children how to count with *meaning*, suggesting that only qualified teachers can impart such *meaning:*

> Children come to us 'counting'. Though from a mathematician's perspective we should probably teach sets before one-to-one correspondence, *teachers* have to do the best they can with what comes to school. .... We can't ignore the facts that children count, that parents push counting. We *can* work with parents to help them understand how children *really* learn math, and we *can* help children understand the *meaning* behind counting (Greenberg, 1993, p75);

> In their haste to teach counting, many adults neglect to teach number up to 10 in connection with actual objects or people, each number up to 10 in relation to one, and each number up to 10 in relation to the number amounts next to it (Greenberg, 1993, p78).

Through a series of questions it was hoped to establish if there was any basis for believing that this view, of parents naively interfering in young children's counting practices, was shared by nursery teachers. Questions were designed to determine whether nursery teachers considered parental involvement in promoting their young children's counting skills as a necessary source of strength and thereby welcomed, even expected, or alternatively, was it viewed as inconsequential, possibly detrimental to children (in the light of the Piagetian view that sensory-motor manipulation of sets of objects leads the child to an intuitive understanding of one-to-one correspondence rather than verbal counting per se):

> Colligation and intuitive correspondence become true cardination only when they become operational, and this occurs only when there is co-ordination with ordination (Piaget, 1952, p138).

The view that numerical knowledge is constructed socially, in a discursive sense, rather than constructed individually, has yet to replace the rather narrow emphasis on children's experiential interaction with objects. Piagetian views of numeracy continue to influence practices in nursery schools concerning young children's introduction to number. The notion that young children are numerically incapable (due to their failure to 'conserve') prior to the stage of concrete operations carries the implication that explicit teaching of number (guided instruction) is inappropriate (Piaget, 1952). There is not much doubt that Piagetian research has revealed young children's lack of 'understanding' of numbers' relationships with one another. None-the-less there is evidence that young children's understanding of number is not dependent on the prior development of logical capacity (Resnick, 1989; Frye et al, 1989; Fuson, 1988; Fuson & Hall, 1983; Gelman & Gallistel, 1978). However, many nursery based number tasks/activities may be designed to assist young children to 'understand' number relationships though logical inference from their activity with concrete materials.

But do nursery teachers also socially construct numerical 'understanding' in young children, in a rhetorical-responsive manner, by instructing or guiding their young children in number relationships through talk, or do they just permit the young children to develop or construct their *own* 'understanding' at their own pace through their own activity?

Nursery teachers were questioned about the nature of their classroom practices designed to assist young children appropriate number, in order to establish if these were in any way substantially different from the discursive parental home practices. If differences did exist, then it might be argued that either school or home was better. Nursery teachers were asked if they thought that there were differences, and which they thought was better, school or home, parent or teacher. If differences were perceived between home and school number learning, then most certainly children would be seen to be following two different paths towards the goal of number competence, understanding through guided discursive 'use' in the home case, and understanding from 'play activity' in the school case. Nursery teachers were questioned as to how much guided talk goes on in nursery classrooms during young children's number related activities.

Durkin et al (1986) have documented the influence of everyday relational language regarding size, amount, comparison, etc., and Tizard and Hughes (1984) have pointed out the extent to which children and parents use relational language in the home to mediate meaning, including that of number. These studies demonstrate the extent to which early learning about number is embedded in conversational exchanges and discursive play. In the work by Saxe, Guberman, & Gearhart (1987) attention is drawn to the importance of such discursive formats for the early development of number understanding.

In relation to the third aspect of the nursery teacher interviews, Greenberg (1993) has admitted that, "Children come to us 'counting'" (p79), but to what extent? The variable number knowledge that young children bring to school (Aubrey, 1993;1994), is to be investigated by questioning nursery teachers, to determine the range and extent of these differences. The interview questions put to nursery teachers about young children's already developed number skills focused on four basic skills, which are acknowledged by previous research as being essential developments towards number 'understanding':

1) extent of counting range, the ability to memorize and recite the number word sequence by rote;
2) Enumeration, the ability to assign a number word label to each object in a set;
3) Cardinality rule, the ability to assign the final count word to indicate the number of objects in a set;
4) Quantitative comparison, the ability to appreciate that a higher number in the counting sequence signifies 'more'.

By questioning nursery teachers about the number skills that young children have attained prior to entering school, it may be possible to detect the existence of a 'number gap'. It has been noted elsewhere, and by Price (1989), that:

> In fact, the 'math gap' appears early and widens progressively there after (Price, 1989, p53).

Munn & Schaffer (1993), have noted the importance of early adult participation in young children's interactive experiences with literacy and numeracy, in relation to later benefits for the child during schooling:

> We would expect that those children who early on experience the most frequent and sensitive interactions around literacy and numeracy will be those children who subsequently enter school with the greatest ability in respect of early reading and number work (Munn & Schaffer, 1993, p78).

It would appear that early competence in numeracy may possibly determine future progression, or rate of progression in numerical subjects, throughout a child's school life:

> Preschoolers who exhibit a weakness in basic number concepts and counting skills may be at risk of failure when, at a later age, they are required to master school arithmetic; for example, children whose knowledge of the counting words is deficient and those who fail to appreciate the concept of 'more' will find basic addition and subtraction difficult and confusing (McEvoy, 1989, p110).

Stevenson et al (1986), have shown that, by the first grade, Minneapolis-area children's mathematics achievement scores are already below those of Japanese and Taiwanese children in comparable communities. Why does a *"math gap"* appear? Children are cognitively the same the world over. If what is different is the socio-cultural communities, then it may be supposed that certain cultural societies may place a higher value upon their children attaining early skill in number than others. Is there a high value placed on young children attaining early skill in number in our nursery schools? Nursery schools and teachers can only be expected to reflect socio-cultural aspirations and expectations.

There is now a growing appreciation amongst some educational researchers that the development of emergent literacy and numeracy is not just related to social settings, such as a nursery school or home, but to the adults who discursively interact in the activity of young children, it is this adult interaction in social context that appears to determine young children's early cognitive achievements:

> The relatively low proportion of literacy/numeracy intervals without any adult interaction demonstrated the dependence on adults of such young children for literacy and numeracy experiences. The nurseries had books freely available (with the exception of one nursery which safeguarded its books against damage!), as well as puzzles, crayons, jigsaws and other potentially educational material, but the children's use of such material was dependent on adult encouragement and responsiveness
>
> (Munn & Schaffer, 1993, p71).

For the early development of both literacy and numeracy, then, a social constructivist perspective is acknowledged by some researchers to be a more appropriate stance than an individual constructivist perspective. But such views are certainly not widespread amongst all nursery educational researchers, Greenberg (1994, p18/88) for instance writes:

> Children learn as they live, work, play, and converse with peers. As they exchange ideas, they challenge each other every bit as much as many adults challenge them - *to think*, to reconstruct their ideas because they have new information and viewpoints

What factors do nursery teachers recognize as contributing to children's emerging number skills? Possible answers include, interactive adult contact, peer interaction, numerical talk. Munn & Schaffer suggest that research into young children's social contextual interactions during care is important because it may be very relevant to young children's future achievements in education:

> The organisational and interactive quality of early child care is, therefore, a matter of direct educational relevance, and research on this particular topic is continuing (Munn & Schaffer, 1993, p78).

CHAPTER 5

A HOME CASE STUDY: KIRK & ASHLEY

5.1 Introduction:The nature of Adult-Child Numerical Apprenticeship

According to White (1971), mothers very rarely spend 5, 10 or 20 minutes teaching their one- or two-year old children. However, White asserts that children get an enormous amount of teaching, at the child's instigation, through constant investigative questioning of daily routine, via social practices and language usage/application, and often involving the taxing children's Why? questions. White (1971, p87), noted that parents mostly acted *in response* to overtones by children:

> Our most effective mothers do not devote the bulk of their day to rearing their children .... Though usually working on some chore, she (mother) is generally within earshot. He (child) then goes to her and usually, but not always, is *responded to* by his mother with help or shared enthusiasm plus, occasionally, an interesting, naturally related idea. These 10 to 30 second interchanges are usually oriented around the child's interest of the moment rather than toward some need or interest of the mother

Mead (1934) asserted that children become more aware of the meaning of their actions when they attempt to communicate, and Rogoff (1991, p195) notes that:

> To act and communicate, individuals are constantly involved in exchanges that blend 'internal' and 'external' - exchanges characterized by the sharing of meaning by individuals.

As children engage in social interaction, they gradually call out to themselves the verbal responses they get from others. This process leads to a two-part self:
 - *'a speaking self'* and a *'self-talked to'*, which interact with each other.

Gradually, externalized conversation becomes internal thought, a developmental transition of external speech to speech for one's self. Vygotsky's analysis of egocentric speech or speech for oneself, interprets such apparent monologue as an act of self communication, external in origin to the individual, but internal in terms of structuring psychological functioning. This social apprenticeship in psychological thought, a blending of 'internal' and 'external' meaning via language is not problematic in the eyes of Rogoff (1991):

> the problem of specifying the process of internalization may be a problem only if priority is given to the internal or individual functioning, with the internal given responsibility for bringing something across a barrier. If, as I suggest, individuals are seen as appropriating some aspects of activity in which they are already engaged as participants and active observers, with the interpersonal aspects of their functioning integral to the individual aspects, then what is practical in social interaction is never on the outside of a barrier, and there is no need for a separate process of internalization
>
> (Rogoff, 1991, p195).

Research by Berk (1985), supports Vygotsky's view that speech for one's self is correlated to social speech from the youngest of ages, and that such speech is often used when children are confronted with demanding intellectual tasks. Berk (1985) found that young children used self-directed speech as a form of verbal stimulation during play, to express feelings, and to emotionally integrate thoughts and experiences. Berk has suggested that different types of self-directed speech can be viewed as independent language forms, each serving a distinct developmental purpose, and each running its own unique developmental course. Self-directed speech is seen as an important way in which children organize, understand, and gain a measure of control over their social microenvironment. Verbally expressed numerical experiences which encourage children's self-directed numerical speech may also promote numerical learning through verbal integration of thought with action. Berk's research suggests that when tasks are new and unfamiliar, adults need to provide verbal guidance that is sensitively tuned to the child's level of development. Such guidance is effective in supporting the child's accomplishments when it is verbally specific and directly tailored to ensure successful completion by the child. Gradually, as the child internalizes aspects of the external verbal guidance, the extent of this external verbal assistance wanes, and it becomes more general and less directive, permitting children to take over the task of verbal regulation, by controlling and focusing self-regulating speech.

Diaz (1984) examined the speech of nearly 100 pre-school children while they performed tasks in a laboratory, and he identified nine different self-regulatory functions of speech:

1. Labelling and describing; 2. Focusing attention; 3. Regulation of motor activity;
4. Facilitating transitions; 5.Ending uncertainty and preservation;

6. Abstraction of distinctive features 7. Praise and self-reinforcement;
8. Whispers; 9. Play and relaxation.

Diaz also studied the early developmental origins of self-directed speech by asking mothers to teach their young children to build a three-dimensional puzzle. The mother's verbal teaching behaviours were noted to be very similar in pattern to the preschoolers' self-directed speech when they did the task alone. Under conditions of increased stress or task difficulty, children were noted to use more self-directed speech to assist their performance. These findings support Vygotsky's view that young children's self-directed speech grows out of social experiences involving verbal support and assistance given to a child by an adult.

Applied to numeracy, this verbal interactional perspective of problem solving, highlights the possible social role of adults in the external verbal regulation of number understandings by young children. Numerical achievements or accomplishments may be a direct consequence of young children's microenvironment, and observed limits of understanding nothing more than a reflection of social limits on interactional use of number discourse by adults and children in their microenvironment. It is in the social microenvironment, where number language is used in context, that numerical thought may be openly verbalized and developed in a rhetorical-responsive manner by adults for the benefit of children. Numerical activities that take place within a child's microenvironment may assist that child to interpret the world numerically. In order to assist and motivate children to use number language, children may need to see and hear adults using number language in social contexts. Social environments that establish an interactive social context for discussing, questioning, and collaboratively using numbers would, in the light of Vygotsky's theory, be expected to motivate and structure the child's numerical thinking.
Studies of mathematical problem solving, for example (Pimm, 1987), indicate how useful dialogues among mathematics problem solvers can be in learning to think mathematically. Numerical discussion in social contexts enables children to verbally internalize the social thinking processes that get played out in such dialogue. The language of numbers is acknowledged to be an important representational tool in structuring numerical thought:

> How humans come to learn about the counting system of their culture is closely related to the nature of our initial representation of number, because in order to understand counting we must somehow relate it to our prior number concepts. ...... In order to understand the counting system - that is, to know how counting encodes numerosity - children must know the meanings of (some of) the number words (Wynn, 1992a, p220).

The cultural use of number, while materially based, cannot be simply or mechanically reduced to material relations. While necessarily located within material contexts, the cultural use of number may always be reduced to a form of linguistic representation. A pattern of sustained didactic conversation in which a parent responsively addresses numerical speech directly to a very young child, systematically modifying the numerical speech in relation to the child's ability to re-respond may be likely to promote the creation of numerical meaning for the child.

Schachter et al (1974), view this parental process of responsively and culturally educating children as a developmental shift on the part of parents:

> Essentially, responsive teacher communication seems to require a developmental shift from nurturance to socialization from ages 2 to 5 (Schachter et al, 1974, p1).

5.2 METHODOLOGY AND NUMERICAL EPISODIC OCCURRENCE

Kirk and Ashley's daily interactions were continuously monitored for a period of 20 months. During that time, Kirk and Ashley's daily interactions were video recorded, and from these recordings a video diary of numerical activity and talk was compiled. When the video camera was not being used, or not operating, field notes of Kirk and Ashley's numerical activity were kept in a conventional diary form, and these were supplemented by notes made by their mother. All forms of daily living routine were monitored from morning till night, both in the home and outside, encompassing: play with toys, play with each other, play with parents, play in a park, television watching, general conversation, meals/snacks preparation and consumption, bathing, book reading, shopping, walking along streets, climbing and descending stairs, jumping, lying in bed before sleeping, and much more. Examples of numerical mediation by adults to young children appears to feature in almost every form of daily routine in which adults and children interact. Children do appear to be interested in numbers (Gelman & Gallistel, 1978 p135) but it also appears that adults'/social others' contributional interest plays an important role in initiating, supporting and developing the child's numerical interests (see the coded research data within this thesis).
The numerical interaction between adults and young children always appears to be directed and shaped by language exchange, where the participants activity is structured by the use of rhetorical-responsive forms of numerical utterance. Young children do talk to themselves about number, as if they are attempting to *accommodate* an idea of number by a mental process of *reflective abstraction* (Piaget, 1952), but this talk may also be viewed as a social constructive appropriation. The child's number talk may be viewed as being originally someone else's utterance (another child's or adult's), in which case the child may be viewed as linguistically imitating social use. The child may appropriate the social meaning of the talk by practising the use of the numerical utterance and noting the social consequence or response to the utterance. Young children do appear to spend a great deal of time in deliberately making use of numerical expressions that they have heard others use, especially in the case of money. By appropriating numerical utterances from social others and making them their own, young children's cognition is being linguistically and socially moulded. Young

children's appropriation of number can be demonstrated by their spontaneous use of number language, usually correctly.
This case study of Kirk and Ashley's use of number demonstrates that young children are able to appropriate their ideas about number from the social context in which they find themselves, and from asking adults questions about number use and meaning.

A very large quantity of social contextual episodes involving Kirk and Ashley in interactive number use were noted during the course of this research, and it is probable that there were at least as many episodes missed as were captured. Altogether there were 446 numerical episodes video recorded around the home involving Kirk and Ashley practising the use numbers (when they were both involved in the episode it was counted twice, see APPENDIX A1), and 179 diary entries (see APPENDIX A2) that report their practices of number use in both the home and outside the home eg. shopping, walking, sitting in the car, playing in the park etc.. The total number of social interactive episodes, recorded and noted, involving Kirk and Ashley in practices involving the use and application of number was 625.
However it is important to note that *quantity* alone does not provide a satisfactory measure of the extent of a child's numerical apprenticeship. The *quality* of the numerical interactive talk must be examined if any real insight is to be achieved, and this can only be accomplished through a suitable coding mechanism. Some episodes of interactive numerical talk may embrace a rich mixture of 'principles' related to social number use, but other episodes may be limited to one or two 'principles'. Therefore, the quantity of numerical episodes is not a sufficient guide to analyze a numerical apprenticeship, and an examination of the *quality* or *content* of the talk must be undertaken.
A two dimensional coding mechanism has been designed to examine the *numerical content* of the child's numerical interactive talk, as well as the *mode of mediation*, and so provide a more satisfactory basis for measuring both the quantity and quality of the numerical apprenticeship.

5.3 UNITS OF ANALYSIS: CATEGORIES OF MEDIATIONAL/NUMERICAL ACTIVITY

In order to produce a rigorous analysis of the interactive numerical dialogic utterances in which Kirk and Ashley act as the focal participants, the numerical dialogue will be subjected to a coded analysis.

The question of who is doing the numerical talk must first be answered. The talk may originate with either the child who is seen to initiate or construct the numerical utterance without any adult/social other prompt, or it may be numerical talk that has been initiated, promoted, or prompted by an adult/social other.

When it can be clearly seen that an adult/social other has engaged the child in interactive numerical talk, possibly in cases of instruction, guidance or assistance, then the numerical talk be coded within an *A*- sub-division.

If he numerical talk has been initiated by the child, then the question arises, "To whom is the numerical talk directed?", and the answer may be either for the child's self or for a social other, since according to Vološinov:

> A word is territory shared by both addresser and addressee, by speaker and his interlocutor (Vološinov, 1973, p86).

When the initiation of numerical talk clearly emanates from the child's utterance, without any adult/social prompt, possibly due to a contextual situation in which the child find's itself in, and where the child's numerical talk may be noted as being uttered for an adult/social other present (a possible listener), the talk may be coded within a *P*- sub-division.

If the child's numerical talk does not appear to be for any other listener, it may be concluded that the numerical utterance is for the child's *self*, (as both addresser and addressee), and in this case the talk may be classified in an *S*- sub-division.

Thus all the interactive numerical talk may be classified within one of three sub-divisional categories, *A*-, *P*-, or *S*-. It is important to recognize that the three sub-divisions, *A*-, *P*-, and *S*-, should not be considered to be mutually exclusive. Speech for others is also speech for oneself, and the speech of others is often imitated and it may subsequently function in a self-regulative manner. The P- sub-division may also act as a self-regulative performance and it may also become linked to an A- sub-division. A flow diagram on the following page indicates the routes that were followed in sub-divisionally codifying all the interactive numerical dialogue.

The coding classification has a second dimension, a numerical dimension, that classifies aspects of number utterance use.
Each of the three sub-divisions (S-, P-, A-) accommodate seven sub-categories (I, II, III, IV, V, VI, VII) which characterized the content, or numerical nature, of numerical talk. Numerical rightness or wrongness is mostly ignored, it is the numerical act or performance that is being classified within a category.
The seven separately coded categories were developed from the research data, they were not arbitrary developed apart from the data, neither were they imposed on the data from external sources. The codes grew out of the research data, and they represent the numerical nature of the utterances, in other words the numerical content present. These seven sub-categories are outlined with examples, immediately after the mediation flow diagrams.

Flow Diagram 1

Who is verbalizing the number?

Child's decision alone

Adult initiated

A categories

Constructive rhetorical-responsive numerical discourse that may be causually attributed to an Adult or social other. There will be verbal interaction between the child and the adult/social other, and it may involve numerical intervention, correction or assistance, in the form of instruction and guidance, but it need not take on this aspect, - it could involve prompting eg. 'How many?', 'Count carefully', 'What number is this?' The adult, or social other, will be actively structuring and directing the course of the numerical discourse, acting in a mediating capacity, and will not be acting just as a responsive listener.

To whom does the verbalization appear to be directed?

Self

Adult or social other

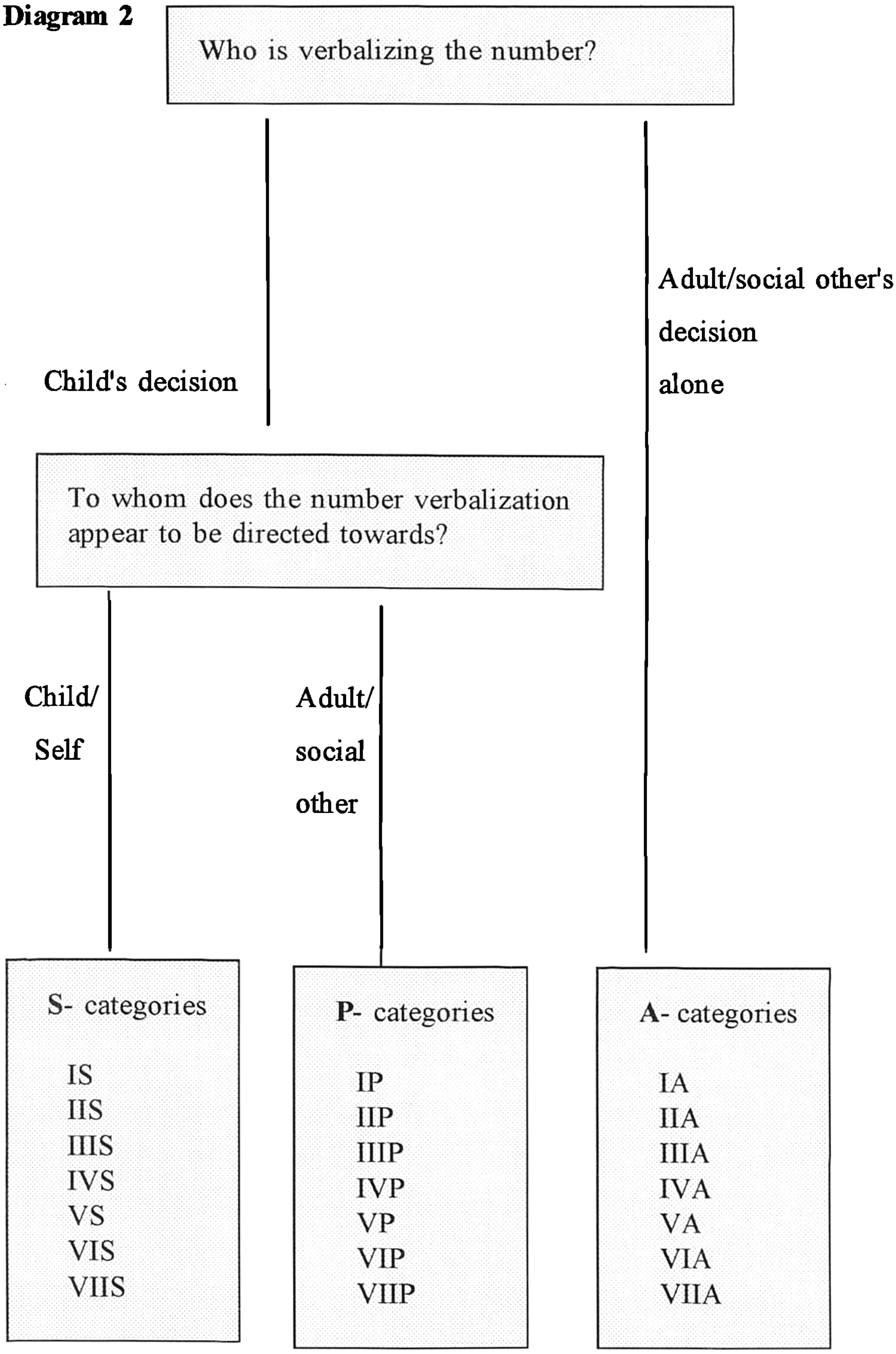
S categories

Number verbalization appears to be directed towards Self, it is entirely self initiated and self promoted, it is talk functioning as self-regulating speech, it is talk deemed to be directed towards no other apparent listener, it may be considered to be egocentric talk.

P categories

Rhetorical-responsive numerical interaction that may be deemed to have been generated by a child for an adult or social other **P**resent, a listener, real or imagined, a presence that may be attentive, but it could equally be passive. The numerical discourse is child initiated and child propagated, - although the adult or social other may act verbally responsively eg. 'Yes', 'No', 'Good', 'I think you made some mistakes', - but acting as a listener without direct numerical mediative intervention. The adult or social other may be indirectly responsible for the contextual situation which has prompted the child's numerical talk.

Flow Diagram 2



S- categories, interactive number practices for Self

IS - **Number recital**, without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child sitting alone in his/her bath singing part of the number sequence.

IIS - **One-to-one correspondence** sequential counting, actual or intentional, without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child is observed to count coins that have been removed from his/her pocket

IIIS - **Cardinal labelling** practised without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child is playing alone with a colouring book and crayons, suddenly the child spontaneously vocalizes his/her quantity of crayons.

IVS - **Subitization** practised without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child finds a dice and starts to call out the cardinal number of spots seen on each die face without practising one-to-one correspondence counting.

VS - **Symbolic number figures** 'read' without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child is playing alone with a toy telephone and the child is observed to call out the names of the cardinal numbers indented on the key-pad.

VIS - **Number labelling** practised without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child is playing with toys, but suddenly exclaims "I'm three, I'm not two!".

VIIS - **Number sum** practised, eg. addition/subtraction/division/multiple, without adult/social other verbal interaction, numerical intervention, assistance or presence being noted;

Example: Child studies outstretched fingers on his/her hand, and comments to self, "Five and five is ten"

P- categories, Interactive number practices for social other Present

IP - **Number recital**, without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;
Example: Child sitting in his/her bath, suddenly calling out, "Listen to me, I can say it now", and then sings part of the number sequence.

IIP - **One-to-one correspondence** sequential counting, actual or intentional, without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;
Example: Child comments to mother, who is busy watching television, "See how many I've got" and then counts coins removed from his/her pocket.

IIIP - **Cardinal labelling** practised without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;
Example: Child is playing alone with a colouring book and crayons, father is reading, suddenly the child spontaneously vocalizes his/her quantity of crayons.

IVP - **Subitization** practised without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;
Example: On being given a dice by its mother, the child immediately begins to call out the cardinal number of spots seen on each die face without practising one-to-one correspondence counting.

VP - **Symbolic number figures** 'read' or recognized without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;
Example: Mother is watching a television quiz show, the child is also watching, number figures are displayed on the television screen as part of the programme, and the child begins to call out the names of the cardinal numbers shown.

VIP - **Number labelling** practised without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;

Example: Child is unhappy with a television programme and asks father to switch the television onto another channel, "Check what's on four".

VIIP - **Number sum** practised, eg. addition/subtraction/division/multiple, without adult/social other verbal or numerical initiation, intervention or assistance, but presence being noted as a possible listener;

Example: Child shows mother outstretched fingers on his/her hand, and comments, "Look, five and five is ten"

A- categories, Interactive number practices constructed by Adult for a child

IA - **Number recital** initiated, coaxed, or extended by active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance;
Example: Child sitting in his/her bath, mother sings part of the number sequence, and then coaxes the child to imitate the sequential singing.

IIA - **One-to-one correspondence** sequential counting, actual or intentional, with active adult/social other participation, possibly involving verbal interaction, numerical intervention instructional assistance or guidance;
Example: Adult comments, "See how many I've got" and then counts coins in his/her pocket. Adult then persuades or causes the child to imitate the count.

IIIA - **Cardinal labelling** practised with active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance;
Example: Child is shading a colouring book with crayons, mother watches for a while, then mother asks the child how many crayons he/she has. Depending upon the answer given, there may or may not be some numerical intervention.

IVA - **Subitization** practised with active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance;
Example: The child is engaged by its mother in a game of dominoes, the mother and child both call out cardinal numbers associated with the spots on the domino faces.

VA - **Symbolic number figures** 'read' or recognized with active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance;

Example: Mother reads a counting book to her child, making the child point to symbolic number figures as she calls out the cardinal name, mother then coaxes the child to call out the cardinal name as she points to the symbolic number figures.

VIA - **Number labelling** practised with active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance.

Example: Father comments to child that Mummy will be home soon, that she is on the number eighteen bus, and that she will arrive at six O'clock, and that it is only half-past five at present.

VIIA- **Number sum** practised, eg. addition/subtraction/division/multiple, with active adult/social other participation, possibly involving verbal interaction, numerical intervention, instructional assistance or guidance.

Example: Mother shows child outstretched fingers on her hand, and comments,

"Look, five and five is ten"

5.4 NUMERICAL EPISODE REPRESENTATION

It is quite impossible within the constraints of this thesis to outline and represent all the recorded numerical episodes in which Kirk and Ashley acted as apprentices, and *'served time'* in appropriating our rhetorical-responsive number sense. However, the theoretical argument of this thesis can only be substantiated, and the questions posed answered, on evidence. It is therefore imperative that I provide such evidence, and so demonstrate that number use by children is as much a social practice as it may be a cognitive development.

I will therefore proportionally select some 154 representational episodes, about ¼ of the 625 recorded episodes, so that it can be clearly seen how such numerical episodes are often dialectically constructed by young children during interaction with their social environmental surroundings, cognitively supported and structured through social linguistic interaction, and numerical meaning mediated and regulated through rhetorical-responsive adult participation in that interaction. A selection from this representation will be used as examples to illustrate points in the Total Analysis section.

Thus the research evidence that is to be provided to illustrate examples of socially constructed rhetorical-responsive numerical mediation will be selected from the 154 proportional quantity of representational examples listed in APPENDIX A3. This should be proof enough that a *'number apprenticeship'* has been served by Kirk & Ashley.

5.5 NUMERICAL EPISODE SAMPLE REPRESENTATION ANALYSIS

All numerical conversations were coded in the format already outlined, and the complete total of 635 coded episodes, Diary (D) and Video (V), are represented in APPENDICES A1 and A2. A sample list of 154 examples of numerical talk are presented in APPENDIX A3 with their particular codings, and the linguistic interchanges in this sample are used to illustrate numerical mediational exchanges. The representational nature of these 154 sample episodes as compared to the total may be judged in terms of comparative percentages.

The 154 sample examples presented represent 24.3% of the total in terms of episodic quantity. However, as has already been noted, quantity alone is insufficient as a measure of numerical interactive talk, and the coding may serve as a more reliable guide to the quality nature of that numerical interactive talk.

Altogether there were 1573 coded expressions related to the nature and content of the numerical interactive talk that took place within the 625 episodes. The representation of the coding quantity in the examples sample may be viewed as representing the *sample quality* of the numerical interactive talk.

The 154 episodes that have been are outlined in APPENDIX A3 account for 421 coded interchanges, representing 26.8% of the total number of codes (see Table 1). And, if it makes any sense in terms of representation, the mean percentage between quantity of examples and quantity of codes would be 25.6%.

Therefore it may be safe to say that the 154 sample episodes in APPENDIX A3 represent approximately ¼ of the total recorded, both in terms of episodic quantity, and quality through coding considerations.

TABLE 1 **TOTAL EPISODE CODING REPRESENTATION**

	TOTAL No. VIDEO (V)	TOTAL No. DIARY (D)	TOTAL No. (V) + (D)	SAMPLE TOTAL EXAMPLES
IS	15	17	**32**	11
IP	106	20	**126**	34
IA	48	9	**57**	17
IIS	15	14	**29**	9
IIP	105	50	**155**	41
IIA	96	17	**113**	26
IIIS	8	4	**12**	4
IIIP	173	69	**242**	63
IIIA	204	39	**243**	57
IVS	3	4	**7**	3
IVP	17	18	**35**	10
IVA	34	6	**40**	9
VS	13	9	**22**	8
VP	68	15	**83**	27
VA	85	17	**102**	25
VIS	1	1	**2**	1
VIP	75	6	**81**	23
VIA	64	2	**66**	16
VIIS	1	1	**2**	1
VIIP	17	18	**35**	11
VIIA	55	34	**89**	25
TOTALS	**1204**	**369**	**1573**	**421**

% of codes represented = 421 ÷ 1573 × 100 = **26.8%**

EXAMPLES SAMPLE: PROPORTIONAL REPRESENTATION

Episodes:	No. (V)	No. (D)	No. (V +D)	No. Examples
	446	179	625	154

% of examples represented = 154 ÷ 625 × 100 = **24.3%**

% of codes represented = **26.8%**

Mean % of representation (codes, examples) = (26.6 + 24.3) ÷ 2= **25.6%**

TABLE 2 **TOTAL CODED DATA - BASED UPON 1573 CODES**

Sub-categories

%	I	II	III	IV	V	VI	VII	TOTAL
Sub-divisions S	32	29	12	7	22	2	2	105
P	126	155	242	35	83	81	35	756
A	57	113	243	40	102	66	89	709
TOTAL	215	297	497	82	207	149	126	1573

TABLE 3

SAMPLE : TOTAL CODED EXAMPLES
- BASED UPON 421 CODES

Sub-categories

%	I	II	III	IV	V	VI	VII	TOTAL
Sub-divisions S	11	9	4	3	8	1	1	37
P	34	41	63	10	27	23	11	209
A	17	26	57	9	25	16	25	175
TOTAL	62	76	124	22	60	40	37	421

TOTAL (V+ D) CODING PERCENTAGES

- BASED UPON 1573 CODES IN 625 EPISODES

TABLE 4 Sub-categories

%	I	II	III	IV	V	VI	VII	TOTAL %
Sub-divisions								
S	2.0	1.8	0.8	0.4	1.4	0.1	0.1	**6.6**
P	8.0	9.9	15.4	2.2	5.3	5.2	2.2	**48.2**
A	3.6	7.1	15.5	2.5	6.5	4.2	5.7	**45.1**
TOTAL	**13.6**	**18.8**	**31.7**	**5.1**	**13.2**	**9.5**	**8.0**	**99.9%**

TABLE 5

SAMPLE REPRESENTATIVE CODING PERCENTAGES

- BASED UPON 421 CODES IN 154 EPISODES

Sub-categories

%	I	II	III	IV	V	VI	VII	TOTAL %
Sub-divisions								
S	2.6	1.9	1.0	0.7	1.9	0.2	0.2	**8.5**
P	8.1	9.8	15.1	2.2	6.5	5.5	2.6	**49.8**
A	4.1	6.0	13.6	2.2	6.0	3.8	6.0	**41.7**
TOTAL	**14.8**	**17.7**	**29.7**	**5.1**	**14.4**	**9.5**	**8.8**	**100**

5.6 REPRESENTATIVE SAMPLE ANALYSIS: ACCURACY OF REPRESENTATION

With 21 different codings possible, and each coding often influencing the presence of others, a proportional 100% representation of each coded category is very difficult to achieve, and probably impossible, within the constraints of a quarter of the complete sample. However, the sample examples represented in APPENDIX A3 have been proportionally selected to provide a balanced picture of the complete sample, and a 100% proportional representation has been pursued.

TABLE 6

SUB-DIVISION (all sub-categories) %	**% Total (V+D)**	**% Represented**	**Proportional**
S	6.6	8.5	**128.8**
P	48.2	49.8	**103.5**
A	45.1	41.7	**92.5**

mean proportional sub-division representation **108.3%**

TABLE 7

SUB-CATEGORY (all sub-divisions) %	**% Total (V+D)**	**% Represented**	**Proportional**
I	13.6	14.8	**108.8**
II	18.8	17.7	**93.7**
III	31.7	29.7	**94.0**
IV	5.1	5.1	**100.0**
V	13.2	14.4	**109.1**
VI	9.5	9.5	**100.0**
VII	8.0	8.8	**110.0**

mean proportional sub-category representation **102.4%**

Both the mean sub-division representation, and the mean sub-category representations indicate that the representative sample episodes lie within a ± **10% representational range**.

5.7 A Discussion of the examples Proportional Representation

In the representative examples (Appendix A3), of Kirk and Ashley's interactive numerical dialogical talk, the S-codes tend to be over represented, the P-codes are very slightly over represented, and the A-codes slightly under represented. The S-codes, numerical talk for oneself, comprise the smallest sub-division, they occur relatively rarely, only 6.6% of the total, and the 1.9% over representation does not distort their low levels of occurrence. The P-codes, numerical talk for others present, is relatively well represented, only a 3.5% over representation. The under representation of the A-codes, numerical talk interactively developed by an adult or social other, by 7.5%, may be noted and account taken of this under representation. Since the principle argument of this thesis is that young children's numerical talk is interactively and interpsychologically developed socially, I do not wished to be accused of over representing the A-coded categories, hence their under representation (to compensate for any inherent researcher bias).

In Appendix A3, the seven sub-categories, which indicate the nature of the numerical talk, are all proportionally well represented, they all lie within a ± **10%** representational range.

In the following chapter section, representational research extracts from Appendix A3 will be used to analytically illustrate the social interactive contextual dependence of Kirk and Ashley's episodic use of numerical utterance.

5.8 AN ANALYTICAL DISCUSSION OF THE RESULTS OF THE TOTAL DATA

Total (V+D) Coding Percentage analysis

- based upon 1573 codes in 625 episodes

TABLE 4

%	Sub-categories I	II	III	IV	V	VI	VII	TOTAL %
Sub-divisions								
S	2.0	1.8	0.8	0.4	1.4	0.1	0.1	**6.6**
P	8.0	9.9	15.4	2.2	5.3	5.2	2.2	**48.2**
A	3.6	7.1	15.5	2.5	6.5	4.2	5.7	**45.1**
TOTAL	**13.6**	**18.8**	**31.7**	**5.1**	**13.2**	**9.5**	**8.0**	99.9%

The very low percentage level of 'talk for self', **6.6%** in the S-category codes, indicates that most of Kirk and Ashley's numerical talk was socially interactive, either as a social responsive display or practice (the sub-division P-categories), or involving social rhetoric to guide, assist, or prompt numerical utterance (the sub-division A-categories). This may be seen in the following representational examples:

16-11-93 (D) evening CODED VA

Mum was reading a counting book to Ashley while he lay in bed. Mum was prompting Ashley to recognize the number symbols. Ashley was very attentive and he participated by responding to Mum's questions, although he was not always correct.

22-11-93 (D) morning CODED VA

Ashley was joining a number jig-saw puzzle together, where each number figure between 1 and 10 had to be joined together in sequential order. Dad asked him to point to the number "eight", and Ashley pointed to the puzzle piece with the figure 8 printed on it. Ashley has made some progress on the recognition of number figures.

09-12-93 (D) afternoon CODED VP, VA

During our walk home from a preschool playgroup, Kirk spontaneously started to 'read' the street number plates outside buildings. He first noticed 75 and said "seventy-five", the next number he came to was 73 and he said "seventy-three". As we continued along the street Kirk continued to call out the number labels, until the numbers all finished, after about ten minutes. Although Kirk did not receive any assistance with the saying of the first few numbers, later on he did receive help from Dad (eg. after completing the sixty series, Kirk became stuck at 59, so Dad said "fifty-nine", then Kirk would continue with "fifty-seven" on sighting 57, but 55 also had to be verbalized by Dad). Dad continued to give some assistance and hints to Kirk with his verbalization of the forty's, thirty's and twenty's series numbers. Kirk was given ample opportunity to tackle each number by himself, but Dad stepped in to assist when it appeared apparent that he was stuck. Kirk's nursery teacher at school confirmed to Dad that she had in no way attempted to help Kirk to recognize double figured numbers. His teacher said that she had done "nothing" with him on that. Kirk's double figure number interpretations had been derived from his own social interactional appropriations.

12-07-94 (D) afternoon CODED IP, IA; IVP, VIIP, IIIP

As Dad walking down a flight of stairs with Kirk and Ashley onto a train platform, both Kirk and Ashley started to count the steps as they made their descent. First Kirk started to count, then Ashley imitated the behaviour.
Kirk: (counting the steps, but not necessarily in one-to-one correspondence with the number words uttered) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, seventeen, eighteen, nineteen" (sixteen missing)
Dad: (completing Kirk's count or recitation) "Twenty"
Ashley, who had started from a higher position, continued to count beyond twenty.
Ashley: (also counting the steps, but not necessarily in one-to-one correspondence with the number words uttered) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-five, twenty-six, twenty-seven, twenty-eight, twenty-nine" (then Ashley continued) "twenty-eleven, twenty-twelve"
Dad: (interrupts Ashley's count) "It's thirty after twenty-nine"
Ashley lost his concentration and stopped counting.
Once the three of us were on the train, we walked towards a group of four chairs, two facing another two. The instant Ashley saw the arrangement that we were about to occupy he interpreted it in terms of a number sum.
Ashley: (looking and pointing at the group of four seats) "Two and two; four!"

As Ashley looked around his environment, it was obvious that he was beginning to see the world in terms of number, he had been given the 'sight' of number through his *numerical apprenticeship.* Ashley's face displayed an expression of delight as he revelled in his numerical recognition that the four seats were composed from two sets of two seats.

The numerical utterances of Kirk and Ashley cannot be viewed as utterances constructed or belonging to them as individuals (Vološinov/Bakhtin), since there is ample evidence that approximately **45.1%** of the total quantity of numerical utterance was developed or prompted by an adult/social other (the total of the A- sub-division categories). Aspects of social other instruction, assistance, and guidance no doubt influenced the developmental course of Kirk and Ashley's numerical utterances, and this is most readily seen in the number recitation (up to twenty), 'tuition' by Mum episodes. The eventual social performance by Kirk of a numerical string utterance up to twenty was initially initiated, prompted and guided by Mum. The number string recitation was communicated and led by a social other (Vygotsky) in the A- sub-division, and after a few days it made an appearance in the social performance P- sub-division. See below:

13-02-94 (D) evening CODED IA

At night time, before sleeping, Ashley asked Mum when she was coming to bed.
Mum: (replying to Ashley's question) "In twenty seconds" (Mum the started verbally reciting the number sequence, as if counting twenty seconds to Ashley) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty"
When Mum was in bed, she spoke to Kirk, saying, "Count up to twenty", but Kirk did not respond, so Mum herself started to verbally recite from ten.
Mum: (verbally reciting for Kirk's benefit) "eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty; you do it, ... eleven"
Kirk: (taking up Mum's cue of eleven) "eleventeen, twelve, fourteen, fifteen, sixteen, eighteen, nineteen, twenteen"
Mum: "That's not right, it's eleven; there's no eleventeen or twenteen, it's eleven and twenty;try again, eleven, twelve, go on"
Kirk: "eighteen, nineteen, twenty"
Mum: "Count from eleven; eleven"
Kirk: "twelve"
Mum: "thirteen"
Kirk: "fourteen"
Mum: "fifteen"
Kirk: "sixteen"
Mum: "seventeen"

Kirk: "eighteen"
Mum: "nineteen"
Kirk: "twenty"
Mum: (then tried to encourage Kirk to recite the sequence once again for himself) "Count it yourself from eleven"
Kirk: "eleven, twelve, fourteen, fifteen, sixteen, eighteen, nineteen, twenty"
Mum: "It's seventeen, eighteen, nineteen, twenty; sixteen, seventeen, eighteen, nineteen, twenty; Do it again; eleven"
Kirk: "eleven, twelve, fourteen"
Mum: (interrupting Kirk to correct his recital) "eleven, twelve, thirteen"
Kirk:"eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty"
Ashley had been lying silently listening to the whole episode.

27-02-94 (D) afternoon CODED IS, IP, IA

Kirk was playing upstairs with Ashley, they were both in the bedroom alone for some time. Kirk was heard practising his number sequence recital up to twenty.
Kirk:(could be heard saying to himself) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty"
When Kirk had completed his number sequential recitation he was excited, and satisfied, about his accomplishment. He ran downstairs into the livingroom where Mum was sitting.
Kirk: "Mum, I counted up to twenty properly"
Mum: "Let me hear you"
Kirk: (repeats his number recitation for Mum) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty"
Mum: "Good boy!, go and tell Daddy"
Kirk entered the dining-room where Dad was seated.
Kirk: (speaking to Dad) "I counted up to twenty properly"
Dad: (responding to what Kirk has said to him) "Let me hear you"
Kirk: (recites his number sequence again) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, eighteen, nineteen, twenty"
Dad: (responding by correcting Kirk's recital) "You missed out seventeen, it's seventeen, eighteen, nineteen, twenty; sixteen, seventeen, eighteen, nineteen, twenty"
Kirk: (listens to Dad's corrected rendering, then leaves the room)

Kirk and Ashley's numerical utterances cannot be meaningfully separated from the contextual social situation, the utterance and context always appear to be inextricably interconnected with one another, and the numerical utterances do appear to be linguistic constructions developed from their immediate social situation. The interactive numerical utterances of Kirk and Ashley appear to develop out of social intercourse, they appear to be socially generated, they appear to be socially promoted and practised, and they are not seen to arise individually or privately. The following examples illustrate the embeddedness of Kirk & Ashley's numerical utterance and the social contextual situation:

10-09-93 (D) morning CODED IVP

While walking along to a local shopping centre with Kirk and Ashley, Kirk noticed a woman approaching from the opposite direction. The woman was pushing a baby in a pushchair and she held the leaches of three dogs, who straggled alongside her and the pushchair. Kirk noticed the dogs.
Kirk: "She's got three dogs"

08-10-93 (D) morning CODED IIIP, IIA
At breakfast time, Kirk appeared to notice that the usual quantity of toast (3) was not being made.
Kirk: (speaking to Dad) "Why are you only making one?"
Dad replied that he had eaten earlier and that the one toast was just for him.
Later on, while gathering in the milk from the doorstep, Dad asked Kirk to count how many pints had been delivered (there were four). Kirk responded by pointing to each pint in turn while reciting the count words, he coordinated each of his points with a count word in a one-to-one correspondence.
Kirk: "one, two, three, four"

14-10-93 (D) afternoon CODED VP

During the walk home from a playgroup, Kirk noticed the shape of a street lamp-post, it was tall with a long head at the top to position the light tube over the road surface.
Kirk: (speaking to Dad) "Is that a seven?"
Dad replied that it was in the shape of a written number seven.
Kirk often associates the outline of shapes with numerical symbolic representation. For instance he identifies fingers with the number 1, they are both vertical in shape. When he refers to quantities of items he often holds up his fingers saying, "these ones". Kirk also identifies a straw with a one, although he often also bends a straw into other symbolic shapes of numbers, eg. making a seven (7), making a two (2), and making a four (4)

21-10-93 (D) afternoon CODED IP, IIIA

Mum was posting four letters, Kirk went with her to the post box at the end of the street, Kirk carried the letters.

Kirk: "Are you posting all these?"
Mum: "Yes"
Kirk: (started to count the letters, but continued to recite the number sequence after running out of letters to count) "one, two, three, four, five, six, seven, eight, nine, ten"
Mum: "There's only four"
Kirk: (counts the letters again, but still continues to ten) "one, two, three,four, five, six, seven, eight, nine, ten"

Even in the case of the S- sub-division categories, the numerical talk is seen to arise from the social environment, it is in effect socially framed numerical talk that the child is attempting to self-regulate and make 'the use - the meaning' (Wittgenstein, 1953), their own through practice. For Kirk & Ashley, this social framing of 'the use - the meaning' through self-regulative practice may be seen in the following examples:

31-12-93 (D) evening CODED VS

Kirk joined together, in the correct order (from 1 to 10), the pieces of his number jig-saw puzzle, without any assistance or prompting, he did it for himself.

01-01-94 (D) afternoon CODED IVA, IVP; VS

Kirk, Ashley and Mum all played dominoes. Kirk is very confident and accurate at recognizing all the number patterns on the dominoes.
Mum reported that she had given Kirk and Ashley two bananas, and Kirk immediately arranged the two bananas on the table, like so, saying "sixty-nine"

19-01-94 (D) afternoon CODED VS

Ashley was observed at lunch-time playing with one of the number pieces from the wooden number jig-saw puzzle, - it was the number six piece. He positioned it in an upright position, and then he spoke to himself, "That's six". Ashley then turned the number piece upside down, and spoke to himself again, saying, "That's nine". The '6' and the '9' are printed in such a way that they do look like each other when they are turned upside down. A few weeks earlier, Ashley had been mixing up his recognitions of six and nine, and Dad had shown him the difference by pointing out that in one case the curve pointed upwards and in the other case the curve pointed downwards. Dad had also shown him that by turning a six around it looked like nine, and turning a nine around it looked like a six. It was this aspect of the six and nine that Ashley was practising for himself. Dad's earlier instruction was being imitated and self-regulated by Ashley, and as Vygotsky has so eloquently put it:

> In the child's development, ..., imitation and instruction play a major role.

They bring out the specifically human qualities of the mind and lead the child to new developmental levels. In learning to speak, as in learning school subjects, imitation is indispensable. What the child can do in cooperation today he can do alone tomorrow. Therefore the only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as at the ripening functions (Vygotsky, 1986, p188).

24-02-94 (D) afternoon CODED VP, VA, IIIP, IIIA, IIIS, VS

Whilst shopping in a local supermarket, Ashley requested some chocolates, so Dad picked up a packet of 5 Bounties. At the checkout, Ashley appeared to notice the printed number '5' on the packaging of the Bounties.
Ashley: (speaking to Dad, and pointing towards the packet) "Is that five?"
Dad: "Yes, that's five"
Ashley: (continuing the conversation) "Are there five chocolates in there"
Dad: "Yes, there are five chocolates inside the packet"
Ashley: (continuing to verbalize his social interactive discovery to himself) "Inside the packet there are five chocolates, that's a five" (points to the '5' on the side of the packaging)

07-03-94 (D) afternoon CODED IIIP, IIIS

While Dad was driving Kirk was sitting in the car looking out of the window. He suddenly called out what he saw, uttering a numerical description.
Kirk: "There's a triangle, it's got three sides"
Now did Kirk subitize the number of sides of the triangle, or did he simply verbally regurgitate previous interactive instruction, that a triangle has three sides? In either case, he was communicating to everyone in the car that a triangle has three sides, but he was most probably also speaking to himself, self-regulating the 'threeness' of a triangle.

10-09-94 (V) afternoon CODED IIS, IIIS, IIIP

Kirk is sitting holding one of his story books, he spontaneously begins to count the pages to himself. He does not read the page numbers, but counts the number of individual page sheets as he turns them over. He steadily works his way through the book.
Kirk: (having already counted up to eight he continues) "Nine, ten, eleven, twelve, thirteen, fourteen; There's just fourteen"
Dad: "Pages?"
Kirk: "Yea, fourteen pages"
Kirk is now using number as a means of enquiry, and he applies his appropriation of cardinal meaning. **He** wanted to know how many pages were in the book. He quantifies the book in numerical terms and then communicates his answer to Dad.

---

three

It is interesting to note from Table 4, that almost a third **(31.7%)** of a Kirk and Ashley's numerical talk concerns *cardinality,* either the quantification of items, or the use of number as a quantity description. The following examples are typical of this usage:

26-07-93 (D) evening CODED IIIA

Ashley had been given a bowl of tinned fruit. There were three half slices of pears in his bowl.
Ashley: (looking at the fruit) "Is that two?" (speaking to Dad)
Dad: "No, that's three"
Ashley: "Oh, it's"

09-09-93 (D) evening CODED IIIP

Mother sent Kirk upstairs to fetch a disposable nappy
Mum: "Bring me a nappy"
Kirk: "Just one nappy? or two or three or four?
Mum: (Does not reply)
Kirk: "Just one?" (brings down one nappy)

14-10-93 (D) night CODED IIIA, IIIA; IIA, IIS

While lying in bed Kirk asked Dad questions about the cardinal quantity three.
Kirk: " What is three?"
Dad: (represents three by holding up three fingers) "That is three"
Kirk: (looking at Dad's three fingers, then a few moments later Kirk holds up three of his own fingers) "Is that three?"
Kirk: (then precedes to demonstrate that he already knows that five is a hand)
"Is this five?" (holds up a whole hand of outstretched fingers)
Dad reassured Kirk that his hand of fingers represented five.
During the daytime, Ashley was shown that a hand of fingers represented five. Dad opened up his hand and pointed to each of his fingers and thumb, saying one, two, three, four, five. While lying in bed at night, Ashley repeated the process to himself. His counting performance correctly paired a sequential number word in a one-to-one correspondence to each of his fingers and thumb.

30-10-93 (D) evening CODED IIP, IIIP; IIIP, IIIP

Ashley approached the fireplace where there were two pairs of slippers, his and Kirk's. Ashley instinctively started to point at each slipper in turn, and started to count their quantity.
Ashley: "one, two, three, four; four"

Later on that same evening whilst sitting in the livingroom watching television, Kirk expressed an interest in oranges.
Kirk: "I'm going to get three oranges"
Dad: (escorts Kirk into the kitchen where the oranges are kept)
Kirk: (picks up three oranges) "I've got three" (speaking to Dad)
Kirk returned to the livingroom and consumed his three oranges.
Kirk is well aware of the cardinal quantity three.

27-11-93 (D) morning CODED IIIP

Dad was walking to the post-office, pushing Kirk in a pushchair.
Kirk: (speaking to Dad) "Why have we got three pushchairs?"
Dad: (responding inquisitively to Kirk's question) "Three pushchairs?"
Kirk: "Yes, one up the stairs, and this one, and the double one"
The push-chair that was 'up the stairs' had been stored away for about a year, but Kirk obviously remembered it. Kirk had correctly counted the number of push-chairs that we possessed, without actually seeing them, demonstrating that he could abstractly count 'in his head' up to three. Kirk also further demonstrated that he is aware of the meaning of the cardinal value 'three'.

29-11-93 (D) morning CODED IIIP, IIP

In the morning before going to school, Kirk enquired about the number of people in the house.
Kirk: "Why are there only three of us?"
Dad: "Because Mum has gone to work"
Kirk: "So there are only three of us?" (Kirk starts to point to each of us, Dad, Ashley, and himself) "one, two, three"

31-12-93 (D) morning CODED IIIP

Early on in the morning Kirk once again spontaneously said, "There's four people in this house"

17-09-94 (V) morning CODED IIP, IIIP, IIA, IIIA

Kirk decides to count all the video-tapes in his cartoon collection

Kirk: "fourteen tapes"
Dad: "Do it again"

Kirk: (begins to touch each of his video-tapes, he matches each tape in one-to-one correspondence as he moves steadily along each of three short shelves, he starts at the top shelf and ends with the bottom shelf) "One, two three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen"
Dad: "Yes"
Kirk: "There's fourteen"
In this example Kirk has demonstrated his appropriation and use of the 'cardinal principle', repeating the last word in a count sequence to provide the answer to a 'how many' question.

The relatively high proportion of one-to-one correspondence counting **(18.8%)** indicates the importance placed on it by both children and adults, 9.9% and 7.1% respectively in the P- and A- codes. One-to-one correspondence counting features second only to cardinality in both the P- and A- categories, and it is practised more that number recital. The following are some of the examples of Kirk & Ashley's social interactions and practices of one-to-one correspondence counting:

04-04-93 (D) evening CODED IIP

Kirk is looking at a small book, it has pictures of animals in it, and he shows it to Dad.
Kirk: "There's the pussy cats" (he then points to each of three cats in the picture, pairing a number word with each cat in a one-to-one correspondence) "one, two, three"
Father: "Good boy" (pats Kirk on the head as a sign of praise) "How many rabbits are there?"(referring to the next picture of four rabbits on the adjoining page)
Kirk: (points to each one of the four rabbits in turn, pairing each rabbit with a number word) "one, two, three, four"
Dad: "Good boy" (pats Kirk on the head again)

20-04-93 (D) morning CODED IIP

Ashley was being dressed by his father, Kirk was watching. As Ashley's shirt was being buttoned-up Kirk began to count the buttons. He started with the bottom button and counted in a sequential order, "one, two, three, four", ending up at the top of the shirt. Kirk had pointed and touched each button as he counted out loud. There were four buttons on Ashley's shirt. Ashley was quietly paying attention to Kirk's counting performance.

09-08-93 (D) morning CODED IIP, IIIA

Dad was constructing a bookshelf, and part of the process involved drilling some holes in wood. In one piece, four holes were drilled, they were positioned as if they were the corners of a square. Kirk was watching the process. When the drilling had ceased, Kirk pointed to each hole in turn, starting arbitrarily with one hole and moving round all the holes in a circular fashion correlating his points with the saying of number words in a one-to-one correspondence.
Kirk: "one, two, three, four"
Dad: (watching Kirk's counting performance, replies) "Yes, there are four holes"
Kirk: (continuing to look at the holes that he has just counted) "Which one is four?"
Dad: (counts the holes again, this time in a reverse direction from that followed by Kirk) "one, two three, four; four holes altogether"

16-10-93 (D) morning CODED IIP, IP

Kirk had a book in his hands, a book about ten children, and the picture on the front cover shows all the ten children standing next to one another.
Kirk: (speaking to Ashley) "Let's count" (Kirk starts to point to each of the children in turn, working his way steadily along the line of children) "one, two, three, four, five, six, seven, eight, nine, ten"
Ashley: (prompted by Kirk to start counting) "one, two, three, four, ...
Kirk: (interrupting Ashley) "You have to point"

07-02-94 (D) morning CODED IIA, IIIA
Ashley found a menu from a box of chocolates lying around the dining-room, he was looking at the pictures of the chocolates.
Ashley: (speaking to Dad) "How many are there?"
There was no immediate reply from Dad, so Ashley repeated his question.
Ashley: "How many are there?"
Dad moved over to where Ashley was seated on the carpet and looked at the chocolates menu that Ashley was holding. Ashley then spontaneously started to point to each picture of the twelve displayed chocolates, steadily moving along each of three rows of four chocolates in turn.
Ashley: (coordinating and matching each of his points with a sequential number word, achieving a one-to-one correspondence) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve"
Dad: "there's twelve"
Ashley: (pointing to a picture of a chocolate in the centre of the menu) "Is that twelve?"
Dad: "They are all twelve, all twelve together, all of them" (Dad made a circular gesture with his hand, as if to enclose all of the pictures of the chocolates)

Ashley was able to count up to twelve accurately and confidently, but he was still in the process of appropriating *'the use-the meaning'* of larger cardinal numerosities. He knows, from past uses, what a cardinal two, or three, or five means, but a cardinal value of 'twelve' did not appear to mean anything to Ashley. In the above example he appears to be associating each chocolate with a 'number label', possibly because he is quite familiar with the social practice of number labelling. Cardinality is not just a principle, as Gelman & Gallistel (1978) would have us believe, it is a number word that *'means'*. Ashley is well aware that in any one-to-one correspondence count the last word is the cardinal numerosity, but that cardinal numerosity must still 'mean' something to the counter. In the above case, 'twelve' did not appear to hold any meaning for Ashley, in the context of a chocolates menu. But 'twelve' being used as a number label may have appeared to Ashley as quite a sensible 'use-meaning' for discriminating between chocolates (as opposed to flavouring).

13-03-94 (D) evening CODED IIS
As Ashley descended the stairway in the house he started to count to himself. From top to bottom there are fourteen steps including a split-level landing, but not including the bottom floor way. As he took each step downwards he uttered the next number word in the sequential number word series, matching steps and number words in one-to-one correspondence.
Ashley: (descending the house stairway, speaking and counting to himself) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen"
Ashley often appears to initiate counting practices for himself, he actively seeks out things to count, and he has no trouble in finding countable items, he promotes his own number self-regulation.

30-07-94 (D) morning CODED IIP

While out shopping, Ashley stopped to count the tray of eggs that Dad was in the process of picking up. There were twelve eggs on the tray, arranged in two rows of six.
Ashley: (speaking to Dad who was holding a tray of eggs) "Let me count them"
Ashley was imitating a counting behaviour that had been initiated by Kirk. Kirk had asked to count the tray of eggs 2 -3 weeks earlier.
Ashley: (pointing progressively to each egg in the tray once, and matching each egg in a one-to-one correspondence with a sequential number word utterance) "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve"

In the above example, Ashley counted correctly and confidently, he knew exactly what he was doing. He started at one end of the tray and counted along one of the rows towards the other end, reaching six; he then continued along the adjacent row in a reverse direction from that which he had just followed, returning to the end from which he had started. It was an expertly executed count, demonstrating that Ashley had appropriated and self-regulated 'counting principles' through his social interactional apprenticeship.

What does appear surprising is that number string recital does not occupy a greater percentage of Kirk and Ashley's numerical talk, only 13.6% of the total, about the same proportion as number figure 'reading' or recognition, 13.2%.

Early examples of number string recitation always appeared to be linked to attempts to count, and did not involve number recitation for its own sake. In this respect, number recitation appears to be in behavioural terms, imitative of adult counting practices:

09-04-93 (D) morning CODED IP

Kirk finds some coins lying on the livingroom carpet.
Kirk: (speaking to Ashley) "Let me count, one, two, three, four, five, six, eight, ten, six, eight, ten" (he picks up the money and runs towards the chairs) "I'm going shopping, bye"

15-05-93 (D) evening CODED IP, IIIP
Kirk, Ashley and Dad were out for a walk in the street. Approaching a house with an overgrown shrub, Kirk observed some bumble bees buzzing around some pink flowers. Kirk stopped to watch, and then he drew Dad and Ashley's attention to the presence of the bumble bees.
Kirk: "Look at all these bumble bees, look (points in the air towards the bees) one, two, three, four, five, six, eight, ten; ten bumble bees)

Other examples of number recitation are:

28-05-93 (D) morning CODED IP

While Kirk was being dressed in the bedroom, he was looking out of the window. Suddenly, he started to verbally count out loud.
Kirk: "one, two, three, four, five, six, seven, eight, nine, ten"

07-10-93 (D) afternoon CODED IS
During a walk home from a playgroup, Ashley was sitting in the pushchair playing with a teddy bear. He started pointing to the eyes in an alternating sequence, first one

then the other, and as he did so he recited the sequence of number words.
Ashley: "one, two, three, four, five, six, seven, eight, nine, ten"
Ashley's points and words were not synchronized, he appeared to be practising number recitation.

22-12-93 (D) afternoon CODED IP

While playing in the livingroom with Ashley, Kirk suddenly started reciting the number word sequence.
Kirk: "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, six"

06-03-94 (D) morning CODED IS

Ashley ran through the central corridor from the livingroom to the kitchen reciting the sequential number series.
Ashley: "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve"

11-07-94 (D) afternoon CODED IP, IS

As the whole family walked home from a park, Ashley (who was sitting in a push-chair) started to recite the number word sequence.
Ashley: "one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-five, twenty-six, twenty-seven, twenty-eight, twenty-nine, thirty"
Ashley's recital was probably both for himself and the others accompanying him, - testing his own recall ability and demonstrating it to others, and possibly receiving some feedback should he have gone wrong. Ashley also appeared to be in the process of self-regulating the number string.

In the above example, Ashley is not yet three years old, but his number word sequence recitation up to thirty may be viewed by some as being surprising. It need not be viewed as surprising at all. Ashley's appropriation of the number word sequence has been accomplished through his daily social interactions involving the notion of *'counting play'.* The extent of his sequential recitation is reflected in the extent of his 'counting play' interaction. For Ashley, his number recitation and counting skill has been a social accomplishment, it includes a degree of imitation and instruction, from Mum, Dad, and Kirk through a numerical apprenticeship.

There are cases where both Kirk and Ashley were counting in one-to-one correspondence but had to terminate their count due to their lack of number string words, and not due to an inability to practice the one-to-one correspondence principle. The one-to-one correspondence principle is often and very commonly practised, more so than number string recital.

The following examples were typical of such practise by Kirk & Ashley:

06-12-93 (D) evening CODED IIP

During the evening the whole family was sharing a packet of peanuts. Kirk had been given a very large pile, so he sat down on the carpet and started to eat his share of the peanuts. Suddenly, he stopped eating, and he started to count the peanuts.
Kirk:(as he separated each peanut from the pile he matched it with a sequential number word) "one, two, three, four, five, six" (Kirk gave up at this stage, he realized that there were far too many for him to count)

22-09-94 (V) evening CODED IIIP, IIA, IA, IIIA

Dad has bought Kirk a large packet of sweets. Mum and Ashley have gone out, only Dad and Kirk remain in the house.
Kirk: (holding his packet of sweets) "I'm opening them so you can taste them"; "Just eat two"
Dad: "See if you can count how many you have got in the packet"
Kirk: "Then we won't be able to put it in"
Dad: "You need something to put them in"
Kirk: "No, no, put it on this"
Dad: "How many have you got altogether?"
Kirk: (spills out all the sweets from the packet onto the chair) "No, let's share them out"
Dad: "No, just put them back into the packet one at a time, and count how many"
Kirk: (placing the sweets back into the empty packet, one at a time, he pairs each sweet with a sequential number word as he places it back into the packet) "One, two, three, four, five, six, seven, eight, nine, ten, eleven, eight" (Kirk realizes that he has said the wrong number word and stops counting) "I'll have to start again"
Dad: "No, twelve"
Kirk: (pours out all the sweets that were already placed in the packet) "I'll have to start again"
Dad: "Right"
Kirk: "One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, four, five, six, seven"
Dad: "No, you've made a mistake, seventeen"
Kirk: "Seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-six"
Dad: "Twenty-five"
Kirk: "Twenty-five"

Dad: "twenty-six"
Kirk: "twenty-six; twenty-?"
Dad: "Seven"
Kirk: "Twenty-seven, twenty-eight"
Dad: "Yes"
Kirk: "Twenty-nine, twenty-?"
Dad: "Thirty"
Kirk: "Thirty, thirty-one, thirty-two, thirty-three, thirty-four, thirty-five, thirty-?"
Dad: "Thirty-six"
Kirk: "Thirty-six, thirty-?"
Dad: "Seven"
Kirk: "Thirty-seven, thirty-six"
Dad: "Eight"
Kirk: "Thirty-eight"
Dad: "Nine"
Kirk: "Ten"
Dad: "Forty"
Kirk: "Forty"
Kirk: "Forty-one, forty-two, forty-three, forty-four, forty-five, forty-six, forty-?"
Dad: "Seven"
Kirk: "Forty-seven, forty-?"
Dad; "Eight"
Kirk: "Forty-eight, forty-?"
Dad: "Nine"
Kirk: "Forty-nine, forty-?"
Dad: "Fifty"
Kirk: "Fifty, fifty-one, fifty-two, fifty-four"
Dad: "Fifty-three"
Kirk: "Fifty-three, fifty-seven"
Dad: "Four"
Kirk: "Fifty-four, fifty-five, fifty-six, fifty-seven; I've got fifty-seven"
Dad: "Fifty-seven sweets? That's a lot"
Kirk: "Too many"
Dad: "Yea"

In the above example Kirk has once again demonstrated that he obeys the 'one-to-one counting principle', and the 'cardinal principle'. However, Kirk was unable to count confidently in this example, due to a lack of practice of counting with a number string quite so long. The large quantity of sweets that had to be counted was beyond his usual number word counting string. Kirk was unsure of the number words that should follow one another, and he had to be greatly assisted by Dad. Kirk's knowledge of the number sequence let him down, not his ability to count in one-to-one correspondence or his ability to use the cardinal principle.

Number labelling is a common feature within our technological society, and young children also practice their appropriations of this feature. It does not appear to take long before Kirk and Ashley begin to demonstrate their use number labelling, and it soon becomes a relatively important feature of their numerical descriptive talk, principally with age, but also in respect to money and time utterances, and also television channel viewing. Some examples are:

29-12-93 (D) morning CODED VP, VIP
In the morning while Ashley was having breakfast, he was watching television. The sign for BBC 2, which is a figure '2', appeared on the screen.
Ashley: (looking at the TV screen) "That's how old I am"
Ashley did not say that it was a "two", he appeared to assume that we all knew that it was a "two". Kirk responded to Ashley's utterance by quoting his own age.
Kirk: "I'm three"

21-08-93 (V) morning CODED VIA, VIA, IA, VIP, IIIP

Today is Ashley's birthday, he is 2-years old today. Ashley is in the livingroom busy opening presents that he has been given. The first present that he opens is a toy till with numbered buttons to press, and a till drawer that opens. The numbered buttons are labelled: 1, 2, 5, 10, 20, 50.

Ashley: (pulls the toy till out of its box)
Kirk: "Put it down on the floor"; "Let me play with it with you"
Ashley: (places the till down on the carpet and both he and Kirk start to play with the toy till, pressing the numbered buttons and opening the till drawer (which is also opened by pushing a button labelled 'Open')
Dad: (gives Ashley some foreign coins to put in the toy till drawer)
Kirk: "I want money Dad"
Dad: "Right" (Dad goes off to fetch more foreign coins)
Kirk: (shouts to Dad) "Mummy has given me money already"
Dad: (returning, and giving Kirk more coins) "There's a five and that's a fifty"
"There's a packet of money" (giving a packet of foreign coins to Ashley)
Kirk: "I want a packet of money"
Dad: "Ashley will give you some"
Both Kirk and Ashley begin to play with the till and coins.
Ashley: (throws away one of the coins that he doesn't like the look of)
"I've thrown it away"
Kirk: (tries to close the till drawer while Ashley continues to fill it up with coins)
"That's enough"
Ashley: "No, I want to put money in it"
Dad: "There's a tape as well"

Kirk: "Oh"
Dad:(gives an audio tape to Ashley) "Here; That's a new one for you"
Kirk: "I want a new tape"
Dad: "You have to open it"
A few moments later Dad crouches down and shows Kirk and Ashley how to operate the toy till.
Kirk: "How do you put it on?; How do you put it on?"
Dad: "What on?"
Kirk: "This on" (pointing to the toy till, which has a key to lock the drawer)
Dad: "You've to close it and turn the key, that's all the numbers" (drags a pointing finger over all the numbered buttons on the top of the till)
Kirk: (pushes the till drawer back into the till base, and closes the till drawer)
Dad: "That's it; That's it locked; You have to open it; Wait till he puts all the money in"
Dad continues to play with Kirk and Ashley, pretending to buy things and giving change, then Kirk and Ashley talk and play together with the toy till, pressing the buttons and opening the till drawer. A few minutes later Ashley walks over to where Dad is seated and gives Dad some of the money.
Ashley: "Here's your money Dad"
Dad: "Thankyou"
Ashley: "I'm giving you more" (Ashley continues to give Dad some coins)
Dad: "Five" (as Ashley gives Dad a coin)
Ashley: (repeating Dad's utterance) "Five"
Dad: "Ten" (as Ashley gives Dad another coin)
Ashley: (repeating Dad's utterance again) "Ten"
Dad: "Eleven, twelve" (as Ashley gives Dad two more coins)
Ashley: "Eleven, twelve"
Dad: "Thirteen" (as Ashley gives Dad another coin)
Ashley: "Thirteen"
Dad: "Fourteen" (as Ashley gives Dad yet another coin)
Ashley: (walks back to the till to get more coins)
Ashley: (returning with more coins) "Here's your fourteen" (giving Dad another coin)
Dad: (pointing to a previous coin that he had given to Dad) "That's the fourteen";
"That's more"
Ashley: (begins to lay more coins on the coffee table beside Dad's seat)
Kirk: (continues to play with the toy till)
Dad: "Put all the money back now"
Kirk: "Oh"; (Kirk walks over to the coffee table and collects the coins)
"Here's money"
Ashley: (lies down where Kirk was, and begins to play with the till)
Kirk: (returns to play with the till)
Kirk and Ashley both continue to press the number buttons on the toy till, and opening/closing the till drawer, they talk to one another as they play. They then tip the till upside down and the coins all spill out onto the carpet, they then begin to play with the coins. Ashley gives Mum some of the coins. Kirk picks up more coins from the carpet.
Kirk: "I need these two money's" (talking aloud while picking up the coins)
"I need all of the money"

Ashley and Kirk continue to pick up coins from the carpet.
Ashley: "I'm going to the fruit man, to buy some fruit"; (gives Mum some of the coins) "Here's all your money"

13-11-93 (V) afternoon CODED VIP, VIP, IIIP, VIP, IP, IP, IIIA

Kirk and Ashley pretend to go shopping. Ashley is playing with his toy till and coins, he also has a bag full of toys that he has packed. Kirk is also carrying a bag of toys. Kirk asks Ashley to give him some money from the till.
Kirk: "I'm going out on shopping day"; "I came on shopping day, it's Friday"
Ashley: "I've got a nice bag"
Kirk: "Can I have two pence?"
Ashley: "No"
Kirk: "Can I have some two p's, yea?"
Ashley: "Yea"
Kirk: "Oh; Can I have four p's, can I?"
Ashley: "No"
Kirk: "Yea?"
Ashley: "No"
Kirk: "I like four, and I like ten, and four, and five, I like"
Ashley and Kirk continue to talk to one another.
Kirk: "I've got money, I need this money"
Kirk: "I'm at work"
Kirk: "I'm puting all the old ones back, I want new ones, these are the old ones"
Ashley: "Do you want twenty 'p' "
Kirk: "I want five 'p' "
Ashley: "No, twenty 'p' "
They both continue to play and talk.
Kirk: "Have you got another two 'p' ?; I've got all the old 'p' "
Ashley: "Have you got a wallet to keep them in?"
Kirk: "I'm taking them back to work and then I'll give them back to you, when they get old"
Ashley: "They're getting old"
Kirk: "No, not yet, in another two days"
Ashley: "in another two days?"
Kirk: "Yea, in another two days"
Ashley: "That's two"
Kirk and Ashley continue to talk and play.
Kirk: "What do you want?"
Ashley: "A pot of beer"
Kirk: "What do you want?"
Ashley: "A pot of beer"
Kirk: (not happy with Ashley's answer, - which is taken from a nursery rhyme"
"What do you want?; What do you want?; What do you want?";
"One, two, three, four, five, six, seven, eight, nine, ten" (pressing the till buttons)
Ashley: "six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen"

Kirk: (still playing with coins in the till) "Aha, Aha"
Ashley: "I've got my change"
A little while later Kirk dismantles three sections of plastic track for toy cars to roll down, he lays the three sections on the carpet and he walks around the pieces.
Kirk: (pointing at the track pieces) "We're going to sell them, we're selling them";
"We're selling them; Eight, 'j', 'l' "
Ashley: "That's 'h' "
Kirk: "That's 'h'; that's 'p'; that's 'q'; that's all our numbers in the shop that we have";
"Got; One, two, no; One, two, three"
Granddad: (speaking to Ashley who has picked up a bag of bricks) "That's a lot you've got isn't it?"
Ashley: "Yea, got hundred"
Kirk: "That's what I've got, hundred"

It is not surprising to see that both subitization (5.1%) and number sums (8.0%) seem to be relatively rare within Kirk and Ashley's mediated numerical talk, for these may be considered to be 2nd. order number practices, they require the application of already self-regulated number skill. For example, subitization requires the practice of cardinal labelling, and number sums may require both cardinal labelling and one-to-one correspondence counting to already be self-regulated to a certain extent.

The following examples illustrate how Kirk & Ashley practised subitization to communicatively describe and quantify perceived numerical aspects of their social environment to others:

20-03-93 (D) *afternoon* CODED IIIP, IVP

We had all gone out for an afternoon walk, and I was pushing both Kirk and Ashley in their double pushchair along the bank of a canal. The children were looking at the scene around them. There were ducks in the canal, and we had brought some bread to feed them. Ashley spied two ducks swimming towards us.
Ashley: "There's two over there, there's two"

01-05-93 (V) afternoon CODED IVA, IIIA, IA, IP

Kirk and Ashley are playing outside in the front garden, they have come across a bunch of dandelions.
Kirk: (sitting down picking dandelions) "Here, here you are, here's a big one" (gives Dad a dandelion) "Put it down beside me" (lays another dandelion down on the ground by his side) "You put the dandelions down here" (lays down a few more dandelions)

Dad: (watching Kirk) "How many dandelions have you got?"
Kirk: (touching only two) "One, two; (hesitates, then restarts) "One, two, three, four" (Kirk emphasizes the "four", but he has retouched only the first two dandelions, -there are four dandelions, - Kirk appears to have subitized the quantity rather than counted in one-to-one correspondence and recited the count sequence to match his subitized quantity)
Ashley: (watching and listening) "What have you got?; One, two, three, four, nine"
Kirk: (touching the broken stems of the dandelion plant) "I broke this one, and I broke this one, and I broke this one, and I broke that one and this one"

20-10-93 (D) morning CODED IVP
Whilst breakfast was being made, Kirk was playing on the floor with three coins. He placed them in a row, with gaps in between the coins, he looked at the row of coins.
Kirk: (speaking to Dad) "Is that three?"
Dad confirmed that he had three coins.

In the above example, Kirk had made a cardinal subitization, but needed to have it confirmed. Kirk may have had some lingering doubt as to what constituted the cardinal quantity of three, but this seems unlikely from his previously demonstrated counting skills well in excess of three. Kirk had not counted his three coins in one-to-one correspondence and so he had not applied any 'cardinal rule' as such, he had made a subitization. This would suggest that subitization is a separately acquired skill from counting, and possibly a skill that develops through lots of practice. During any practice of subitization, accuracy will need to be confirmed. Subitization may be confirmed, either by counting and applying the cardinal rule, or by asking someone else to confirm the result, and it is this latter course that Kirk opted to choose. In the above example, Kirk's question, "Is that three" may be interpreted as a practice of subitization, and not cardinality. Other examples are:

01-01-94 (D) evening CODED IVP, IVA, IIA, IIIA, VS

In the evening Kirk was making small piles with the pieces of a jig-saw puzzle, - he placed a few of the jig-saw pieces on top of one another, and he formed three such piles.
Kirk: (looking at the numbers of pieces in each of the piles that he had formed, but without counting, just subitizing) "There's three here, and three here, and three here"
Dad pointed out to Kirk that one of his piles had four pieces in it, and suggested that he check it to see. Kirk counted the pieces in the pile and agreed that it did have "four".
Later on Kirk joined the number jig-saw puzzle together, without assistance

08-01-94 (D) afternoon CODED IVP, IIIA

While the whole family were out shopping, we passed a hotel with four flags displayed on its roof top. Kirk was looking at the flags, then he spontaneously quantified their number as he described what he was looking at.
Kirk: "There's four flags"
Dad: "Yes, there's four"
Kirk appeared to have subitized the quantity of flags. He did not point at them, or count them in any externally observable way.

In the case of number sums, sub-category VII, these do not initially appear in any form (see Table 15), but they do develop in time, they are a prime example of the socio-historical developmental nature of young children's interactive numerical talk. Some of the examples of number sums that were mediated to Kirk & Ashley are:

29-09-93 (D) morning CODED IIIA, VIIA

While Kirk was being dressed he described something in numerical terms by holding out a hand with outstretched fingers. Kirk asked Dad if this was "ten", but Dad replied that it was only "five". Dad then took hold of both of Kirk's hands and opened out all the fingers, telling Kirk that this is "ten". Dad then held up one of Kirk's hands with outstretched fingers and said that, "this is five"; and repeating the exercise with Kirk's other hand of fingers. Dad then said to Kirk, "two fives make ten", and Dad held up once again Kirk's two hands of outstretched fingers saying, "this is ten".

1-12-93 (D) evening CODED IIIP, IIP

At bath-time Ashley was lying down in the water by himself. Suddenly and spontaneously he announced that "We've got four taps", (two on the bath and two on the sink)
Ashley: (he *then* pointed to each of the four taps in the bathroom and matched them in a one-to-one correspondence with a sequential number word) "one, two, three, four"

Ashley may have either subitized the number of taps, or he may have counted them 'in his head, silently to himself' before announcing his cardinal quantity, four. His four was given first, but he then counted to check. Since the two sets of taps are not aligned together in any way, he would have had to look in two separate directions and add together, if his four was not a product of subitization.

03-12-93 (D) evening CODED IIIA, VIIA
Kirk was lying in bed and he started to play his finger number game. He extended some fingers on his hands and asked Dad, "How many?". This time Kirk appeared to be curious about how different patterns of fingers still made 'three'.
Kirk: (having raised up three fingers on one of his hands) "How many is that?"
Dad: "three"
Kirk: (changing the finger pattern to a different combination of fingers, but still showing three fingers on the same hand) "How many is that?"
Dad: "three"
Kirk: (smiles, satisfied with the answer;Kirk has become aware that different combinations of fingers can produce the same cardinal quantities.
Kirk the proceeded to go through the routine that he had established the previous evening, displaying various combinations of fingers on both of his hands and asking Dad, "How many". At one stage, Kirk displayed a whole hand of fingers and was given the answer, "five". Kirk then proceeded to compare this answer with 'three' on one hand and 'two' on the other hand. Kirk also explored the answers of 'two' and 'two', 'three' and 'three', and 'five' and 'five'.

What is of vital importance in the above episode is that it is Kirk's 'interest' or 'curiosity' that appears to be the motivating force behind his questions, but it is almost equally certain that these questions would never have been asked if it were not for the interactive participation of Mum and Dad. Parents who respond to young children's questions may play an equal if not a major role in fostering a child's 'interest' or 'curiosity'. It is quite possible to see parents as the principal motivating force behind a child's questions. The questions of a child do not need to be interpreted as a construction of the child, the questions may be viewed as a planted *'seed'* in the child by parental or social other rhetorical-responsive interaction. Other examples of the social planting of 'number sum' questions in Kirk are:

20-12-93 (D) evening CODED IIIP, IIIA, IIP, VIIA
In the kitchen, Dad was making some toast for Kirk and Ashley's supper, Kirk was watching.
Kirk: "Why are you making three?"
Dad: "I'm not, I'm making four"
Kirk: "Why are you making four?" (Kirk then counts the slices of toast in the grill pan by pointing to each slice and pairing it in a one-to-one correspondence with a sequential number word) "one, two, three, four"
Dad: "So that you can have two each; two and two is four"
Kirk: (holds up two fingers on each hand, and shows Dad) "Is this four?"
Dad: "Yes; two and two is four"

Kirk has started to apply and use the number sums that he has been recently practising with Mum, Dad and Ashley.

06-01-94 (D) afternoon CODED IVS, IIA, IIIA, VIIA

At home, Kirk was playing in the dining-room when he found a dice. He sat down on the carpet and looked at each of the face patterns, turning the dice as he did so. As he observed each face he called out the number of spots present, and was always correct. After he thought that he had done each face, he repeated the process again. After being given half a packet of sweets, Ashley proceeded to take them all out of the packet. He lined the sweets up next to each other and then began to stare at them, after a few moments he picked them all up. Kirk also lined up his sweets, but asked Dad to count them. Dad counted the sweets for Kirk, "one, two, three, four, five, six". Dad then broke the line into two sections of three sweets, saying "three and three is six".
Kirk: (looking at the rearrangement of his line of sweets, and repeating Dad's words to himself) "Three and three is six"
Dad: (re-enforcing the number utterance) "Three and three is six"
Kirk: (picks up one of the sweets and eats it, saying) "And what's five?" (now there was one row of three and one row of two)
Dad:"That is five" (pointing to the sweets) "Three and two is five"
Kirk: (pointing towards the two rows of sweets, and again repeating Dad's words to himself) "Three and two is five"
Dad: "Yes"

27-01-94 (D) evening CODED IIIP, VIIP

While Mum was in the livingroom, she asked Kirk to bring her "five oranges" from the kitchen. Dad was in the kitchen, and Kirk asked him for the oranges.
Kirk: "Mummy wants five oranges"
Dad picked up five oranges and gave them to Kirk (without counting them out to Kirk).
Kirk: (returning to the livingroom with the oranges) "I've got five; two and three"

In the above example Kirk demonstrates that he is now in a habit of breaking up larger cardinal quantities into sums of smaller cardinal quantities. Kirk appears to be 'practising' his appropriation of cardinal number meaning through 'practical activity', but his activity is socially motivated and it is communicatively performed for social others as much as for himself. Kirk's number sum practice takes place through language, it is structured by language, not by object. Kirk's cardinal appropriations are being dialectically created in the course of his micro-environmental interaction, and

they have been socially initiated, socially directed, and socially motivated, through language.
A case where Kirk begins to use and apply his steadily increasing knowledge of number sums is illustrated below:

26-02-94 (D) afternoon CODED IVP, VIIP, VIIA

While out shopping, Kirk saw a window display of television sets. The were arranged in an L - shape, three along one edge, and three along the other. Kirk spontaneously pointed to the television display.
Kirk: (quantifying the cardinal numerosity of the sets, without counting in a one-to-one correspondence) "Three and three, that's six; are there six TV's?"
Dad: (confirming the numerosity and Kirk's calculation) "Yes, there are six TV's; three and three is six"

In this example, Kirk had calculated the number of televisions in the display by subitizing the cardinal quantity along each edge of the display, and then by referring to his memory (or accessing his steadily increasing 'data bank') of number sums, he was able to conclude that '3' and '3' should be '6', but he still needed this to be confirmed by interacting with someone else, Dad.

These seven sub-categories of cultural number 'use-meaning', developed within three mediational sub-divisions, provide an overall picture of the nature of Kirk and Ashley's social interactive numerical talk. However, this total analysis (Table 4) does not adequately allow us to watch the development process, the *'social painting'*, that has led to the construction of this rhetorical-responsive numerical interactional picture, since all we see is the finished product. Consequently, the socio-historical developmental course that that talk has taken will now be investigated through an examination of the numerical utterances present in each quarter of the total ethnographic data.

5.9 QUARTERLY SOCIO-HISTORICAL ANALYSIS

Using a quarterly analytical technique, the total coded data, 1573 codes in all 625 episodes, will be tabulated in quarterly sections to create a socio-historical developmental analysis.

The time span of the research, 20 months, will be divided up into four periods and the analytical results compared with one another in order to determine if there are any socio-historical trends in Kirk and Ashley's numerical interactional utterances, or any consistencies.

The four periods will consist of five consecutive months, and the numerical episodes associated with those months will be displayed in terms of code percentage occurrence. The analytical data will be tabulated in Tables 8, 9, 10 and 11, and collated in tables 13 and 14. Tables 15, 16 and 17 will enable a comparative analytical interpretations and conclusions to be drawn between the four quarters.

1st QUARTER: February, March, April, May, June 1993
2nd QUARTER: July, August, September, October, November 1993
3rd QUARTER: December '93, January, February, March, April 1994
4th QUARTER: May, June, July, August, September 1994

TABLE 8 1st QUARTER:February, March, April, May, June 1993

	DIARY (D)	VIDEO (V)	TOTAL (D+V)	PROPORTIONAL %
IS	1	2	3	2.1
IP	6	8	14	9.7
IA	0	2	2	1.4
IIS	0	1	1	0.7
IIP	6	8	14	9.7
IIA	2	8	10	6.9
IIIS	0	1	1	0.7
IIIP	6	24	30	20.7
IIIA	2	30	32	22.1
IVS	0	0	0	0
IVP	2	0	2	1.4
IVA	0	3	3	2.1
VS	0	2	2	1.4
VP	1	3	4	2.8
VA	1	6	7	4.8
VIS	0	0	0	0
VIP	1	9	10	6.9
VIA	0	10	10	6.9
VIIS	0	0	0	0
VIIP	0	0	0	0
VIIA	0	0	0	0
	28	117	145	100.3%

__TABLE 9__ 2nd QUARTER: July, August, September, October, November 1993

	DIARY (D)	VIDEO (V)	TOTAL (D+V)	PROPORTIONAL %
IS	5	2	7	**2.5**
IP	4	35	39	**13.9**
IA	0	13	13	**4.6**
IIS	4	1	5	**1.4**
IIP	17	14	31	**11.0**
IIA	5	14	19	**6.4**
IIIS	1	1	2	**0.7**
IIIP	16	28	44	**15.7**
IIIA	10	33	43	**15.3**
IVS	0	0	0	**0**
IVP	3	1	4	**1.1**
IVA	1	0	1	**0.4**
VS	1	2	3	**1.1**
VP	3	10	13	**4.6**
VA	3	26	29	**10.3**
VIS	0	1	1	**0.4**
VIP	2	10	12	**4.3**
VIA	2	10	12	**4,3**
VIIS	0	0	0	**0**
VIIP	3	0	3	**1.1**
VIIA	3	0	3	**1.1**
	—	—	—	—
	83	201	284	100.2%

TABLE 10 3rd QUARTER: December 1993, January, February, March, April 1994

	DIARY (D)	VIDEO (V)	TOTAL (D+V)	PROPORTIONAL %
IS	9	8	17	**2.3**
IP	7	31	38	**5.1**
IA	8	22	30	**4.0**
IIS	10	7	17	**2.3**
IIP	21	32	53	**7.2**
IIA	9	41	50	**6.7**
IIIS	3	3	6	**0.8**
IIIP	42	76	118	**15.9**
IIIA	25	100	125	**16.9**
IVS	4	2	6	**0.8**
IVP	2	6	17	**2.3**
IVA	5	21	26	**3.5**
VS	8	8	16	**2.2**
VP	11	20	31	**4.2**
VA	13	37	50	**6.7**
VIS	0	1	1	**0.1**
VIP	2	38	40	**5.4**
VIA	0	24	24	**3.2**
VIIS	1	1	2	**0.3**
VIIP	12	5	17	**2.3**
VIIA	30	27	57	**7.7**
	—	—	—	—
	231	510	741	99.9%

TABLE 11 4th QUARTER: May, June, July, August, September 1994

	DIARY (D)	VIDEO (V)	TOTAL (D+V)	PROPORTIONAL %
IS	2	3	5	**1.2**
IP	3	32	35	**8.7**
IA	1	11	12	**3.0**
IIS	0	6	6	**1.5**
IIP	6	51	57	**14.1**
IIA	1	33	34	**8.4**
IIIS	0	3	3	**0.7**
IIIP	5	45	50	**12.4**
IIIA	2	41	43	**10.7**
IVS	0	1	1	**0.2**
IVP	2	10	12	**3.0**
IVA	0	10	10	**2.5**
VS	0	1	1	**0.2**
VP	0	35	35	**8.7**
VA	0	16	16	**4.0**
VIS	0	0	0	**0**
VIP	1	18	19	**4.7**
VIA	0	20	20	**5.0**
VIIS	0	0	0	**0**
VIIP	3	12	15	**3.7**
VIIA	1	28	29	**7.2**
	—	—	—	—
	27	376	403	99.9%

TABLE 12 **QUARTER PERIODIC TOTAL CODING**

	(D)	(V)	Total (D + V)
1st QUARTER	28	117	145
2nd QUARTER	83	201	284
3rd QUARTER	231	510	741
4th QUARTER	27	376	403
	369	**1204**	**1573**

TABLE 13 **EPISODIC QUARTER TOTALS**

	1st	2nd	3rd	4th	TOTAL
IS	3	7	17	5	**32**
IP	14	39	38	35	**126**
IA	2	13	30	12	**57**
IIS	1	5	17	6	**29**
IIP	14	31	53	57	**155**
IIA	10	19	50	34	**113**
IIIS	1	2	6	3	**12**
IIIP	30	44	118	50	**242**
IIIA	32	43	125	43	**243**
IVS	0	0	6	1	**7**
IVP	2	4	17	12	**35**
IVA	3	1	26	10	**40**
VS	2	3	16	1	**22**
VP	4	13	31	35	**83**
VA	7	29	50	16	**102**
VIS	0	1	1	0	**2**
VIP	10	12	40	19	**81**
VIA	10	12	24	20	**66**
VIIS	0	0	2	0	**2**
VIIP	0	3	17	15	**35**
VIIA	0	3	57	29	**89**
	145	**284**	**741**	**403**	**1573**

TABLE 14 **EPISODIC QUARTER PERCENTAGES**

%	1st	2nd	3rd	4th	σn	mean%
IS	2.1	2.5	2.3	1.2	0.50	**2.03**
IP	9.7	13.9	5.1	8.7	3.14	**9.35**
IA	1.4	4.6	4.0	3.0	1.21	**3.25**
IIS	0.7	1.4	2.3	1.5	0.57	**1.48**
IIP	9.7	11.0	7.2	14.1	2.49	**10.50**
IIA	6.9	6.4	6.7	8.4	0.77	**7.10**
IIIS	0.7	0.7	0.8	0.7	0.04	**0.73**
IIIP	20.7	15.7	15.9	12.4	2.96	**16.18**
IIIA	22.1	15.3	16.9	10.7	4.07	**16.25**
IVS	0	0	O.8	0.2	0.33	**0.25**
IVP	1.4	1.1	2.3	3.0	0.75	**1.95**
IVA	2.1	0.4	3.5	2.5	1.12	**2.13**
VS	1.4	1.1	2.2	0.2	0.72	**1.23**
VP	2.8	4.6	4.2	8.7	2.20	**5.08**
VA	4.8	10.3	6.7	4.0	2.43	**6.45**
VIS	0	0.4	0.1	0	0.16	**0.13**
VIP	6.9	4.3	5.4	4.7	0.99	**5.33**
VIA	6.9	4.3	3.2	5.0	1.35	**4.85**
VIIS	0	0	0.3	0	0.13	**0.08**
VIIP	0	1.1	2.3	3.7	1.38	**1.78**
VIIA	0	1.1	7.7	7.2	3.48	**4.00**
%	100.3	100.2	99.9	99.9		

PERCENTAGES ASSOCIATED WITH EACH QUARTER BY SUB-DIVISION

TABLE 15

	%	1st	2nd	3rd	4th	σn	mean %
	IS	2.1	2.5	2.3	1.20.	0.50	2.03
S-codes	**IIS**	0.7	1.4	2.3	1.5	0.57	1.48
Sub-division	**IIIS**	0.7	0.7	0.8	0.7	0.04	0.73
	IVS	0	0	0.8	0.2	0.33	0.25
	VS	1.4	1.1	2.2	0.2	0.72	1.23
	VIS	0	0.4	0.1	0	0.16	0.13
	VIIS	0	0	0.3	0	0.13	0.08
TOTAL		**4.9**	**6.1**	**8.8**	**3.8**	**1.86**	

	%	1st	2nd	3rd	4th	σn	mean %
	IP	9.7	13.9	5.1	8.7	3.14	9.35
	IIP	9.7	11.0	7.2	14.1	2.49	10.50
P-Codes	**IIIP**	20.7	15.7	15.9	12.4	2.96	16.18
Sub-division	**IVP**	1.4	1.1	2.3	3.0	0.75	1.95
	VP	2.8	4.6	4.2	8.7	2.20	5.08
	VIP	6.9	4.3	5.4	4.7	0.99	5.33
	VIIP	0	1.1	2.3	3.7	1.38	1.78
TOTAL		**51.2**	**51.7**	**42.4**	**55.3**	**4.75**	

	%	1st	2nd	3rd	4th	σn	mean %
	IA	1.4	4.6	4.0	3.0	1.21	**3.25**
	IIA	6.9	6.4	6.7	8.4	0.77	**7.10**
A-Codes	**IIIA**	22.1	15.3	16.9	10.7	4.07	**16.25**
Sub-division	**IVA**	2.1	0.4	3.5	2.5	1.12	2.13
	VA	4.8	10.3	6.7	4.0	2.43	6.45
	VIA	6.9	4.3	3.2	5.0	1.35	4.85
	VIIA	0	1.1	7.7	7.2	3.48	4.00
TOTAL		**44.2**	**42.4**	**48.7**	**40.8**	**2.95**	

TABLE 16 **COMPARISONS BETWEEN SUB-DIVISIONS**

	Episodic Quarter					
(all sub-categories)	**1st**	**2nd**	**3rd**	**4th**	**σn**	**Mean %**
S	4.9	6.1	8.8	3.8	1.86	**5.9**
P	51.2	51.7	42.4	55.3	4.75	**50.2**
A	44.2	42.4	48.7	40.8	2.95	**44.0**

TABLE 17 **QUARTERLY MEAN PERCENTAGE TOTALS**

	CODE%	**1st**	**2nd**	**3rd**	**4th**	**σn**	**mean%**
	IS	2.1	2.5	2.3	1.20.	0.50	2.03
	IIS	0.7	1.4	2.3	1.5	0.57	1.48
S-Codes	**IIIS**	0.7	0.7	0.8	0.7	0.04	0.73
	IP	9.7	13.9	5.1	8.7	3.14	9.35
	IIP	9.7	11.0	7.2	14.1	2.49	10.50
P-Codes	**IIIP**	20.7	15.7	15.9	12.4	2.96	16.18
	IA	1.4	4.6	4.0	3.0	1.21	3.25
	IIA	6.9	6.4	6.7	8.4	0.77	7.10
A-Codes	**IIIA**	22.1	15.3	16.9	10.7	4.07	16.25
							66.87%

CODE%	**1st**	**2nd**	**3rd**	**4th**	**σn**	**mean%**
VS	1.4	1.1	2.2	0.2	0.72	1.23
VP	2.8	4.6	4.2	8.7	2.20	5.08
VA	4.8	10.3	6.7	4.0	2.43	6.45
						12.76%

TABLE 17 continued **QUARTERLY MEAN PERCENTAGE TOTALS**

CODE%	1st	2nd	3rd	4th	σn	mean%
VIS	0	0.4	0.1	0	0.16	0.13
VIP	6.9	4.3	5.4	4.7	0.99	5.33
VIA	6.9	4.3	3.2	5.0	1.35	4.85
						10.31%

CODE%	1st	2nd	3rd	4th	σn	mean%
VIIS	0	0	0.3	0	0.13	0.08
VIIP	0	1.1	2.3	3.7	1.38	1.78
VIIA	0	1.1	7.7	7.2	3.48	4.00
						5.86%

CODE%	1st	2nd	3rd	4th	σn	mean%
IVS	0	0	0.8	0.2	0.33	0.25
IVP	1.4	1.1	2.3	3.0	0.75	1.95
IVA	2.1	0.4	3.5	2.5	1.12	2.13
						4.33%

5.10 DISCUSSION OF THE RESULTS OF THE SOCIO-HISTORICAL ANALYSIS

Within each sub-division of S-, P- and A-coded categories, there is a remarkable similarity in the total percentage of each sub-division, indicating a general consistency in the interactive nature of Kirk and Ashley's numerical talk. The S- sub-divisional categories appear to occupy approximately 6% of the total numerical utterances; the P- sub-divisional categories, numerical talk for others, are usually the most frequent, occupying approximately 50% of all utterances; and the A- sub-divisional categories appear to normally occupy slightly less than 50% of all numerical utterances. These results would appear to be consistent with a view of number appropriation as a rhetorical-responsive expression, where social others (often parents) appear to interactively use and involve young children in numerical utterances within social contexts, and the children appear to respond by practising their own use of these same numerical utterances.

Kirk and Ashley's numerical talk seems to develop through an interpretation of their surrounding social environment, eg. "There's three dogs". Kirk and Ashley's numerical talk also appears to be socially focused. Their numerical talk was often uttered as part of routine social communication (50% occurrence in the P- sub-divisional categories), and it became influenced by social routine (always counting the same stairs in the same shop, or quantities of sandwiches or toast for supper). The rhetorical-responsive nature of their numerical utterance is reflected in the high combined percentage of the A- and P- sub-divisions (approximately 94%). It is also possible to consider the S- sub-division to be a form of social numerical utterance as well, since such utterance may be deemed to have previously belonged to social others, and which has been subsequently appropriated and uttered by the self as talk for the self.

The volume of numerical episodes between the four quarters appeared to grow, 145 in the 1st quarter, 284 in the 2nd, and 741 in the 3rd quarter, but the lower quantity in the 4th quarter 403 may also be consistent with this trend since this time period partly overlapped the period when Kirk & Ashley were away on holiday. The large quantity of episodes in the 3rd quarter may be due to researcher zeal and a growing awareness of the contextual situations that would give rise to numerical talk. Despite this aspect of researcher bias, it certainly appears that as time progresses there is also an increase in the child's numerical interactions. When the content of Kirk and Ashley's interactive numerical talk is analyzed in terms of sub-categories I to VII, the content of their numerical talk does not appear to fluctuate wildly (see percentages in table 17), this is evidenced by the low standard deviations. However, there are some developmental trends.

Despite all seven categories being generally consistent with one another in each sub-divisions, (indicating a reasonable measure of reliability), there are some noticeable number appropriation developments, these will now be highlighted between the sub-divisional categories over the twenty month period studied.

The early absence of number sums (cat. VII), involving the ideas of addition, subtraction, division and multiplication and their gradual introduction in the A- and P- sub-divisions in the 2nd quarter, with more extensive evidence appearing in the 3rd and 4th quarters is quite noticeable. It is interesting to note that the A- sub-division appears to be the main source of this number sum talk, and that it is almost non-existent in the S- sub-division.

CODE%	**1st**	**2nd**	**3rd**	**4th**
VIIS	0	0	0.3	0
VIIP	0	1.1	2.3	3.7
VIIA	0	1.1	7.7	7.2
Total	**0**	**2.2**	**10.3**	**10.9**

A similar, but less obvious developmental trend for number subitization is apparent. Subitization appears to slightly grow from quarter to quarter in terms child practice (the P- sub-division), although the adult influenced subitization remains steady and low.

CODE%	**1st**	**2nd**	**3rd**	**4th**
IVP	1.4	1.1	2.3	3.0
IVA	2.1	0.4	3.5	2.5

Based upon their mean quarterly totals, number sums account for only 5.86% in all three sub-divisions (see table 17, sub-category VII), and number subitization only 4.33% (sub-category IV).

There is also a gradual rise in Kirk and Ashley's practice of number figure recognition, 2.8% in the 1st quarter of the P- sub-division and reaching 8.7% in the 4th quarter (with a standard deviation of 2.20). This rise in practice in number figure recognition in the P- sub-division may influenced by earlier adult/social other instruction/guidance or assistance, because the A- sub-division number figure recognition peaks in the 2nd quarter (10.3%) and reaches its second highest level (6.7%) in the 3rd quarter.

CODE%	**1st**	**2nd**	**3rd**	**4th**
VS	1.4	1.1	2.2	0.2
VP	2.8	4.6	4.2	8.7
VA	4.8	10.3	6.7	4.0

The steady decline of cardinal number talk in both the A- and P- sub-divisions from the 1st to the 4th quarters is also noticeable, 22.1% & 20.7% respectively in the 1st quarters, falling steadily in the 2nd and 3rd quarters ~ 15% & 16%, to reach 10.7% & 12.4% in the 4th quarters (with a standard deviation of 4.07 in the A- sub-division and 2.96 in the P- sub-division).

CODE%	**1st**	**2nd**	**3rd**	**4th**	mean
IIIS	0.7	0.7	0.8	0.7	0.73
IIIP	20.7	15.7	15.9	12.4	16.18
IIIA	22.1	15.3	16.9	10.7	16.25
Total	**43.5**	**31.7**	**33.6**	**23.8**	

This steady decline of cardinal number talk over the four quarters may be linked to increases in other aspects of number use and practice, both by adults and by the children, eg. the increase in number sum talk, subitization talk, and number figure reading/recognition. None-the-less, cardinal utterance is still by far the most common form of mediated numerical interactional talk among all seven sub-categories, in all four quarters.

Most adult/social other numerical talk involves cardinal utterance at some stage, and the high mean percentage between the four quarters, 16.25%, is more than double its nearest rival, one-to-one correspondence counting, with a mean of 7.10% (see table 15, A- sub-division section). The practice of cardinal number labelling by Kirk and Ashley is also the most frequently practised aspect of number in the P- sub-category, 16.18% of all number practices in the A- sub-division.

From table 15, it may noted that of all the aspects of number use in the S- sub-division, number string recital, sub-category I, appears to be the most common occurrence of self-regulated number talk. Child performance in the P sub-division is also high, and it is especially worth noting that number string recital does not feature highly in the A- sub-division, it appears to be very low on the adult/social other interactive number agenda.

CODE%	**1st**	**2nd**	**3rd**	**4th**
IS	2.1	2.5	2.3	1.20
IP	9.7	13.9	5.1	8.7
IA	1.4	4.6	4.0	3.0

It may be that this aspect of number is communicated by adults to children in other ways, not simply as isolated recitation, since it is always used in the II sub-category, one-to-one correspondence counting. Certainly, with a mean quarterly percentage of 3.25%, (see table 15, A sub-division), adult/social other instruction or guidance in number string recital is low in comparison with the mediational percentage linked to other aspects of number uses, less than half of the mediational percentage of one-to-one correspondence instruction/assistance/guidance (mean 7.10%), and also only equivalent to half of the adult/social other mediational percentage related to number figure 'reading'/recognition (mean 6.45%). Number string recital is a dynamic aspect of number for young children. New horizons are always being sought and provided by the adult/social other during number dialogue, and the boundaries in terms of extent of recitation is continually changing, Initially the first few numbers, (one, two, three) then extensions to five, then ten then twenty, and then beyond twenty. Number recital occupies almost 10% in the first quarter of the P- sub-division, and that level is proportionally maintained throughout the study, the mean percentage is measured as being 9.35% over the four quarters (standard deviation 3.14). This number recitation practice, with a mean ~ 10%, may be contrasted with the mean of 3.25% in number recitation involving instructional assistance or guidance provided by an adult/social other.

Both number string recital and one-to-one correspondence counting, the I and II sub-categories, are most prevalent in the P- sub-division, - they are practised by Kirk and Ashley without prompts from adults. In all four quarters, the percentages of number string recital and one-to-one correspondence counting in the P- sub-division exceed those in the A- sub-division. Number recitation appears to be one of the three principle sub-categories of number practised by Kirk and Ashley, the other two being one-to-one correspondence counting and cardinal labelling. See below:

CODE%		**1st**	**2nd**	**3rd**	**4th**	**σn**	**mean%**
	IP	9.7	13.9	5.1	8.7	3.14	9.35
	IIP	9.7	11.0	7.2	14.1	2.49	10.50
P-Codes	**IIIP**	20.7	15.7	15.9	12.4	2.96	16.18
						Total	**36.03**

The mean quarterly total percentages of number recitation, one-to-one correspondence counting, and cardinal labelling account for 36.03% of all utterance in the P- sub-division, 26.6% in the A- sub-division, and 4.24% in the S- sub-division, a grand total of 66.87% between all sub-divisions. In other words, two thirds of Kirk and Ashley's social interactive numerical utterances concerned these three principle aspects of number utterance, number string recital, one-to-one correspondence counting and cardinal labelling.

From the analyses produced by Table 17, it can be seen that of the other remaining four measured sub-categories of number utterance, figure 'reading'/recognition (sub-category V), appears to be the most frequent, occupying a quarterly mean total percentage of 12.76% between the three sub-divisions, this is closely followed by number label utterance (VI), with a total quarterly mean percentage of 10.31% between all three sub-divisions.

5.11 CHAPTER SUMMARY

What is very noticeable about these research extracts is how often Kirk and Ashley spontaneously begin to use number without any prompt from the adults, especially in the first three sub-categories of number use. It is not adults who are always actively asking them to recite, count, or quantify, they appear to initiate, demonstrate and practice counting practices to others, as well as to themselves. The performance displays, represented by the P-category percentages, numerical utterances for social others, always appears to be slightly higher or equivalent to the A-categories (adult instructing, assisting, guiding), especially in the first three sub-categories (I, II, III). This may be seen to be due to socio-historical influences in which these first three sub-categories have been previously mediated by adult input, which has now waned (responsibility has been partly handed over). This is noted from the overall decline in the A- sub-division percentage across the four quarters and the rise in the P- sub-division percentage (see table 16).

Number string recitation is quite substantially higher in the P- sub-division, than in the A- sub-division, indicating that Kirk & Ashley are more involved in practising this aspect of number than the adult/social other is in instructing, guiding, assisting them. In fact Kirk & Ashley appear to spend more than twice as much time practising number recitation than extending their string through adult/social other interaction. Although many of the seven aspects of number practices identified and studied often appear to lie with the child's interest, as is demonstrated by higher percentages in IP, IIP, IIIP compared to IA, IIA, IIIA, some of the child's numerical practices appear to develop from adult interaction, especially the 'reading' or recognition of printed numbers and number sums. In the case of number sums (VII), and to a lesser extent number figure 'reading'/'recognition', the adults appear to be the principle motivating force, since the A- sub-divisional categories are higher than the P- sub-divisional categories.

The adult influence appears to actively interest Kirk and Ashley in aspects of number, and subsequently they respond by appropriating that interest in number. Kirk and Ashley's appropriation of number through socializational activity appears to be a two-way process, both the adults and children play rhetorical-responsive roles, the adult's initiations and interests quickly become the child's initiations and interests.

It should be noted that it would have been quite impossible and quite impracticable, (as well as meaningless in relation to the theoretical foundation of this thesis), to have made any attempt to study separately Kirk and Ashley's numerical talk. Each of their numerical utterances were influenced by the other. Their utterances were also influenced, prompted and promoted, directly and indirectly, by their parents. It may also noted that they promoted, directly and indirectly, each other's numerical appropriations on numerous occasions. Consequently, may well be true to suppose that two or more children together are likely to socially appropriate aspects of number at a quicker pace that a lone child, by rhetorically-responsively aiding each other's social uses and practices of number.

5.12 CHAPTER CONCLUSION

On the evidence presented in this chapter, Kirk and Ashley's numerical talk cannot be interpreted as being anything other than a social constructivist rhetorical-responsive development.

My evidence that even a very young child under 2-years of age is able to appropriate and make a spontaneous and correct use of the number 'two' to describe a perceived cardinal quantity is in line with findings by Wagner and Walters (1982). My data would also appear to support the finding by Durkin et al (1986), who suggested that the most frequently used numbers by young children are 1, 2, 3, 4 (in a descending order of frequency use). Both young children and adults appear to become involved in social contextual situations in which these cardinal numbers can be descriptively applied to quantities, consequently it is hardly surprising that these are the numbers that young children first learn to use. The cardinal meaning of 'two' appears to be learned before 'three' or 'four', but the cardinal meaning of 'three' and 'four' may not be learned before 'five'. In the context of counting fingers, the quantity 'five' appeared to be appropriated more readily by both Kirk and Ashley before the cardinal quantity of 'three' or 'four' fingers', (and this is also demonstrated by a little girl on video, dated 28-02-93). The larger cardinal quantities, such as six, seven, eight, nine, ten, eleven, twelve, appeared to be appropriated through their composition of smaller cardinal quantities. Kirk constantly expressed these larger cardinal quantities in terms of the smaller cardinal quantities, eg. making an eight from four and four; six from five and one, or three and three, etc. Counting in a one-to-one correspondence, accurately and confidently, also appears to progress steadily from small quantities, three objects can be counted before six objects. The cardinal rule appears to be learned as an integral part of the socially regulated counting process, where one-to-one correspondence, number string recital and cardinal labelling are learned together, at the same time. The verbal recital of the number sequence up to ten appears to be readily learned before the age of 3-years old, but does not appear to be dependent upon age. By 3-years old Ashley could recite up to forty-four whereas Kirk at age 3-years old could recite only up to twelve. The difference appeared to be partly due to additional parental encouragement and parental involvement (this research), and probably also due to the additional numerical rhetorical-responsive discourse generated by Kirk to/with Ashley. In addition, Ashley received greater encouragement in terms of parental assistance to verbally recite the number sequence during the age period from 2-years to 3-years than did Kirk during the same age period. By the completion of this study, on Kirk's 4th birthday, Kirk was able to verbally recite up to fifty-seven with assistance and Ashley, still only aged 3-years 1 month, could recite beyond forty. These particular examples of verbal recitations were, in both cases, related to the counting of objects (in Kirk's case sweets from a packet, and Ashley's case buttons on a remote control). Kirk and Ashley's verbal recitations were the main feature of all their numerical activity, and counting usually took place with an external vocalization of number words.

The verbal learning of the number sequence may be directly related to a child's counting skill, since the number words must be self-regulated before they can be put into practice in situations involving one-to-one correspondence counting. Young children's ability to recite the number sequence is acknowledged as being of vital importance by a number of other researchers (Wynn 1992; Pollio & Whitacre 1970; Fuson & Hall, 1983; Klahr & Wallace, 1973; Wagner & Walters, 1982; Fuson et al, 1982; Durkin et al, 1986; Schaeffer et al, 1974; Briars & Siegler, 1984; Becker 1989). In one particular example, when Kirk was counting toy fish, although he had mastered the counting 'techniques', he was unable to count beyond twelve because he did not know the number words to use. Ashley also found himself in a counting situation in which he could not finish the count because of a lack of words (he was counting wooden planks on a climbing frame, there were thirteen, but Ashley only knew the first twelve count words, and so the last plank was not counted).

Putting into practice the cardinal use of number words was a principle feature of Kirk and Ashley's spontaneous numerical talk (eg. "there's three dogs!", "there's three seats", "I want three sweets"). The cardinal principle appeared to be readily appropriated from, and related to, its use in social contextual situations. Similarly, one-to-one correspondence counting practice was often appropriated from and related to social situational use and application, and the notion of *'counting play'* was very visible. Numerical symbolic interaction occurred frequently, usually through interaction with numerical labelling, eg. TV remote control, playing with a calculator, toy telephone or toy till, but mostly from reading books about numbers, or books in general, all pages are usually numbered, and even the Bible has numbers scattered throughout its pages (as Kirk quickly found out for himself). It did not take long before both Kirk and Ashley became acquainted with printed numbers, and they soon began to recognize printed numbers being used in a variety of contexts eg. multi-story car-parks, door numbers, bus numbers, etc..

Kirk and Ashley played an active participatory role in a process of socially appropriating number, they often questioned their parents about a number even after they had demonstrated an appropriation of that particular number meaning, it was as if they needed constant social reinforcing (eg. after saying "I've got three, and you've got only two na, na, na.na.na", Kirk may have asked: "Is this three?). Parental interaction does appear to play a major role in initiating, sustaining and developing a child's number practices. The *child often appears to be the initiator of the number* practices, but it should be born in mind that these apparent initiations are often actually imitative responses to previous adult practices. When a child says "I want three sweets", that number use by the child is not so much an example of a child's spontaneous use of number as it first appears, it can be viewed as a response to a previous situation in which an adult may have said, "You're getting only one sweet". All young children's numerical utterances may be viewed as verbal responses to socially perceived situations, and so dialectically mediated through social interaction. The time span of the research covered 20 months, from 01/02/93 until 24/09/94, but there was a three month gap from 16/03/94 - 16/06/94, during which time Kirk and Ashley went overseas with their mother for a holiday. After their return it took a few weeks before the research recording and noting resumed, and so the 625 total number of numerical incidents recorded and noted actually occurred during a period of 16 months. The monthly average is calculated to be approximately 39.1 for both children or 19.5 for each child, (and this does not take into consideration all the numerical episodes that may have been missed). It would have required 24hr surveillance of both Kirk and Ashley, each and every day for 20 months to miss nothing, as well as the same amount of time again to review the captured data, and much more time to edit, dub and transcribe the data. Such an exercise would have been quite unpracticable for this thesis, and for a lone researcher, and a 20 month time period was deemed necessary to completely gather the data for a socio-historical 'apprenticeship' study. A traditional craft or trade 'apprenticeship' period was always long so that it would encompass all aspects of the craft/trade, and this is no different for number, a twenty month period is merely a snap shot of the whole apprenticeship period.

This measured rate of approximately 20 numerical interactions per child per month, would suggest that during any three day period in a child's daily routine, 2 numerical episodes could be expected to occur during day-to-day interaction in the company of a parent or social other. This *quantity rate* is approximately equivalent to ***0.67*** numerical interactions per day, and the coding density, which provides the *quality* measure is ***2.51*** codes per interaction.

This research provides some evidence that possibly some young children are regularly engaged in activities at home that involve the use of number language, and that the meaning of the number language is often mediated interactively in social context by adults. My research does not support the study by Saxe et al (1987), which suggested that younger children differed from older children in their numerical understandings eg. extent of reciting number words in cardinal order and producing consistent cardinal value through counting in one-to-one correspondence. Ashley, at age 2 years, often used number as confidently and as correctly as Kirk, aged 3-years; and at 3-years of age, Ashley substantially surpassed Kirk's numerical performances when he was 3-years old. Overall, I have identified few noticeable differences in the complexity of numerical performances elaborated by parents/adults to children of different ages. However, older children appear to become more involved in numerical interactions, than younger children. Kirk was always more involved in numerical interaction than Ashley, but Ashley's interactions increased in quantity as he became older.

The wide range in numerical skill and knowledge of young children aged less than 5 years old (noted by nursery teachers during interview, see chapter 9), is substantiated by this case study. Some children aged 2 years may possess the numerical developmental competence of some 4-year old children, while some 4-year old children may possess the competence of 2-year olds, age appears to be mostly irrelevant, it is the social numerical interaction that appears to determine developmental competence.

For some children, the material world is ideologically represented in a more numerical manner than for other children, and this socially regulated representation is like a cognitive seed, it can grow strong and quick if well nurtured.

The findings that are reported in this chapter may support a socio-cultural model of developmental cognition, a *'numerical apprenticeship'*, where young children's numerical developmental competence is shown to be socially mediated through the numerical language used in their daily micro-environmental activity, and through the child's *'counting play'*.

CHAPTER 6

SIX DIARY CASE STUDIES
OF YOUNG CHILDREN IN THEIR OWN HOMES
PRACTISING THE CULTURAL USE OF NUMBER
THROUGH SOCIALLY MEDIATED NUMERICAL UTTERANCE

INTRODUCTION

6.1
Social Interactive Play with Peers and Adults in Cognitive Development

There is a growing body of research (Clarke-Stewart, 1973; Elardo et al, 1975; Rogoff & Gardner, 1984; Gauvin & Rogoff 1989; Rogoff 1990; Rogoff et al, 1993) which demonstrates that associations between adults and children during interactive play, influence the cognitive or mental development of the child. Parents have been noted to structure the context of their children's play through adult interaction and guidance (Bradley & Caldwell, 1984; O'Reilly & Borstein 1993). When parents are actively engaged in play with their children, they structure play by including socially relevant props, establish and arrange the play context, engage in play as a partner, maintain the action, guide children in their roles, and generally monitor the play structure through verbal feedback (Sach, 1980; Dunn & Wooding, 1977). Over the course of the first two years, Klein (1988), found that parents increasingly altered their forms of interaction with their children in favour of "mediated learning experiences", whereby the parents developed play situations that were interpreted and structured for the child. According to Klein (1988), as children grow older, parents increasing see interactive play as a suitable context for the development of adult-guided learning. The majority of adults do use number skills effectively in the course of everyday activities, and this adult number use may be incorporated into play with young children, eg.'lets play shopping' (Rogoff & Gardiner, 1984).

6.2 Joint Activity:The Role of Adult Verbal Guidance in Regulating Young Children's Behaviour

Vygotsky's theory indicates that internalized verbal thinking originates in the give-and-take of social interaction, and Vygotskian orientated research (eg. Berk, 1985) has shown that early forms of self-directed speech emerge in social circumstances rich in verbal interaction. In particular, activities that involve role play lay the foundations for effective social communication, where children apply their language and communication skills as they experiment with different social roles. Various play experiences and settings bring together children of different ages who have diverse skills and abilities. When children play together or interact with an adult at meaningful, goal-directed tasks (building with blocks, playing a game, looking at books, role playing) the effect of the interaction is often to verbally translate the task, and at the same time children contextually appropriate the language associated with the task. Once this happens, children often continue to organize and structure their own play in similar verbal ways through self-directed speech.

According to Vygotsky's view of a 'zone of proximal development', adults are most helpful when their guidance assists the child in tasks that are just above and beyond the child's ability and experience, and when the adult assistance is coordinated or linked to the child's current level of development. In the case of a very young child, who may have little idea of what a particular activity is all about, the adult's guidance will often be verbally specific in direction, for example, (during the child's construction of a jig-saw puzzle) "Put this piece here, and the next piece goes there", until the child realizes what is actually taking place and begins to relate the adult's speech to the task accomplishment. Once this happens, the adult's verbal regulation becomes less necessary, and may even be resented by the child. When the child begins to practice strategies independently from the adult, the child may be still using adult directed verbal assistance, but self-directed in the form of internalized external speech. The adult verbal assistance is then able to move on to a more general level, for example in the case of the puzzle, "What shape is this piece? What empty space looks like that shape?". Adults often call attention to important aspects of a task by verbally prompting children, and by so doing verbally assist children to focus their own self-directed speech on important aspects of the task (Wood et al, 1976).

Results of a study by Normandeau et al (1992) suggest that as children become older, the parents allow them to take over more responsibility in the solution of the task. Normandeau et al (1992) also report that parents adjust their verbal interactions to take account of their child's increasing use of premeditated strategies during task problem solving. Despite an apparent lack of expertise by the parents themselves in the solution of the task, the parents were still able to guide their children's reasoning to effect a task solution. Normandeau et al's results support Vygotsky's contention that adults are able to act as mediators between a child's already developed cognitive abilities and a learning environment by adjusting their interactions to a child's level of performance. More importantly though, Normandeau et al's results suggest that the effectiveness of adult guidance does not necessarily rely specifically on the adult's expertise in knowing the solution to a task, but on the adult's expertise in developing the course of the child's activity. Previous studies of joint learning activities (Wood et al, 1976; Wertsch et al, 1984; Rogoff, 1990; Rogoff et al, 1993) have emphasised parent's expertise in 'cognitive monitoring' when they interactively assist children's efforts. Normandeau et al's results focus attention directly on adult's cognitive monitoring ability, namely that of *mediating* children's task solutions.

What an adult does or says when guiding a child is contextually bound and situationally dependent upon the child's momentary behaviour, and related to any immediate obstacles associated with successful completion of the task. For example, if the child has difficulty sustaining attention, the adult might remind the child of the goal of the task ("When the puzzle is finished you can see the whole picture") or point out that there is another step after the one the child has just completed ("Where does this next piece go?"). If the child appears uncertain about what to do next, the adult might assist by verbally reminding the child about important features associated with the task ("Remember, the red ones go here and the blue ones over there"). When children themselves start using the task regulating phrases previously given by an adult, this is a sign that more of the verbal control is being assumed by children themselves.

The regulatory language however must not be seen as emanating from a child, it was interactively formulated by an adult and appropriated by the child.

Children need learning environments which permit them to be verbally active while solving problems and completing tasks. As children mature, and through experience and practice their skills become more routine and automatic, they transform their task-related verbal expressions into less audible whispers, until finally the expressions are appropriated as verbal thought. Internal thought may thus be seen to be originally external to the child, and:

> By focusing on the notion of 'appropriation', the need for the concept 'internalization' is pre-empted (Valsiner, 1991, p310).

From this argument, counting with number words may be viewed as a skill that children initially appropriate through adult assistance in the form of external verbal regulation of children's number word recitations. This verbal form of adult numerical regulatory expression would be expected to become a self-regulating expression for children under the above considerations of how children learn to master tasks that are initially vague (counting being an initially vague task).

It is important to recognize that Vygotsky's emphasis was on communicative speech, rather than on language (Wertsch, 1979). For both Vygotsky (1986) and Vološinov (1973), when speech activity is identified and characterized, they do not consider that such verbal utterances are meaningful in isolation. Rather, they insist that verbal speech can only be communicatively understood if it is contextualized within human activity. It is by learning to function in communicative contexts involving social regulation that a young child can begin to develop self-regulative abilities that are culturally valued. Participatory activity involving social communication gives a young child an opportunity to self-regulate that activity. Often during social interaction a young child begins to assume more responsibility for the communicative and regulative responsibilities formerly carried out by an adult. And this transfer of communicative regulation, from an adult or social other to a child, can be readily seen when a young child begins to verbalize the ordered sequence of number words. In this respect the child's self-regulation of the number word sequence can be viewed as a social communicative process that originates from adult or social other-regulation.

Early studies of the beginnings of young children's number abilities tended always to focus on the child's competencies, what they could or could not achieve (Piaget, 1952). In order to gain further insight into the socio-cultural development of young children's number competencies, the linguistically mediated numerical activity present in young children's social worlds must be observed. From this socio-historical perspective (Vygotskian), the developmental process of becoming numerate involves mediated learning of the elements of the cultural number system in a socially relevant world. The basic unit of analysis is not competence but mediated action involving verbal communication (Wertsch, 1979;1991), where it is being used by a social other, such as an adult, to prescribe meaning to a particular task situation in which a child is actively engaged. According to Wertsch (1979, p5):

> The argument that Vygotsky had in mind when dealing with speech is very similar to Wittgenstein's notion of a language-game has important implications for understanding the transition from interpsychological to intrapsychological functioning

Wertsch (1979) outlines four levels in the transition from external regulation to self-regulation. According to Wertsch, the first level in the transition is characterized by the fact that the child's understanding of the task situation is so limited that communication is very difficult. Wertsch suggests that at this stage, if the child is incapable of participating in the language game, rather than trying to regulate the child's activity by relying on the definition of the situation that may exist for adult speakers, the adult must use speech and gestures which are tied to the definition of the situation that exists for the child. Even though the child at the first level is not taking on the regulative functions necessary for carrying out the task, this level is an important part of a complete description of the transition from other- to self-regulation because it takes into account the child's limited perception, (which is a direct consequence of limited communication). It is this development of communicative context that may lead to a transfer of responsibility from adult to child. Wertsch's second level takes account of a more developed communicative interaction. At the second level the child realizes that the adult's utterances are also directed towards the task, but the child may not always be able to interpret the implicit connection between the adult's speech activity and the task. At the third level the child is able to interpret nonexplicit directives (eg. hints) in such a way as to demonstrate operating competence. At this level it can be clearly seen that the child has taken over, from the adult, some of the responsibility for regulating behaviour during the activity. The transition from other-regulation to self-regulation has begun while the process is still being carried out on the interpsychological plane of functioning. At the fourth level, the child is operating within an intrapsychological plane. A complete transition from other-regulation to self-regulation has taken place. At this stage the child is able to complete the task without any strategic assistance from the adult.

These four levels of psychological transition outlined by Wertsch, from social interpsychological functioning to the individual intrapsychological functioning, from external regulation to self-regulation, may be interpreted in terms of my sub-divisional coding of number utterances outlined in Chapter 5. The A- sub-division accommodates Wertsch's first two levels, the P- sub-division is equivalent to Wertsch's third level, and the S- sub-division matches Wertsch's fourth level.

6.3 Methodology

The aim is to generate additional research data related the socialization of young children into a culture that uses number, in order to triangulate the home data produced in the case study of Kirk and Ashley (see Chapter 5) and to produce a 'thick' description (see Chapter 4).

Six parents agreed to keep a home diary record of their young children's numerical interactions over a short period, 3 months was given. Each parent was sent a letter explaining the nature of the research and what was required of them (this letter is shown in Appendix B). In brief, each parent was requested to write down in a notebook all the daily incidents that involved their child in the use of number, including events in which the parent participated interactionally with the child eg. reading a counting book to the child, playing a game involving number use, or adult initiated conversations that conveyed numerical meaning, eg. "It's seven O'Clock, time for bed"; "Put the television on Channel 3"; "No, you can't have three biscuits!".

From the Diary Accounts that each parent kept concerning their child's home practices involving number use, I hope to determine whether or not the practices observed in the home of Kirk and Ashley were 'normal', or to what extent there was variation; and hence from this research data, be in a position to determine what may be 'normal' home practices surrounding the social mediation of number meaning.

Once again, the theoretical consideration (previously outlined), concerning the inextricably intertwineness of numerical utterance and numerical meaning with use, will be taken as being the principle source of social numerical mediation. The diary accounts of mediated numerical interaction produced by the parents will be interpreted in terms of possible numerical utterance, codified according to the three sub-divisions (S-, P-, & A-), depending upon the contextual and personal circumstances surrounding the numerical utterance, and classified according to the nature of the 'number' utterance (within the seven sub-categories I, II, ... VII). The sub-divisions and the sub-categories are outlined in Chapter 5, and are related to the four levels of inter- intra-psychological transition, from external regulation to self-regulation, outlined by Wertsch (1979).

These home diary reports from parents will be analyzed in exactly the same way as the data gathered in the case of Kirk and Ashley's home case study, through a coded analysis of the numerical utterance that *appears* to have taken place. I emphasize, '*appears*' because the source of the data is second-hand, and what was precisely said or done cannot be exactly determined. The diary note written by the parent, where this is vague, will be interpreted in terms of the numerical utterance that would be expected from the activity. For example, if the parent indicates that a counting book was 'read', then in the absence of any clear statement as to who did the reading and to whom the reading was done, it will be assumed that the child did not 'read' the book alone, but that there was some parental interaction, in which case, the coding will lie in the A- sub-division (Adult assisted/guided/instructed/requested/prompted). Counting books invariably print the number figures, in which case a 'category V' would be a likely coding; also any parental reading of the counting book would most likely involve the child in one-to-one correspondence counting and cardinal labelling, in which case categories II and III may be interpreted as having taken place. If the parent indicates that the child performed some numerical skill in their presence, then the utterance associated with that activity will be classified within the P- sub-division; and if the parent indicates that they observed the child reciting/counting/number labelling alone, and apparently for themselves, it will be classified within the S- sub-division. In this manner the diary accounts provided by parents will be codified, and thereby permit comparison with the home data of Kirk and Ashley that has already been analyzed in Chapter 5.

Keeping a diary record of their young children's numerical activity/language use was clearly a burden for some parents, especially with those that had other children to look after, and so the diary records are not expected to be complete in the sense that every event during a three month period has been reported. Indeed, some of the parents were unable to report for the stipulated three month period, and their records are consequently very brief. However, a few of the parents cooperated enthusiastically, clearly displaying a watchful eye over their child's numerical activities, and the insight revealed in this Chapter concerning the numerical practices of young children at home is due entirely to their efforts.

The parental diary accounts are presented in Appendix B, in the following order of analysis, ranging from 1 to 6:

B1. Ruth McLaren

B2. Paul & Samantha Jackson

B3. Mark Smith

B4. Ivan Roberts

B5. Arthur Jones

B6. Charlotte Clarke

Each of the six diary accounts will be analyzed in turn by interpreting the parental accounts in terms of:

1) The apparent quantity of socially instigated numerical activity as a function of numerical language use
2) The apparent quality of the numerical interaction as a function of numerical language use
3) The nature of the mediated numerical interaction as is defined by the sub-divisions
4) The aspects of number that appear to mediated
5) The forms of activity that appear to give rise to numerical activity/language use

6.4 CASE 1:THE CASE STUDY OF RUTH McLAREN

Ruth lived in a medium sized town in Scotland, with two parents and seven brothers/sisters. She was born on 16/06/89, and at the time of this study, which began on the 14/10/93 and ended on 21/01/94, Ruth was aged ~ 4½-years old.

6.5 ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR RUTH McLAREN

The diary entries for Ruth McLaren (**Appendix B1**) are spread over a period of 3 months, however it is quite clear that there are gaps in the reporting of the incidents, which is often admitted in the diary entries, especially during December, where there are reports for only 4 days prior to Christmas, and none after Christmas. It may be safe to assume then that there were probably more incidents than are reported here, and any measures of quantity are liable to be lower than actual.

In terms of the quantity reported, there are 49 incidents which may be attributed to 90 days, producing a rate of **0.54** per day, - this is slightly lower than in the case of Kirk and Ashley's home data which had a rate of 0.67 (twenty incidents per month). However, if we attribute the number of reported incidents for Ruth to 75 days rather than 90 days, to compensate for the days when her mother indicates that she was too busy to report, then the rate becomes **0.65**, a rate that is quite similar to Kirk and Ashley's home rate. It may be reasonably safe then to say that the rate of numerical incidence, in which numerical utterance was mediated to Ruth, or by Ruth to herself, in the social context of her daily home-life, was quite similar to the rate experienced by Kirk and Ashley.

In terms of the quality of that mediated numerical interaction, an examination of the number of coded categories concerning the aspects number within the numerical incidents reveals that there were 88 codes per 49 incidents, a rate of **1.80** codes per incident. In the case of Kirk and Ashley's home data, the rate was 2.54 codes per incident. Ruth appeared to be receiving a lower quality of numerical interaction than Kirk and Ashley, but that is not surprising, considering how busy Ruth's mother was with her other children, whereas Kirk and Ashley could depend upon more time with their parents, especially when it came to number activity. Also, it may well be that the nature of this data, brief reports by the parents, is insufficiently detailed to permit elaborate coding, and this may result in lower coding densities being produced.

The complete total coding analysis of the diary entries for Ruth's numerical interactions appears in tables 6.1 and 6.2.

Table 6.1 **TOTAL CODING ANALYSIS for RUTH McLAREN**
-based upon 88 codes

Sub-categories

Sub-division		I	II	III	IV	V	VI	VII	Total
	S	1	4	1	0	2	1	0	9
	P	7	9	13	2	3	5	0	39
	A	4	11	9	1	11	4	0	40
Total		12	24	23	3	16	10	0	88

Table 6.2 **TOTAL PERCENTAGE CODING ANALYSIS for RUTH McLAREN**

Sub-categories

Sub-division		I	II	III	IV	V	VI	VII	Total
	S	1.1	4.5	1.1	0	2.3	1.1	0	**10.2**
	P	8.0	10.2	14.8	2.3	3.4	5.7	0	**44.3**
	A	4.5	12.5	10.2	1.1	12.5	4.5	0	**45.5**
Total		**13.6**	**27.3**	**26.1**	**3.4**	**18.2**	**11.4**	**0**	**100.0**

The analysis of the sub-divisional coding, reveals that the sub-division figures (Table 6.2), are quite similar to those of Kirk and Ashley's home data. The P- and A- sub-divisions are evenly matched in terms of quantity, accounting for around 44.3% and 45.5% respectively, and in the case of Kirk and Ashley's home data the figures were 48.2% and 45.1% respectively, quite a remarkable similarity. It would appear that while children are in their own home, they engage in numerical activity to practice or show off their developing skills often to the same extent that they are engaged in numerical activity by parents and others. Where there is rhetoric concerning number (A-), responsiveness, sooner or later, appears on the part of the child (P-). In the case of Ruth, the number speech/activity for self, (S- sub-division) at 10.2%, also appears to be relatively similar, though higher, than Kirk & Ashley's home data (S- 6.6%). This difference may be due to the nature of the reporting of Ruth's data, or it may be due to Ruth actively self-regulating her number activity to a greater extent than Kirk & Ashley, and this could be because of her older age (Ruth was effectively 1 year older than Kirk and two years older than Ashley at the time of the study). However, the S- sub-categories are relatively similar in that they form only a minor quantity of number activity/speech in the home, the A- and P- sub-categories usually accounting for ~ 90%.

In terms of the aspects of number within each of the seven sub-categories, the spread among the sub-categories for Ruth's data is once again reasonably similar to Kirk & Ashley's home data, but with one exception, the absence of category VII in Ruth's data. There is no account reported by Ruth's mother of Ruth engaging in, or being engaged in, number sums, number divisions or number multiples. And even although the percentage in Kirk & Ashley's home data was low, 8.0%, it was an important feature of their number activity/speech, whereas in Ruth's home case it does not appear to be important at all.

The remaining sub-categories are quite similar to Kirk & Ashley's home data, as can be seen from the comparisons listed below:

Table 6.3

Total Percentages	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Ruth	13.6	27.3	26.1	3.4	18.2	11.4	0
Kirk & Ashley	13.6	18.8	31.7	5.1	13.2	9.5	8.0

Ruth participated, or was engaged by social others, in a similar quantity of number recitation as Kirk & Ashley (13.6%); and although Ruth appears to have participated in more one-to-one correspondence counting, and less cardinal quantification, than Kirk & Ashley, her overall percentage of social mediation of numerical meaning, through speech associated with activity, in these first three sub-categories (I, II, III) is 67.0%, which is very similar to the 64.1% for the sum of Kirk & Ashley's social interactions in the first three number use categories.

Ruth appears to have a higher social participation rate in number figure reading (sub-category V) than Kirk and Ashley, 18.2% compared to 13.2 %, and this may be partly due to the influence of her micro-environment. Ruth's parents appear to positively promote reading in their household, taking all their children, including Ruth to the library on a weekly basis. This influence obviously rubs off on Ruth, and it is often noted in the diary accounts that Ruth is 'reading' a counting book. It is not surprising then that Ruth's sub-category matrix reveals a high percentage of number figure activity/speech, due partly to this high incidence of counting book reading promoted in her micro-environment.

Category IV, number subitization, is very low in Ruth's home data, just as is it is in the case in Kirk & Ashley's home data, and it may be noted that the source of the 'number subitization' is similar, often games of dominoes. The percentages of category VI, 'number labelling', are also proportionally similar, 11.4% for Ruth, 9.5% for Kirk & Ashley; and once again the forms of activity are similar, often featuring questions or comments related to age, or television channel numbers.

A consideration of the forms of activity in which Ruth was involved in number activity/speech around the home appears to suggest that variety is important, that young children can appropriate number from all sorts of social activity that involves numerical meaning embedded in speech communication: counting dinner plates or cutlery, being shown how to read the number figures from calenders, learning how to respond to questions on age or how to change television channels to a specified number, and how to interpret cardinal meaning from the quantificational speech of others.

6.6 CASE 2:THE CASE STUDY OF PAUL AND SAMANTHA JACKSON

Introduction

Paul and Samantha, are brother and sister, they are the only two children in their family, - a black single parent family, living in an inner city borough of London. Paul was born on 03/07/91 and Samantha on 11/05/90; and at the time of study Paul was approximately 2½ years old, and Samantha 3½ years old.

6.7 ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR PAUL AND SAMANTHA

The diary entries for Paul and Samantha (Appendix B2) begin on 12-10-93 and effectively cease on 12-12-93. It would be appropriate then to assume that these incidents took place over a 64 day period, since there is only one entry made in January and one in February.

It would be unsuitable to try and analyze the data for Paul and Samantha separately, since they were probably both involved in the 'number mediation' even although only one was performing or receiving attention, the other may be participating in the numerical mediation as a listener, consequently, as was the case in Kirk & Ashley's home data, the quantity of incidents per child will be calculated by dividing the total quantity by two.

The total number of incidents reported is 74, spread over a period of 64 days, for two children, therefore the rate per child per day is $74 \div 64 \div 2 =$ **0.58**. This quantity rate compares quite favourably with previous rates, it is very similar to the rate for Ruth (0.54 for 90 days, or 0.68 for 75 days), and just slightly lower than the rate for Kirk and Ashley, 0.67.

In terms of the quality of the numerical interaction, the coding density is 121 codes per 74 incidents, a rate of **1.64** codes per incident. This rate is similar, but less than that for Ruth, 1.80, but substantially less than Kirk & Ashley's rate of 2.54 codes per incident.

It would appear that the research method is probably contributing to the apparent occurrence of a lower quality rate in the data produced by parental diary studies. A direct comparison to Kirk & Ashley's quality rate may not be possible or justifiable, since much of Kirk & Ashley's data was derived from video transcripts which are far more detailed than parental reports. More than likely, the 1.64 rate for Paul and Samantha, and the 1.80 for Ruth, may have been higher if a video transcript method had also been employed.

A total analysis of the aspects of number that were being socially mediated to Paul and Samantha is indicated in the tables 6.4 & 6.5.

Table 6.4 TOTAL CODING ANALYSIS for PAUL AND SAMANTHA

-based upon 121 codes

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	3	1	0	3	0	0	7
	P	5	9	17	2	13	9	0	55
	A	7	14	15	2	19	2	0	59
Total		12	26	33	4	35	11	0	121

Table 6.5

TOTAL PERCENTAGE CODING ANALYSIS for PAUL AND SAMANTHA

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	2.5	0.8	0	2.5	0	0	**5.8**
	P	4.1	7.4	14.0	1.7	10.7	7.4	0	**45.5**
	A	5.8	11.6	12.4	1.7	15.7	1.7	0	**48.8**
Total		**9.9**	**21.5**	**27.3**	**3.4**	**28.9**	**9.1**	**0**	**100.1**

In the case of Paul and Samantha's numerical interactions at home, once again a similar pattern to Kirk & Ashley, and Ruth, appears to develop.

The quantity of self directed numerical interaction/numerical speech (S-) appears to be low, 5.8%, and this falls within the normally expected range (6.6% for Kirk & Ashley, 10.2% for Ruth). The other sub-divisional categories for Paul & Samantha are also represented to a similar extent as in the other home case studies. In the P- sub-division the analysis of Paul & Samantha's data indicates 45.5%, compared to 48.2% for Kirk & Ashley, and 44.3% for Ruth. In the A- sub-division, Paul & Samantha's data indicates 48.8%, compared to 45.1% for Kirk & Ashley, and 45.5 % for Ruth. This study of Paul & Samantha's numerical interactions at home confirms the possible existence of a 'normal' sub-divisional pattern, one that may be expected in other studies, an equal balance of both A- and P- sub-divisions, around the 45% level, and the balance, usually less than 10%, in the S- sub-division.

There is no mediation of number sums, divisions or multiples, as was the case in Ruth's study. However, there is a very high incidence of 'number figure reading/recognition' in Paul & Samantha's data, evidenced by the high percentage in sub-category V, 28.9%, compared to Ruth's study which had 18.2% in category V, and Kirk & Ashley with 13.2% in category V. Paul and Samantha's mother appeared to be emphasizing number recognition to the children by reading counting books, encouraging then to play with number puzzles, and drawing their attention to numbers on doors and household items (including the fridge! and the video display), while the children played with television button/telephone numbers and games of number snap. This high level of number figure recognition has not distracted the children from other aspects of numerical activity, except possibly number string recitation, where the percentage figure of 9.9% is lower than in the other case studies (13.6% for Ruth, and 13.6% for Kirk & Ashley). The percentage occurrence of one-to-one correspondence counting and cardinal number labelling, categories II and III, are both normally represented, as is the case with categories IV (number subitization) and VI (number labelling).

A direct comparison with the percentage figures produced by the home data of Kirk & Ashley, and that of Ruth, reveals that Paul and Samantha also experience similar home numerical practices in terms of the sub-divisional practices of mediation and the sub-categories of number use, with the exception of the high percentage of number figure reading/recognition (see Table 6.6).

Table 6.6

Total Percentages	I	II	III	IV	V	VI	VII
Kirk & Ashley	13.6	18.8	31.7	5.1	13.2	9.5	8.0
Ruth	13.6	27.3	26.1	3.4	18.2	11.4	0
Paul & Samantha	9.9	21.5	27.3	3.4	28.9	9.1	0

6.8 CASE 3:THE CASE STUDY OF MARK SMITH

Introduction

Mark lives in central London and attends a nursery school in the morning, he comes from a white middle class family. Mark was born on 08-11-89, and at the time of the study he was ~ 4 years old.

Unfortunately his mother did not follow the instructions given to parents' completing diary accounts of their child's numerical interactions with their surrounding home micro-environment. His mother's diary accounts (Appendix B3) indicate very few specific instances of actual number mediation in the home, but instead often report her view of his 'number understanding', or his previous acquired number skill and past performances. In addition, there is a complete absence of diary dates in her accounts, and this makes direct comparison with the other studies in terms of quantity and quality quite impossible.

None-the-less, the accounts of Mark's already developed number skill, and his limitations, plus the mediational role that his mother appears to have played in promoting the enhancement of Mark's number appropriation is worth considering because it offers yet another insight into how aspects of number often appears to be socially mediated through adult assistance/guidance.

6.9 ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR MARK SMITH

Since there are only 18 accounts of numerical interaction from late September to January, (see Appendix B3) it is quite apparent from the nature of these accounts that they are probably not a full or comprehensive account of Mark's daily numerical interactions over a period of over three months, otherwise he is not participating in the usual variety of numerical interactions that have been noted to occur in other young children's homes. There is insufficient mention of actual number oriented utterances or specific examples of Mark's skill at one-to-one correspondence counting in play with toys, number puzzles, counting books, playing with wooden bricks or other constructional toys, games, no examples of dominoes or playing with number cards, no accounts of number recitation while jumping, climbing steps, or sitting in the bath, indeed there are few accounts of number being used Mark's play. It is almost certain that some aspects of number will be there, but his mother may not have looked at his play for aspects of number use, otherwise such accounts would certainly have been reported. What we do see, are reports of some prior parental mediation in respect of 'tutoring' number figure recognition, through door and car numbers, clock-face time, calender dates, and some numerically based comments made by Mark, mostly on age, that may have surprised his parents. There is no mention of Mark playing with a calculator, telephone key-pad, or remote control panel, or his parents reading him counting books.

In general, the impression given is that in Mark's micro-environment the mediation of aspects of number is limited, eg. comments such as:

"He often points out numbers we would generally overlook"; and,

"at the moment we are concentrating on letters".

From the accounts provided, the coded categories (summarized in tables 6.7 & 6.8) reveal a pattern that would suggest either insufficient reporting, or an imbalance in Mark's social interactions with number.

Table 6.7 **TOTAL CODING ANALYSIS for MARK SMITH**
-based upon 41 codes

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	0	0	0	0	0	0	0
	P	1	0	1	0	4	6	1	13
	A	3	2	5	0	6	9	3	28
Total		4	2	6	0	10	15	4	41

Table 6.8 **TOTAL PERCENTAGE CODING ANALYSIS for MARK SMITH**

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	0	0	0	0	0	0	**0**
	P	2.4	0	2.4	0	9.8	14.6	2.4	**31.7**
	A	7.3	4.9	12.2	0	14.6	22.0	7.3	**68.3**
Total		**9.7**	**4.9**	**14.6**	**0**	**24.4**	**36.6**	**9.7**	**100**

The tabulated analysis of the numerical interactions of Mark indicate a different pattern from the previous analysis of home data, but as has already been noted, this may be due to the reporting of the data rather than any difference in Mark's social numerical interactions. In Mark's case, there appears to be a complete absence of his number use/speech in the S- sub-division, a reasonable (though low) percentage in the P- sub-division, and a high percentage in the A- sub-division. These figures would suggest that his mother was able to report numerical incidents in which she was actively involved, or acted as a social other listener to Mark, but was unable to report incidents in which Mark used number activity/speech for his own purposes. Because the S- number activity/speech is usually very low, normally 5 - 10%, the analysis percentage provides a reasonable measure of how attentive in terms of observation the parent has been in reporting his/her child's numerical interactions. If the parent is not very attentive, or not reporting everything, then this S- percentage can easily be lost, as may be the case here.

In terms of the sub-categories, the percentage table 6.8 indicates that Mark may have been involved in a very low percentage of one-to-one correspondence counting, a total of 4.9%, (and 0% in the P- sub-division) whereas the other case studies usually indicate 20 - 30% for this sub-category, and often 50% of that figure in the P- sub-division. The quantity of cardinal labelling is also very low (especially in the P- sub-division again), approximately half of what has been reported in the other case studies. Also in Mark's case analysis, there is a very high proportion of numerical incidents involving number labelling, category VI appears to be over represented, at least twice what would normally be expected, this again would suggest that the reporting of Mark's numerical interactions is flawed.

6.10 CASE 4:THE CASE STUDY OF IVAN ROBERTS

Introduction

Ivan is a young boy who lives in an inner city borough of London. He was born on 06/11/89, and at the time of the study he was 4-years old. Ivan attended a nursery school in the afternoon, and he attended the Parent & Child playgroup, one that is reported in chapter 8 (and some of his numerical activities/speech are reported as part of that playgroup data). At the playgroup Ivan was observed to be well skilled in terms of number recitation, one-to-one correspondence counting, number figure reading/recognition and cardinal labelling. The following accounts written by Ivan's mother about his numerical interactions within his home micro-environment give further insight into the social role played by his mother in mediating these aspects of number to Ivan. The accounts cover a period of only one month, rather than the three months requested (see Appendix B4).

ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR IVAN ROBERTS

Table 6.9 TOTAL CODING ANALYSIS for IVAN ROBERTS

-based upon 46 codes

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	1	1	0	1	0	0	3
	P	0	1	1	0	3	1	0	6
	A	0	5	13	0	7	9	3	37
Total		0	7	15	0	11	10	3	46

Table 6.10 TOTAL PERCENTAGE CODING ANALYSIS for IVAN ROBERTS

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0	2.2	2.2	0	2.2	0	0	6.6
	P	0	2.2	2.2	0	6.5	2.2	0	13.0
	A	0	10.9	28.3	0	15.2	19.6	6.5	80.4
Total		**0**	**15.2**	**32.6**	**0**	**23.9**	**21.7**	**6.5**	**100**

The accounts of Ivan's number interactions (see Appendix B4), made by his mother, do not appear to give a complete or full account of Ivan's possible numerical interactions. There is no mention of Ivan playing with toys, puzzles or games, there is no mention of him reading or being read counting books, and no accounts of his casual number utterances at home. The majority of the accounts relate to the mother's role as a tutor, deliberately mediating numerical interaction with Ivan, large quantities of A- sub-division mediation and very little P- sub-division. Other studies have shown that the P- often occurs as much as the A-, and therefore these reports may not represent a full or complete picture of Ivan's numerical interactions over the period reported.

The analysis of the quantity of numerical incidence indicates 19 incidents in 30 days, a rate of **0.63** incidents per day, a rate that appears to be in line with the other studies. In terms of quality of numerical interaction, the coding density rate is 46 codes per 19 incidents, a rate of **2.42** codes per incident, again, a rate that is in line with the other studies. This quality rate of 2.42 is slightly higher than the other diary studies, and may be due to the apparent deliberate mediation of certain aspects of number to Ivan by his mother (the rate is still less than the rate for Kirk & Ashley, which was 2.51 codes per incident).

It is important to note from the analysis that there is a complete absence of number string recitation in the reporting of Ivan's numerical interactions/speech. This is a highly unlikely event, especially since he was observed in a playgroup reciting up to ten before throwing a paper aeroplane into the air (captured on video).

It is also interesting to note that Ivan's mother was beginning to mediate number sums/divisions to him, something that had not been noted from the parents of children in the other studies, except in the case of Kirk & Ashley. Ivan's percentage of number sums/divisions/multiples (sub-category VII) is 6.5%, slightly less than in Kirk & Ashley's case of 8.0%. The absence of subitization in Ivan's analysis is not surprising since it is usually a very small percentage, around 3-5%, and the obvious lack of P- sub-divisional reporting by Ivan's mother has probably resulted in it being overlooked. The analysis table also indicates a very small percentage of P- sub-divisional one-to-one correspondence counting, only 2.2%, and this again would be abnormal. It may be assumed that Ivan's mother has failed to report his personal performances of one-to-one correspondence counting for himself and others, because it is known that Ivan is an accomplished counter (from playgroup activity). Ivan once counted 29 baby-cups in the pre-school playgroup that he attended (this is captured on video), and he would have been expected (on the basis of the other diary studies) to have performed some one-to-one correspondence counting during his play at home over a period of thirty days.

The other sub-categories are reasonably well represented, the percentages of cardinal labelling, number figure recognition, and number labelling all lie within expected ranges, and although the latter two categories are slightly high, this may be principally due to parent 'tutoring' (a high A- sub-division and low P- sub-division percentage). If allowances are made to compensate Ivan for the obvious insufficient reporting by his mother in certain sub-divisions and sub-categories, then the picture that would be produced of Ivan's numerical social interactions would probably conform reasonably well to the general pattern developed in other analysis.

6.12 CASE 5:THE CASE STUDY OF ARTHUR JONES

Introduction

Arthur lives in a rural area of Shetland with his parents and five older brothers and sisters. Arthur was born on 30/10/90, and at the time of the study he became 3-years old. Arthur's mother kept a diary account of his numerical interactions (Appendix B5) and although the accounts are spread over a three month period, the number of interactions were few, but once again it is likely that there were more than is reported.

6.13 ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR ARTHUR JONES

For most parents, the actual writing of the reports of their child's numerical interactions appeared to be tiresome, since many of the reports tend to be short in length. Arthur's mother freely admitted that she was not 'pushing' number 'onto' Arthur, believing that he had plenty of time to grasp number prior to entering school. Arthur's mother appears to consider number a 'school' subject, and she probably believes, rightly or wrongly, that for a child number has its uses mainly in the context of the school, consequently as Arthur approaches school going age she plans on 'doing more'. Arthur's mother appeared not to have been unduly concerned about deliberately creating examples of 'numerical mediation' to Arthur to enable her to complete reports for the research. Consequently the reports of Arthur's social interactions with number may incorporate less bias towards deliberately contrived number mediation than in some of the other case studies.

Over the three month period there were only 12 episodes of numerical interaction reported, a rate of **0.13** per day. This rate is only about one-fifth to one-quarter that reported in other studies, 0.67 for Kirk and Ashley, 0.54 for Ruth, and 0.58 for Paul & Samantha, 0.63 for Ivan. This would lead to a conclusion that Arthur may be receiving less numerical mediation than the other young children. Alternatively, it may be concluded that the quantity of numerical interaction for Arthur is not inflated by the inclusion of 'deliberate tutoring' to satisfy the curiosity of a researcher.

In terms of the quality of the interaction, there were 25 coded categories for the 12 incidents, producing a coding density of **2.1** codes per incident. The quality of Arthur's numerical interactions appears to be slightly higher than some of the other diary studies, 1.80 for Ruth and 1.64 for Paul and Samantha. If there is any deficiency in the quantity of Arthur's numerical interactions, then he is apparently being compensated in terms of quality (although his quality rate is still below that of Kirk & Ashley, 2.54).

What appears to have routinely taken place in terms of the quantity and quality of Arthur's numerical interactions may be 'more reliable' than is the case with some of the other diary studies, where deliberate tutoring may be suspected.

Table 6.11 TOTAL CODING ANALYSIS for ARTHUR JONES

-based upon 25 codes

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	1	0	0	0	0	0	0	1·0
	P	3	1	2	0	0	0	0	6
	A	4	7	6	1	0	0	0	18
Total		8	8	8	1	0	0	0	25

Table 6.12 TOTAL PERCENTAGE CODING ANALYSIS for ARTHUR JONES

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	4.0	0	0	0	0	0	0	4.0
	P	12.0	4.0	8.0	0	0	0	0	24.0
	A	16.0	28.0	24.0	4.0	0	0	0	72.0
Total		**32.0**	**32.0**	**32.0**	**4.0**	**0**	**0**	**0**	**100**

The total percentage coding analysis in Arthur's case (see table 6.12), indicates that there is a high percentage in each of the adult assisted/guided A- sub-division categories (total 72%), which sharply contrasts with the exposure of the existence of low P- sub-division category percentages (total 24%), and S- (total 4.0), this would imply that the 'mediation of number' in all sub-categories appears to be filtering through to Arthur from the adult (or social other) category. This analysis would support a rhetorical-responsive view of number as a socially mediated appropriation, through a linguistic communication of number meaning that is embedded in cultural use.

Table 6.12 also reveals that for some parents, the age of a child probably does have some influence on what type of numerical interaction a parent will engage their children in. Arthur's parents obviously prefer to engage him in number recitation, one-to-one correspondence counting and cardinal labelling, before number figure recognition, number labelling, number subitization or number sums.

In many of the other case studies, the first three categories (I, II, III) usually account for 60-70% of the total, but in Arthur's case they account for 96% of the total. Consequently it could be argued that Arthur is not being exposed to a wide variety of cultural uses of number by his parents, or that these first three sub-categories are often mediated to young children first.

It may noted that, as is the case with some of the other studies, the reporting of Arthur's total numerical interactions may be flawed.

6.14 CASE 6:THE CASE STUDY OF CHARLOTTE CLARKE

Introduction:

Charlotte lives in a council house situated in a medium sized town in Scotland. She has an older brother (Allan), an older sister (Joyce), and younger sister (Mary). Charlotte was born on 26/01/91, and at the time of the study she was less than 3-years of age. Charlotte is a niece of the researcher. The accounts of her interactions are in Appendix B6.

6.15 ANALYSIS OF THE TOTAL NUMERICAL INCIDENTS REPORTED FOR Charlotte Clarke

Charlotte's mother appears to have taken a great deal of interest in reporting Charlotte's numerical interactions, since the reports are well documented in terms of both detail and variety of contexts. Charlotte's mother appears to have involved Charlotte in 'counting' almost at every opportunity possible, from shopping to setting the table, from ironing to baking and washing dishes, counting Christmas trees while walking, in playing games, and in talking about age. There is a slight hint of 'deliberate adult prompting', but much of this prompting may have happened anyway, in spite of the research interest providing additional cause.

Charlotte's mother has also managed to capture numerical interactional episodes in which she was not directly involved, mainly while Charlotte was engaged in play. Episodes such as playing Mummies and handing out 'dinner money', playing shopping and buying quantities of items and getting change, counting during dance steps and in learning how to bow, singing nursery rhymes, playing with a toy telephone, gluing 'four' toilet roll pieces at playschool, and having a dollies tea party with 'three sugars' in her tea. Such episodes demonstrate that young children, even those not yet three-years old, can appropriate number from adult use, and begin using number language themselves in their own play. Charlotte's case study provides additional support (in addition to Kirk & Ashley's video recorded episodes) that young children can make use of number in play, and that parents should not hold the view that 'number' is a school subject, and to quote one parent, "I will do more number" when my child approaches school age.

The reports of Charlotte's numerical interactions span 3½ months, they began of the 16th of October and ended on the 31st January, a total of 108 days. The quantity of separate numerical incidents is 81, producing a rate of **0.75** incidents per day. This is the highest recorded home rate of numerical incidence, higher than Kirk and Ashley's (0.67 per day), Paul & Samantha (0.58) or Ruth (0.54), and it contrasts sharply with the rate for Arthur (0.13) - who was almost exactly the same age as Charlotte.

In Charlotte's case study, a coding density of 191 codes spread through 81 incidents, produces a quality rate for her numerical interaction of **2.36** codes per incident. This rate is also higher than most of the other diary studies (with the exception of Ivan (2.42) where deliberate numerical mediation was obvious), but still less than the rate for Kirk & Ashley (2.51), this may be due to the research methodology, video transcripts probably provided a richer source of data than diary accounts.

With a quantity rate of 0.75 and a quality rate of 2.36, Charlotte's rates of numerical interaction are the highest measures evaluated from the analyses of all the diary case studies. Charlotte's rates are on a similar par with Kirk & Ashley's home data, exceeding them in quantity, but slightly lower in quality.

A complete coded analysis of the data reported for Charlotte will produce additional insight into the social form of the linguistic mediation concerning her numerical interaction. This data is shown in tables 6.13 and 6.14.

Table 6.13 TOTAL CODING ANALYSIS for CHARLOTTE CLARKE
-based upon 191 codes

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	1	4	4	0	0	0	0	**9**
	P	4	11	20	1	0	11	1	**48**
	A	7	44	60	2	7	12	2	**134**
Total		**12**	**59**	**84**	**3**	**7**	**23**	**3**	**191**

Table 6.14
TOTAL PERCENTAGE CODING ANALYSIS for CHARLOTTE CLARKE

Sub-categories

		I	II	III	IV	V	VI	VII	Total
Sub-division	S	0.5	2.1	2.1	0	0	0	0	**4.7**
	P	2.1	5.8	10.5	0.5	0	5.8	0.5	**25.1**
	A	3.7	23.0	31.4	1.0	3.7	6.3	1.0	**70.2**
Total		**6.3**	**30.9**	**44.0**	**1.6**	**3.7**	**12.0**	**1.6**	**100**

The tabulated percentage coding of Charlotte's data (table 6.14) indicates that with 70.2% in the A- sub-division, a large proportion of the numerical incidents in which Charlotte was involved originated at the instigation of social others, mainly her mother. This high percentage in the A- sub-division would suggest that there may have been some deliberate tutoring for the purpose of generating data for this research, none-the-less it is important to note that this deliberate tutoring is a rich source of numerical interaction for a child.

The coded analysis does not appear to show Charlotte performing or practising number use to the same extent as in some of the other more reliable studies. In Charlotte's case, the P- sub-category is only 25.1%, compared to 44.3% for Ruth, 48.2% for Kirk & Ashley, and 45.5% for Paul & Samantha's data. This low percentage in the P- sub-division may be partly due to an over representation in the A- sub-division caused by Charlotte's mother emphasizing number use through 'tutoring', and it may not necessarily be due to any lack of performance in number use by Charlotte. Further analysis is required to investigate if this is the case.

It should be borne in mind that Charlotte's overall quantity rate is higher than the others. If Charlotte's P- sub-division percentage rate is applied to the quantity of numerical interaction, then we can see that her rate of P- coding, 25.1% of 0.75 = 0.19, which is only slightly less than some of the others, comparable to Ruth (44.3% of 0.54 = 0.24), Paul & Samantha (45.5% of 0.58 = 0.26), although Kirk & Ashley's P-coding rate is still relatively higher (48.2% of 0.67 = 0.32). Charlotte's P-coding rate then would suggest that she is still very much in need of her mother's tutoring to enable her to appropriate, and subsequently apply, number use in her play.

The percentage of S- sub-divisional codes in Charlotte's data (4.7%) is quite in line with some of the other analyses. It appears that the use of number in the context of a self-regulative practice for a child is a very rare occurrence. For a young child number practices appear to be appropriated from social contexts through social interaction, and they appear to be subsequently practised in social contexts through social interaction, or interactive play with others, real or imaginary, but number practices just do not appear to often feature in social isolation.

In terms of the seven sub-categories of the forms of number interaction, it is apparent from the data displayed in table 6.14 that Charlotte has not been involved to any great extent in number figure representation, since sub-category V accounts for only 3.7% of the total. In the reports by her mother, there are very few examples where Charlotte has interacted with number figures, eg. her house number - (which was sparked off by her making a model house at playschool without a door number, because she didn't know hers), the example of playing cards with her dad, and the example of examining the alarm clock face to note the time to sleep and the time for playgroup. There were no examples of either parent reading counting books to Charlotte (which would have number figures printed on the pages), or of Charlotte being shown the number figures on her toy telephone, or other toys such as the control dials of her toy kitchen stove. This lack of number figure interaction contrasts with many of the other studies, where for instance number figure interaction often features very prominently, in Paul & Samantha's case study it was 28.9%, Ivan 23.9%, Ruth 18.2%, and Kirk & Ashley 13.2%.

In Charlotte's case, the percentage of numerical interaction that simply involved number recitation was very low, only 6.3%, half what has usually occurred in some of the other studies. Number recitation often features in the P- sub-division as an accompaniment in children's casual play, eg Hide-and-Seek, jumping, throwing, or running; and Charlotte has a slightly low percentage in this sub-division. However, number recitation can, and is, often encouraged by adult interaction during play with a child, eg. pushing a child on a swing, or possibly while waiting on a hot drink or a bowl of soup to cool. There are often many examples of adults reciting numbers with children jointly, especially if the adult is attempting to 'tutor' the child by extending the child's number word sequence. This does not appear to have been happening in Charlotte's case, or has not been reported.

It certainly appears that much Charlotte's mediated number interactions were purposely directed towards one-to-one correspondence counting of items, since many of the examples of her mediated numerical interactions often appeared to evolve when something could be counted. It appeared that Charlotte was often involved by her mother and social others in counting items such as cups, plates, cutlery, socks, Christmas trees and presents, squares on board games, rings, buttons and shoe buckles. Also, her mediated numerical interaction appears to have been directed towards the cardinal labelling of quantity. Consequently, the average percentages in both of these sub-categories, one-to-one correspondence counting and cardinal labelling, appear to be higher than in the other diary case studies. Charlotte's percentages of mediated numerical interaction in one-to-one correspondence counting and cardinal labelling is approximately one third higher than in the other diary case studies. If the percentage figures for categories II and III were reduced by a third to make them more in line with the other studies, then Charlotte's quantity rate, 0.75 for numerical interaction, would probably drop to a rate similar to the other studies. These mediated practices of one-to-one correspondence counting and cardinal labelling may be considered to be the principal source of Charlotte's high quantity rate of socially mediated numerical interaction.

In Charlotte's case, the percentage occurrence of number labelling is in line with the other studies. For Charlotte, mediated number labelling was mostly developed around age discussions. Charlotte's mother appears to be beginning to slowly introduce Charlotte to number sums/divisions since there is a 1.6% occurrence in sub-category VII. This small percentage is not surprising considering the complete absence of sub-category VII in many of the other studies (with the exception of Ivan, whose study is probably unrepresentational of a normal situation, and Kirk & Ashley - whose Dad was a Maths teacher). Sub-category VII appears to deal with an aspect of number in which most parents are reluctant to involve young children. Charlotte's mother began to demonstrate to Charlotte that one brick plus another brick made two bricks, but she was not prepared to go any further, to quote, "but that's as far as I took it".

Overall, Charlotte's mother appears to have interested Charlotte in number through social interaction, thereby providing Charlotte with a perception of number as an element of social discourse, where meaning may be appropriated like words in language, from social use. Charlotte has been subsequently observed practising such social number use in her play, demonstrating her eagerness to appropriate and practice social meaning associated with dinner money, house numbers, telephone numbers and age. Charlotte appears to be part of a social micro-environment that assists her to appropriate the social use of number through mediated guidance/instruction.

6.16 CHAPTER SUMMARY

In many of the studies there is a high percentage of A- sub-division percentages, 80.4% for Ivan, 72.0% for Arthur, 70.2% for Charlotte, 68.3% for Mark; while both Paul & Samantha, and Ruth, have 48.8% and 45.5% respectively. The P- and S- percentage codes similarly vary (see table 6.16).

However percentage figures alone are not sufficient to indicate the extent or nature of a child's mediated numerical interactions. The quantity and quality of that interaction must be taken fully into account as well. It may be surmised that the variations of quantity and quality from study to study has a direct bearing on the percentages in each of the sub-divisional categories.

In the home diary case studies the quantity figures varying from 0.13 to 0.75 incidents per day, and the *quality measures from 1.64 to 2.42 (see table 6.15). In has been noted* that the research reporting by the mothers has probably had an influence on the results. In Mark's case, measures of quantity or quality could not even be determined, and in Ivan's and Arthur's cases the measures are not deemed to be reliable, both are based upon very few episodes. The cases of Ruth, Charlotte, and Paul & Samantha, appear to be far more likely to represent realistic measures of mediated numerical interaction to young children in their homes. These later case studies are reasonably consistent with the detailed analysis in Chapter 5 of Kirk & Ashley's numerical interactions at home.

TABLES OF COMPARATIVE ANALYSIS OF ALL THE HOME DIARY STUDIES

Table 6.15

	quantity rate	quality rate
Ruth	0.54	1.80
Paul & Samantha	0.58	1.64
Mark	-	-
Ivan	0.63	2.42
Arthur	0.13	2.1
Charlotte	0.75	2.36
Mean rate	**0.53**	**2.1**
σ	0.21	0.3

Table 6.16

Total Percentages	%	S	P	A
Ruth		10.2	44.3	45.5
Paul & Samantha		5.8	45.5	48.8
Mark		0	31.7	68.3
Ivan		6.6	13.0	80.4
Arthur		4.0	24.0	72.0
Charlotte		4.7	25.1	70.2
Mean diary study	**%**	**5.2**	**30.6**	**64.2**
σ		3.1	11.5	12.7

Table 6.17

Total Percentages	I	II	III	IV	V	VI	VII
Ruth	13.6	27.3	26.1	3.4	18.2	11.4	0
Paul & Samantha	9.9	21.5	27.3	3.4	28.9	9.1	0
Mark	9.7	4.9	14.6	0	24.4	36.6	9.7
Ivan	0	15.2	32.6	0	23.9	21.7	6.5
Arthur	32	32	32	4	0	0	0
Charlotte	6.3	30.9	44.0	1.6	3.7	12.0	1.6
Mean diary study	**11.9**	**22.0**	**29.4**	**2.9**	**16.4**	**15.1**	**3.0**
σ	9.9	9.5	8.8	1.6	10.9	11.5	3.8

The coded data from all the home diary studies (see tables 6.15 & 6.16) indicates that socially mediated numerical interaction for a young child, has a ***mean quantity rate of 0.53 incidents per day, and a mean quality rate 2.1 codes per incident***; and that an *adult* is likely to have initiated the mediation of the numerical activity to the child in **64.2%** of incidents, while a child initiates the numerical activity practice for a social other in **30.6%** of incidents, the young child appears to only perform number activity for themselves in **5.2%** of incidents.

All the studies demonstrate that young children's micro-environments provide them with varying rates of quantity and quality of numerical interaction related to their social experiences of number use. The mean figures produced in most of the categories from the home diary studies (see table 6.17) would suggest that the figures resulting from the detailed home study of Kirk & Ashley are not unusual, but may reflect a normal pattern of numerical mediation for a child. A direct comparison is show in table 6.18.

Table 6.18

Total Percentages	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Mean diary study	11.9	22.0	29.4	2.9	16.4	15.1	3.0
σ	9.9	9.5	8.8	1.6	10.9	11.5	3.8
Kirk & Ashley	13.6	18.8	31.7	5.1	13.2	9.5	8.0

The comparative analysis of the categories of aspects of number in the home diary studies (see table 6.17) indicates that parents do not readily mediate number sums/divisions or multiples to young children, nor do they find it easy to involve their young children in number subitization (usually dominoes or a dice features in this sub-category).

The percentages among the various sub-categories of number in table 6.17 suggests that parents mediate different aspects of number to a different extent during number interaction with their children. Cardinal labelling is the most common (mean 29.4%) closely followed by one-to-one correspondence counting (mean 22.0%).

It may be surprising to see that number recitation is not a prominent sub-category, but then this may be because recitation has limited use - even for adults. Number recitation has no direct application or use in its own right, we do not tend to recite numbers just for the sake of it, and neither do children. For a young child number recitation mainly occurs in casual play, running, jumping, throwing, playing a game or singing a nursery rhyme, or when an adult is deliberately tutoring a child to extend that child's number recitational sequence.

For some adults, the mediation of number to a child often involves number figure 'reading' or recognition. The case studies of Paul & Samantha centred mainly around number figure mediation, and it also featured prominently in the case studies of Mark and Ivan. A counting book was often used in the case study of Ruth. In general, number figure reading or recognition appeared to be important in most of the home diary case studies (excepting Charlotte and Arthur) and it appears to be more important than in the home case study of Kirk & Ashley. This is an aspect of number that could be viewed as being more dependent on adult interaction than some of the other sub-categories, such as number recitation, cardinal labelling and one-to-one correspondence counting. Where it occurs in the diary case studies, number figure reading/recognition is often two-thirds concentrated in the A- sub-division (just as are approximately 64.2% of all mediated numerical interactions). Interaction with number figure reading/recognition by a child then is often directly related to the extent of mediation initiated by an adult. This is also true of number labelling, sub-category VI. It can seen from Table 6.17 that there is a wide disparity in the percentages associated with number labelling, and once again this can be directly attributed to the extent of adult mediational practices.

Parental attitude towards number certainly appears to be a factor that influences the quantity rate. In Charlotte's case, her mother certainly appears to be highly in favour of introducing Charlotte to social number use, and consequently Charlotte's rate is the highest. In Arthur's case, his quantity rate was only 0.13, and this possibly reflects his mother's lack of concern about mediating aspects of number use. Arthur's mother indicated that she did not wish to 'push' her child into number just yet, saying that she would "do more" next year when he would be approaching school age. Arthur's mother does not appear to be very concerned about involving her child in aspects of number use, consequently she does not mediate number very often, and this results in Arthur having the lowest rate of numerical mediational interaction.

Yet, despite Arthur's mother believing that number for a young child is only relevant in the context of school, young children do appear able to appropriate the social uses of number, since their play is often full of examples of number use, eg. Charlotte asking for "three" sugars while playing in a toy kitchen; Ruth playing shops with toy money, Samantha counting toast, saying, "I will have two, Paul can have one, and you two like me"; Paul painting with a cousin, counting paint brushes, "One" to "Five".

6.17 CHAPTER CONCLUSION

The diary studies suggest that approximately 64.2% of a young child's numerical interactions occur in the A-sub-division, implying that these were numerical mediations that were initiated, or prompted, by a adult or social other, and this would support a social constructivist theory of number appropriation, suggesting social (parental) use leads to individual (child) use. It would appear that number mediation often begins in an A- sub-division and progresses through to the P-sub-division, but very little filtering through to the S- sub-division in the case of a young child. These results then are consistent with Vygotsky's psychological theory, which would suggest that any psychological development of number in a child is dependent upon the social use of number in culture.

The mean figure of 64.2% in the A- sub-division implies that adult (or social other) instigated numerical interaction is a very important source of mediated number activity for a child. Consequently, it should be recognized that parents (and others) play an important social role in providing much of the quantity and quality of numerical interaction for a child through social numerical discourse, involving questioning, prompting, instructing and guiding the child in number use and its social application. With constant adult mediation, a child can be provided with a rich and varied diet of number activity, as is the case with Charlotte, and without this constant adult mediation, a child's numerical activity appears to be very shallow, as is evident from the case study of Arthur.

This analysis of home diary studies then, suggests that children grow up in micro-environments that often provide them with different quantities and qualities of mediated numerical interaction across a broad spectrum of number categories, and that adults or social others directly influence the extent of a child's mediated numerical interaction. This chapter also demonstrates that young children are able to incorporate the social uses of number into their play, they practice the social applications of number while playing.

The results also confirm that the detailed case study of Kirk & Ashley's numerical interactions are typical of a young child's mediated numerical activity within the micro-environment of home.

CHAPTER 7

PARENTAL INTERVIEWS

INTRODUCTION:

7.1 Adult Verbal Socialization:Its Psychological Influence on Young Children's Cognition

For a young child, the mastery of language is important not just to satisfy a social need to communicate, but to form and structure individual social consciousness. According to Vygotsky, speech has a social as well as a psychological function and these functions are intertwined with one another in the creation of meaning. The relationship between the social and psychological functions of language is important to the theoretical position adopted in this thesis towards young children's appropriation of number. Here, the interpsychological phenomena of number meaning, regulated through social language usage, is viewed as an individual regulating phenomenon, intrapsychologically regulating meaning in the individual in terms of social consciousness through social language usage, and it has already been acknowledged elsewhere in this thesis that this view of language as a intapsychological 'tool' questions the existence of individual innate human consciousness in the absence of social communication.

Previous argument has already noted that at the very early stages of human development a child may perceive object reality only through interaction with social others, and consequently the numerical properties of world objects may only be revealed in terms of human social communication. Social intercourse forms the initial basis of the mastery of language and consequently, social intercourse must be viewed as the initial basis for any psychological development of number structured by language:

> A child learning his mother tongue is learning how to mean; he is building up a meaning potential in respect of a limited number of functions. These functions constitute the semiotic environment of a very small child, and may be thought of as universals of human culture (Halliday, 1994, p36).

Social intercourse typically takes a linguistic form, which may be called episodic text. The child interprets text not only as being specifically relevant to the context of situation but also being contextually relevant to its socially structured culture. It is the *verbalization of activity* that enable a child to do this, and at the same time it enables the child to appropriate the higher order meanings that constitute the culture. According to Halliday, the child relies heavily on the social system of language to decode meanings in day to day life:

> so it is first and foremost through language that the culture is transmitted to the child, in the course of everyday interaction in the key socializing agencies of family and peer group (Halliday, 1994, p41).

Past research on language understanding and use (Tough, 1977; Wells, 1977) has clearly shown a gulf between testing young children's communicative skills and observing spontaneous communicative activity in their own homes. This past research on everyday language acquisition emphasizes certain crucial aspects in the process of normal language *development:*

1) The importance of context and the social embeddedness of language in relation to cognition
2) Communication is a social process, where each participant responds to the others
3) Young children are active initiators of communication, displaying a questioning disposition
4)Young children benefit from interaction with adults who express puzzlement and uncertainty

Children begin to acquire new words incidentally to their environment (Rice, 1990). After limited exposure to new words, they use linguistic, contextual, and pragmatic information about word meaning to construct knowledge of how a word functions in practice and the possible meaning of the word (Dickinson, 1984; Markman & Wachtel, 1988; Rice & Woodsmall, 1988). Children are often aware of several meanings for similar sounding words (eg. 'to' him, and 'two' hymns), yet drawing on their semantic and pragmatic knowledge, they are able to extract the relevant meaning to a given context when interpreting an utterance (Rice, 1990). The relationships between vocabulary, reading comprehension, and discourse language skills begins to emerge in early childhood (Dickinson, Cote & Smith, 1993), and it can only be expected that *the same may be true for number skills.*

7.2 Parental Affect :Its Influence on the Process of Young Children's Number Socialization

The principle argument of this thesis is that an individual consciousness of number is derived from a rhetorical-responsive social consciousness of number developed through mediated linguistic communication. This is an interactive social process, a process of number socialization, and it may be presumed to predispose young children to appropriate an implicit social code of number importance, transmitted through affect. A parent who never or very rarely emphasizes aspects of number to his/her child, may give the impression that number is inconsequential, not relevant, or not overtly important; yet another parent may be continually mediating and emphasizing aspects of number to his/her child. Is there to be no difference in the young children's numerical appropriations in these different cases of parental affect for number?

In a recent study of young children's language developments (Bloom, 1993), adults have been noted to elaborate a child's mental appropriations through actions and talk directed at what to do with toys during play, or verbalize the causes or circumstances that have led to an emotional experience. Bloom's study revealed that *the form and content of social interactions* contributes to the child's development by assisting the child to interpret perceptions and feelings, to elaborate mental meanings, and to increase understanding. For Bloom, socialization reflects the impact that children have on their own development as well as the impact by others, such as caregivers. Socialization is acknowledged to be a cognitive interpsychological relationship, and Bloom notes that:

> Socialization is a mutual process: It is influenced by a child's development as much as it influences that development (Bloom, 1993, p251).

It is commonly accepted that children acquire their forms of language from the patterns and regularities that they infer from the speech that they hear. Children often learn about emotion and speech expression by inferring patterns and regularities in the speech activity *use* by others, and this may also be true for aspects of number. It may be that young children only appropriate the aspects of number that are meaningfully mediated to them in social context by caregivers.

According to Bloom, caregivers are sensitive to the abilities and needs of children, and they adjust their speech responses to suit the needs of children:

> Thus, how children tune in to information in the social context depends on what they have in mind - their own goals, expectations, and actions. Caregivers seem to know this intuitively and use the information they in turn take from the child about the child to provide structured, useful information in their intentions. The mutuality in the mother's socialization practices when they played with their children and responded to their emotional expressions echoed the bidirectionality inherent in the relationship between developments in language and socialization (Bloom, 1993, p252).

Does this happen in the case of number? Are parents or other caregivers sensitive to the needs and abilities of young children in terms of aspects of number socialization? In the Bloom study, mothers provided information that was highly relevant for what their children were learning, the mothers did not remain passive:

> If the children were Piaget's children by virtue of the active part they took in their own learning and development, their mothers were Vygotsky's mothers by virtue of their own active part in that development
> (Bloom, 1993, p252).

In terms of aspects of number socialization, are mothers, or other caregivers, Vygotskian in behaviour? This question, and the others already posed, will hopefully be answered by this chapter.

PARENTAL INTERVIEWS

7.3 Methodology

If linguistic communication has some bearing on a child's psychological development of number skill, then an investigation of aspects of home interaction in terms of customary micro-environmental activities may demonstrate that parental (or social other) mediation of number, through language and from within a social context, directly or indirectly, influences or leads a child to develop number skills.

The conclusions drawn from Chapter 6, demonstrate that number is often linguistically embedded in young children's micro-environments by social others, and that an implicitly coded cultural value of number is possibly being indirectly transmitted to young children through the nature and extent of mediated number in their social micro-environments. This aspect will be investigated further by questioning a more extensive cohort of parents about the nature and extent of their interactive mediation of social numerical practices to young children.

To investigate this possible parental (social other) mediational role in their child's psychological appropriation of number, 40 parents were questioned about their child's already developed number skill, the expected course of future developments, and the parental home activities which may have influenced the child's appropriation by socially mediating cultural aspects of number. Parents (guardians, sometimes a nanny) were asked eleven semi-structured questions which were pre-printed on an interview schedule to ensure a degree of uniformity in the separate interviews, and to aid the data recording process. These questions are displayed in Appendix C.

Any question related to possible sex differences was not incorporated into the semi-structured interview schedule, since previous research on young children's development of number has not shown this to be a major factor:

> No account was taken of sex since sex differences have very rarely been reported in studies of number development
>
> (Desforges, A. & Desforges, C. 1980, p98)

It is not within the constraints placed upon the research in this thesis to investigate the possibility of sex differences in social interaction involving the mediation of number. Any possible sex differences related to effect of mediated social interaction on young children's development of number, may be a suitable subject for further research.

For similar reasons, no account of the social economic status (SES) of parents was incorporated into the interview questions either. The relationship between parent's SES and young children's number development was the subject of study in Saxe et al (1987).

Saxe et al (1987) investigated the everyday home environments in which children of middle- and working-class parents were involved in number. In the context of assisting their child in a pre-set task, Saxe et al reported some differences between mothers' in those social groups, in terms of goal aspirations for their child and in instructional technique, they also reported some differences between the two social groups in terms of children's understanding of number. This research however has been criticised by Rogoff (1987), and she maintains that on most of Saxe et al's analyses there were no social class differences. The research of Saxe et al, and the commentary by Rogoff, has been covered in more depth in an earlier chapter dealing with past research (chapter 3).

In a collection of studies on the relationship between the home environment and cognition, by Gottfried (1984), it is reported that:

> All of the investigators have reported that proximal home environment variables correlated with the cognitive development of young children. The overall finding showed that home environmental factors contributed significantly to cognitive development, *independent of their association with SES [socio-economic status]* (Gottfried, 1984, p334).

It is sufficient to say here that the question of any possible SES influence is disputed by eminent researchers in the field, and any possible effect that SES may be likely to impinge upon the home interactional factors which give rise to numerical mediation, is liable to be overshadowed by other more immediate home environmental factors, such as the numbers of brothers/sisters etc.. Any investigation of possible effect of SES is quite beyond the scope of the research in this thesis, consequently, no account has been taken of parent's SES in the interview questions.

The semi-structured interview questions were designed to focus exclusively on the caregivers' home practices in terms of mediating number to their child, and to ascertain the extent of their child's already developed number skills. Most of the interviews were conducted on the premises of pre-school playgroups, when parents had some time to spare. Each interview lasted approximately 15 minutes, and the majority of interviews were audio recorded. Parents (guardians) were randomly chosen for interview, there were no pre-determined criteria, other than that they had a child over 1-year and under 5-years of age; and in the sample chosen, there were 23 boys and 17 girls.

In addition to the semi-structured interview questions, Parent Mediated Intervention Tests were designed to formally test young children's already developed number skills. A copy of these interventional questions and tasks was given to each parent that was interviewed (they are displayed in Appendix C). Parents were requested to ask their child the questions at home, and allow them to perform the number use tasks. Parents were then requested to note down on the test sheet their child's answers and responses to the questions/tasks, and return the sheet to the researcher. By linking the parental interview answers to the child's answers produced by the home mediated interventional questions/tasks, it was hoped that a measure of reliability in relation to the child's already developed number skills may be determined. In the event however, very few parents (only 10%) returned answers to the home mediated interventional test questions/tasks. The reason why is open to conjecture, lack of interest, lack of time, poor child performance, may all be surmised. Where parents did return answers to the home mediated interventional test questions/tasks these will be presented together with the interview details.

A sample of the forty interviews is presented in APPENDIX C, in the form of a brief summary, and the complete data has been collated in tables 7.1 to 7.4.

The complete interview data will now be analyzed and interpreted in a Interviews Summary, then conclusions drawn.

7.4 INTERVIEWS SUMMARY

First of all, much of what was stated by parents in terms of their child's number skill accomplishments must be treated with a certain amount of scepticism. Parents do tend, often unintentionally, to over estimate their child's abilities, they are naturally proud of their child's achievements. And by all accounts, a child of 2-years who could recite the number sequence up to 20, count in one-to-one correspondence accurately up to twelve, and recognize all the number digits, would be considered to be quite unusual (but similar accomplishments are reported here). However, the actual accomplishments by the children are not in question, it is not the aim of this thesis to examine young children's achievements or accomplishments in terms of number skill use, but to examine the role of social mediation towards that number skill development.

It is quite clear from these interviews that young children do develop number skills quite early on in life, and this does appear to happen through the cooperation and constant mediation by mothers and other caregivers. From what was stated during most interviews, there is no doubt that mothers, and other caregivers, do behave according to Vygotskian theory, they do socially mediate aspects of number to their young children. The interviews demonstrate that adults lead their young children to an intrapsychological regulation in terms of the social uses of number, often from the age of 1-year. Mothers, and other caregivers, also appear to be sensitive to their child's possible number appropriations, they do not approach aspects of number from a didactic perspective, but acknowledge the role of *counting in play* in a young child's learning. Mothers, and other caregivers, appear to mediate aspects of number to their young children through play.

The role of the child is not forgotten either, for mothers and caregivers also appear to take into account their child's current interests. Much of a child's mediated number stems from the child initiating activity, and the mother or other caregiver joining in, then mediating aspects of number where appropriate. For instance, when a child is jumping, playing on a swing, climbing the ladder of a slide, a mother or caregiver will often recite numbers in sequence; when the child climbs stairs, plays with coins or bricks, one-to-one correspondence counting may be demonstrated by the adult; when the child is looking at a book, playing with a toy telephone, or getting on a bus, symbolic number figures may be sounded by the adult. In this respect, the mediation of number is a rhetorical-responsive process, and to quote Bloom again:

> Socialization is a mutual process: It is influenced by a child's development as much as it influences that development (Bloom, 1993, p251).

A summary of the caregiver interviews are presented in the following tables:

Table 7.1 Recitation skill

Table 7.2 One-to-one correspondence counting

Table 7.3 Number figure recognition

Table 7.4 Total Time of Mediated Interaction

Table 7.1

age	recitation	age at first recitation (or expected)	age at first mediation (or expected)	parent expectation of a pre-school child
1. 4yrs 6m	up to 20	<2 yrs	~ 1yr	up to 20
2. 4yrs 3m	up to 15	2-3 yrs	No	Yes
3. 4yrs 0m	up to 10	2-3 yrs	1yr	up to 10
4. 3yrs 11m	up to 120	<2 yrs	1yr	up to 50
5. 3yrs 11m	up to 20	<2 yrs	<1yr	up to 10
6. 3yrs 6m	up to 14	2 yrs	1yr	Yes
7. 3yrs 6m	up to 20	2-3 yrs	1½ yrs	Yes
8. 3yrs 6m	up to 10	2-3 yrs	3 yrs	up to 20
9. 3yrs 5m	up to 20	2-3 yrs	1½ yrs	up to 20
10. 3yrs 5m	up to 14	2-3 yrs	2 yrs	up to 20
11. 3yrs 3m	up to 15	2-3 yrs	2 yrs	up to 20
12 3yrs 3m	up to 12	<2 yrs	1½ yrs	up to 10
13. 3yrs 3m	up to 5	2-3 yrs	some	Yes
14. 3yrs 1m	up to 14	<2 yrs	<1½ yrs	up to 10
15. 3yrs 0m	up to 13	2 yrs	1 yr	Not Important
16. 3yrs 0m	up to 10	2-3 yrs	2 yrs	up to 10
17. 2yrs 10m	up to 12	2-3 yrs	some	Yes
18. 2yrs 6m	up to 10	2-3 yrs	2 yrs	Not Important
19. 2yrs 6m	up to 5	2-3 yrs	1½ yrs	Yes
20. 2yrs 6m	up to 12	<2 yrs	1 yr	up to 25+
21. 2yrs 6m	up to 10	<2 yrs	1½ yrs	Yes
22. 2yrs 6m	up to 20	<2 yrs	1 yr	up to 20
23. 2yrs 5m	up to 8	<2 yrs	1 yr	up to 20
24. 2yrs 4m	up to 10	<2 yrs	1 yr	up to 20
25. 2yrs 4m	up to 14	<2 yrs	some	up to 20
26. 2yrs 3m	up to 3	2-3 yrs	2 yrs	Yes
27. 2yrs 3m	up to 10	<2 yrs	1 yr	up to 10
28. 2yrs 3m	up to 16	<2 yrs	<1 yr	Yes
29. 2yrs 2m	up to 5	<2 yrs	1½ yrs	up to 10
30. 2yrs 2m	up to 12	<2 yrs	<1 yr	up to 100
31. 2yrs 1m	No	2-3 yrs	2½ yrs	up to 5
32. 2yrs 0m	up to 20	<2 yrs	1½ yrs	Yes
33. 2yrs 0m	No	2-3 yrs	<2 yrs	Yes
34. 1yr 10m	up to 4	<2 yrs	<1 yr	Yes
35. 1yr 10m	up to 3	<2 yrs	<1 yr	Yes
36. 1yr 9m	up to 3	<2 yrs	1 yr	up to 100
37. 1yr 7m	up to 3	<2 yrs	1 yr	up to 20
38. 1yr 6m	up to 5	<2 yrs	<2 yrs	Yes
39. 1yr 6m	No	<2 yrs	1 yr	Yes
40. 1yr 3m	No	<2 yrs	1 yr	Yes

Table 7.2	one-to-one correspondence counting	age at first one-to-one correspondence counting (or expected)	age at first mediation of one-to-one counting (or expected)	parent expectations of a pre-school child
1. 4yrs 6m	up to 20	2-3 yrs	no. ans.	up to 20
2. 4yrs 3m	up to 4	2-3 yrs	some	Yes
3. 4yrs 0m	up to 10	2-3 yrs	1 yr	up to 10
4. 3yrs 11m	up to 20+	<2 yrs	1 yr	up to 50
5. 3yrs 11m	up to 18	<2 yrs	1 yr	up to 10
6. 3yrs 6m	up to 14	2-3 yrs	1 yr	Yes
7. 3yrs 6m	up to 10	2-3 yrs	1½ yrs	Yes
8. 3yrs 6m	up to 10	2-3 yrs	3 yrs	up to 20
9. 3yrs 5m	up to 20	2-3 yrs	2½ yrs	up to 20
10. 3yrs 5m	up to 8	2-3 yrs	2½ yrs	up to 20
11. 3yrs 3m	up to 10	2-3 yrs	2 yrs	up to 20
12 3yrs 3m	up to 10	2-3 yrs	2 yrs	up to 10
13. 3yrs 3m	No	3-4 yrs	some	Yes
14. 3yrs 1m	up to 12	<2 yrs	‹1½ yrs	up to 10
15. 3yrs 0m	up to 13	2-3 yrs	No	Not important
16. 3yrs 0m	up to 10	2-3 yrs	2 yrs	up to 10
17. 2yrs 10m	up to 4	2-3 yrs	some	Yes
18. 2yrs 6m	up to 10	2-3 yrs	2 yrs	Not important
19. 2yrs 6m	up to 4	2-3 yrs	1½ yrs	Yes
20. 2yrs 6m	up to 12	2 yrs	1½-2 yrs	up to 25
21. 2yrs 6m	up to 10	2-3 yrs	1½ yrs	Yes
22. 2yrs 6m	up to 4	<2 yrs	1½ yrs	up to 4
23. 2yrs 5m	up to 3	<2 yrs	1½ yrs	up to 20
24. 2yrs 4m	up to 4	2-3 yrs	1 yr	up to 20
25. 2yrs 4m	up to 8	2-3 yrs	No	up to 20
26. 2yrs 3m	up to 3	2-3 yrs	2 yrs	Yes
27. 2yrs 3m	up to 5	<2 yrs	1½ yrs	up to 10
28. 2yrs 3m	up to 6	<2 yrs	1 yr	up to 20
29. 2yrs 2m	up to 5	2-3 yrs	1½ yrs	up to 10
30. 2yrs 2m	up to 10	<2 yrs	<2 yrs	up to 50
31. 2yrs 1m	No	2-3 yrs	2½ yrs	Yes
32. 2yrs 0m	up to 20 with help	<2 yrs	1½ yrs	Yes
33. 2yrs 0m	No	2-3 yrs	<2 yrs	Yes
34. 1yr 10m	up to 5	<2 yrs	1 yr	Yes
35. 1yr 10m	No	2-3 yrs	1½ yrs	up to 10
36. 1yr 9m	up to 2	<2 yrs	some	up to 20
37. 1yr 7m	No	<2 yrs	<2 yrs	up to 20
38. 1yr 6m	No	<2 yrs	1½ yrs	Yes
39. 1yr 6m	No	2-3 yrs	‹1½ yrs	up to 20
40. 1yr 3m	up to 2	2-3 yrs	No	up to 20

Table 7.3

	age	Number figure recognition	age at first number figure recognition (or expected)	age at first number figure mediation recognition (or expected)	parent expectations of a pre-school child
1.	4yrs 6m	1-10	3 yrs	no. ans.	up to 20
2.	4yrs 3m	1-10	3-4 yrs	3 yrs	Yes
3.	4yrs 0m	No	>5 yrs	No	No
4.	3yrs 11m	Yes	2 yrs	<2 yrs	up to 50
5.	3yrs 11m	0-9,12	<2 yrs	<2 yrs	Yes
6.	3yrs 6m	3, 6	3 yrs	3 yrs	Yes
7.	3yrs 6m	1,2,3,5,8	3-4 yrs	3 yrs	Yes
8.	3yrs 6m	1,2,3	3-4 yrs	No	up to 20
9.	3yrs 5m	No	3-4 yrs	No	No
10.	3yrs 5m	No	3-4 yrs	3 yrs	up to 20
11.	3yrs 3m	1-5	2-3 yrs	2 yrs	up to 20
12	3yrs 3m	1-9	2-3 yrs	2 yrs	up to 9
13.	3yrs 3m	No	-	No	up to 10
14.	3yrs 1m	1-5	2 yrs	2 yrs	up to 10
15.	3yrs 0m	No	3-4 yrs	3 yrs	Not Important
16.	3yrs 0m	No	3-4 yrs	3 yrs	Yes
17.	2yrs 10m	No	3-4 yrs	3 yrs	Yes
18.	2yrs 6m	No	>4 yrs	No	Not Important
19.	2yrs 6m	1	2-3 yrs	2 yrs	Yes
20.	2yrs 6m	No	2-3 yrs	some	up to 25
21.	2yrs 6m	1,2,3	2-3 yrs	2-3 yrs	up to 10
22.	2yrs 6m	No	2-3 yrs	No	Yes
23.	2yrs 5m	No	2-3 yrs	2yrs	up to 10
24.	2yrs 4m	No	2-3 yrs	2 yrs	up to 20
25.	2yrs 4m	No	3-4 yrs	Yes	up to 20
26.	2yrs 3m	1,2,4,5	2-3 yrs	2yrs	Yes
27.	2yrs 3m	1-4	<2 yrs	1½ yrs	up to 10
28.	2yrs 3m	1,2,4	2-3 yrs	2 yrs	Yes
29.	2yrs 2m	No	3-4 yrs	No	up to 10
30.	2yrs 2m	1-4	<2 yrs	<2 yrs	up to 100
31.	2yrs 1m	No	3-4 yrs	3-4 yrs	Not Important
32.	2yrs 0m	No	2-3 yrs	<2 yrs	Yes
33.	2yrs 0m	1,2,8	<2 yrs	<2 yrs	Yes
34.	1yr 10m	Yes	<2 yrs	<2 yrs	No
35.	1yr 10m	1,2,3	<2 yrs	1½ yrs	up to 10
36.	1yr 9m	No	2-3 yrs	No	up to 20
37.	1yr 7m	No	2-3 yrs	<2 yrs	up to 10
38.	1yr 6m	No	<2 yrs	1½ yrs	Yes
39.	1yr 6m	No	No idea	No	up to 9
40.	1yr 3m	No	4 yrs	-	up to 10

Table 7.4 **Total Time of Mediated Interaction**

(minutes)

E - everyday
S - somedays
J - just when occasion arises
M - more than once per day

1.	4yrs 6m	no. ans.
2.	4yrs 3m	2-5 S
3.	4yrs 0m	›10 E
4.	3yrs 11m	E
5.	3yrs 11m	‹2 E M (~ 10 times)
6.	3yrs 6m	2-5 E M (~10 mins total)
7.	3yrs 6m	2-5 S
8.	3yrs 6m	›20 E M
9.	3yrs 5m	2-5 E (M sometimes)
10.	3yrs 5m	›20 E M
11.	3yrs 3m	›20 E M
12	3yrs 3m	›20 E M
13.	3yrs 3m	2-5 S
14.	3yrs 1m	›20 E M
15.	3yrs 0m	›20 E
16.	3yrs 0m	2-5 E M
17.	2yrs 10m	2-5 E M
18.	2yrs 6m	5-10 E M
19.	2yrs 6m	›20 E
20.	2yrs 6m	2-5 E
21.	2yrs 6m	›20 E
22.	2yrs 6m	5-10 E
23.	2yrs 5m	2-5 E M
24.	2yrs 4m	›20 E M J
25.	2yrs 4m	›20 E M
26.	2yrs 3m	2-5 J
27.	2yrs 3m	›20 E M
28.	2yrs 3m	2-5 E
29.	2yrs 2m	‹2 S
30.	2yrs 2m	›20 E M
31.	2yrs 1m	‹2 J
32.	2yrs 0m	2-5 E M
33.	2yrs 0m	2-5 E
34.	1yr 10m	›10 E M
35.	1yr 10m	‹2 E M
36.	1yr 9m	‹2 S J
37.	1yr 7m	2-5 E M
38.	1yr 6m	2-5 S J
39.	1yr 6m	‹2 E
40.	1yr 3m	‹2 E M

7.5 Analysis of the Interviews

It appears that mothers, and other caregivers, begin to recite numbers to young children as soon as the child is able to talk, usually in the context of nursery rhymes at first. The adult caregiver continues to practice number recitation for the child in a variety of other playful contexts, eg. jumping, swinging etc. (an adult simply lifting a child up may recite, "One, two, three"), until, and even after, the child begins to respond with their own number sequence recitations. Adult caregivers appear to begin mediating number recitation during the period 1-1½ years old, and the child appears to respond by initially mimicking number recitation around the age 2-years, but often before 2-years (see table 7.1).

Usually after number recitation has been practised in a variety of contexts and under different circumstances, one-to-one correspondence counting is introduced by adult caregivers. This usually happens around the age of 1½-2 years. Initially, the adult caregiver performs the one-to-one correspondence counting, again in a variety of circumstantial social contexts, including climbing stairs, counting buttons while dressing/ undressing, packing away toys etc.. It often appears from the interviews that adults tend to initiate the one-to-one correspondence counting activities, but they are usually developed by the adult responding sensitively to the child's current interests, eg. counting lego bricks while the child is playing with lego, counting coins while the child is playing with money. The child tends to respond to these counting performances by the adult caregiver, by attempting to perform them as well, usually watched and assisted by the adult caregiver. As the child becomes older, the caregiver initiates less and the child takes over the role of the initiator in counting activity. Thus, young children appear to learn how to count quantities of items in one-to-one correspondence with number words from mimicking adult utterance performances, then by being assisted and led in these utterance counts by adults, and finally performing counts by themselves under the watchful guidance of an adult. Young children appear to practice these one-to-one correspondence counts with adults during the period 2-3 years of age, and once again the actual age depends upon the adult's initiations. By the age of 3-years, most young children appear to be able to count small quantities in one-to-one correspondence with number words (see table 7.2), and this skill is further developed and extended to higher number quantities during the period 3-4 years.

Where an adult appears not to have initiated and continually mediated one-to-one correspondence counting to their child at an early age, that child is often not reported to count in one-to-one correspondence at an age comparable with the age of children whose caregivers did initiate one-to-one correspondence counting. The interviews with Derek's mother, Omar's mother, Yvonne's nanny, all show that Derek, Omar and Yvonne acquired their one-to-one correspondence skills later than other children, and that their caregivers did not initiate and continually mediate one-to-one correspondence counting at an early age.

Not all young children's adult caregivers appear to consider mediating aspects of number figure recognition, eg. Elizabeth, Linda, Kevin; and other caregivers prefer to leave this up to nursery school eg. the cases of Derek, Colin. If adult caregivers do mediate number figure recognitions, then it is quite usual for a child to develop this number skill, even at the tender age 2-years. There are many interview reports which indicate that 2-year old children are readily able to recognize printed number figures, often developed from reading counting and other children's books, but also commonly learned from switching on TV channel numbers eg. Philip, Janet, Dick, William. In terms of being able to recognize printed number figures a child's age appears to be quite unimportant, in the case of Walter, aged 2-years 0 months, he is reported by his mother to be able to recognize the number figures, '1', '2', & '8', yet he is not to be able to recite a number sequence or count in one-to-one correspondence with numbers. In the case of Roy, aged 1-year 10 months, his mother puts down his figure recognition skill to luck more than judgement, but Diana (2-years 3 months), William (2-years 2 months), Dick (2-years 3 months), and Sarah (1yr 10 months) are all reported to be able to recognize some number figures, and their caregivers mediate number figure recognition; while Colin, aged 4-years 0 months is reported not to be able to recognize number figures, and it is important to note that his mother does not mediate number figures to Colin, believing that school is the proper forum for this aspect of number to be learned.

For those adult caregivers who do consider mediating number figure recognition, the age at which this begins often varies, for some it starts before the child's second birthday, most often however it is started between the ages of 2-3 years, but also some caregivers delay mediating number figure recognition until the child is at least 3-years (see table 7.3). In many cases caregivers do not expect their child to acquire number figure recognition skills until the child is 3- or 4-years of age. It is not surprising then to learn that number figure skills are developed by young children at different ages, since these skills are mediated by caregivers at different ages. The skill of number figure recognition is a prime example of the social mediational influence that caregivers exert over the development of young children's number skills.

Adult (social) mediational influence appears to be a constant feature that surrounds young children's number skill developments; and where mediational influence is absent in an aspect of social number use, the number skill appears not to be developed by the child. Number recitation, one-to-one correspondence counting and number figure recognition all appear to develop in the child after a prolonged period of social mediation by caregivers, and they do not appear to be directly correlated with a child's age.

The total time of mediated numerical interaction (see table 7.4) indicates that young children under 2-years do not participate in mediated numerical interaction to the same extent as older children. According to their caregivers, on average, children under 2-years usually have less than 2 minutes everyday related to mediated numerical interaction, whereas older children always appear to have much more time spent on mediated numerical interaction (caregivers often report more than twenty minutes for older children). This could lead to the postulation that very young children possibly do not develop number skills because of an insufficient cumulative quantity of social interactive numerical mediation, and not because of any insufficient mental development.

It may also be argued that parents are sensitive, in an interactive 'zone of proximal development' to a young child's insufficient mental development, and as a consequence of this sensitivity, they do not spend a great deal of time mediating aspects of number during their interaction. Whatever the reasons for less numerical mediation to a young child, this research appears to indicate that the younger the child, the more likelihood there is of less numerical mediation in terms of time.

It may be stated at this point as well, that the age of the caregiver did not appear to influence the numerical mediational practices, or mediational time, that caregivers devoted to children; nor did caregiver age appear to have any bearing on the caregivers' developmental expectations of young children's number skills.

It is also interesting to note from the interviews that a child's accomplishments in terms of number skills appears to settle down at a level acceptable by both parents and children. The number recitation accomplishments of some of the 4-year old's does not appear to be substantially greater than 3-year old's, or some 2-year old's for that matter.

In terms of number recitation, the majority of parents expected pre-school children to be able to recite up to twenty, and most children appeared to be well on their way to achieve this expected level. However it is not clear from this research whether expected levels are set by parents or by children, or whether this may be an external social appropriation (the expectations of social others and the demands of school). There is ample scope for further research in this area.

The views of parents on a pre-school child's number recitation ability varied from 'not important', or 'whatever the child can achieve', to expected levels which ranged from 5 to 100. One parent, Ivan's mother, indicated that she expected a pre-school child to be able to recite up to fifty, and her own child could recite up to 120. Ivan was the only child reported who could recite beyond 20, and he did demonstrate this number feat while counting baby-cups in a pre-school playgroup (on video, see next chapter).

Caregiver (social) expectation, (and this may be in part due to a perception of the child's present numerical skills), and caregiver (social) mediation also appears to influence a child's developmental accomplishments in one-to-one correspondence counting, and to a lesser extent in number figure recognition.

Caregivers' appear to expect young children to develop one-to-one correspondence counting skills after number recitational skill. The first mediation of one-to-one correspondence counting often begins around the age of 2 years, compared to 1 year for number recitation, and most parents expect their child to be able to count in one-to-one correspondence with number words by the time the child is 3 years of age. The extent of reported one-to-one correspondence counting would suggest again that most children achieve their parents expectations, which are only slightly less in expected accomplishment compared to number recitation.

Although the tabulated data in table 7.2 appears to indicate that one-to-one correspondence counting is an age related development, the younger children do not appear able to count quantities to as high a level as the older children, but this may be partly explained in terms of a lack of social practice, as much as a question of any apparent lack of intellectual mental development (Piaget, 1952). The gradual increase in number recitation, from the "One, two, three" of a child aged less than 2-years old, to a recitation of up to 'twenty' by a 4-year old, is more readily explained in terms of extent of social practice than of increased mental memory development.

From this research, the extent of number recitation, one-to-one correspondence counting skill, and number figure recognition by a child, may all be viewed as a mediated social development, one that appears to be related to contextual daily practice and consequently spread over time. From this perspective, the younger children may be seen to have had little time to practice number recitation and one-to-one correspondence counting (probably only with small numbers), and less time interacting with number figures; whereas older children possess additional years of social interactive numerical practice, and so are able to successfully recite and count to higher numbers, and recognize more number figures. From the interview data in table 7.4, the total time that caregivers appear to spend mediating aspects of number to children above the age of 2 years appears to vary, from 2-5 minutes somedays, to more than 20 minutes everyday. The time devoted to social interaction in which aspects of number may be mediated, appears to vary from household to household, and it does not appear to be related to the child's age (other than the younger the child, often the less time).

Young children may be seen to master aspects of number at different ages, within well defined bands, depending upon the temporal extent of their engagement in numerical mediational practises. Consequently, these interviews suggest that young children's number skills are being interactively developed through rhetorical-responsive micro-environmental activity in which number is socially mediated.

The range of social interactive activities in which aspects of number are mediated to young children are varied. The interviews indicated between ten and twenty different activities. The activities in which caregivers indicated their children were sometimes involved in has been classified, and collectively produces the following taxonomy:

Table 7. 5

Activity through which aspects of number is mediated	**% of adults/children participating in this activity**
songs/verses/rhymes	87.5%
counting books (and others)	85%
play bricks/toys	82.5%
up/down stairs	80%
finger counting (and toes)	75%
body parts	67.5%
money discussions (playing/counting coins)	65%
playground activity	60%
dressing/undressing (buttons, shoes)	52.5%
switching TV channels	40%
household objects (cups/plates/cutlery etc.)	37.5%
shopping items	35%
telephone numbers (real and toy)	32.5%
food prep/serving	25%
house numbers	25%
bus numbers	17.5
board games (dice usage/spot recognition)	15%
playing card games (including number snap)	12.5%
car number plates (figure recognition)	5%
parked cars (counting number of)	5%
domino patterns	2.5%
number jig-saw puzzle	2.5%
others (flowers, road bumps, dogs, sweets height chart poster, VCR digits, birthday card figures, etc.)	2.5%

7.6 CHAPTER CONCLUSION

The interviews have demonstrated that number is mediated to young children in their homes by social others, usually caregivers, and they provide ample evidence that the previous two chapters concerning the nature and extent of numerical mediation in the home are reasonably valid. The forms of mediated interaction would suggest that medium of mediation is the adult usage of numerical language, often associated with play that stems from the child's interests, and always within the context of social interaction. It has been shown that a child's numerical accomplishment is often in tune with a parent's expectations. Parent's expectations often match or are just slightly higher than the child's present accomplishments, but well within the possible range of achievement by the child by school age. Under these circumstances, it is concluded that parents do behave in a manner that would be consistent with Vygotskian theory, where caregivers' lead their children within a 'zone of proximal development' to achieve number skill, through subtle gradual rhetorical-responsive intercourse. These interview results would support a view that an intrapsychological development of number in the child may stem from social numerical interpsychological thought, through mutual social interactional processes involving activity and language, adult mediation and child appropriation.

From the interviews it has been noted that different caregivers' appear to set different numerical goals for their young children to achieve, and although many are similar, some parents have higher expectations than other parents, and some parents do not consider some aspects of number to be important for pre-school children. Consequently, some parents mediate number to their children to a greater extent than other parents, and subsequently young children's development of number skills follow different mediational paths. This produces the impression that number development is an individual development, whereas in fact children are often on a different mediational and expectational social plane.

It has also been noted from the interviews, that pre-school children tend to achieve different standards in terms of number skills from a very young age, and this would suggest that young children who enter primary school will not all be equal in terms of their developed number skills. This aspect will be investigated in chapter 9.

CHAPTER 8

ACCOUNTS OF NUMERICAL MEDIATIONAL DIALOGUE USED BY CHILDREN AND ADULTS IN PRE-SCHOOL PLAYGROUPS/NURSERIES

Introduction

8.1 Social Micro-environment Influences on Numerical Cognition

One of the arguments of this thesis is that an individual child's development is not an individual process. The child's development may be socially promoted through a purposeful, controlled process of socially disseminated social information. Numerical activity in the course of daily life at home, outings to playgroups, shops etc. may lead children into using and applying numerical thought themselves. In this way a child appropriates cultural knowledge concerning number in the form of socially relevant principles, language norms, and value. Practical experience is obviously confined to the lifestyle offered by the immediate socio-cultural context, and under this restriction, the child may only be able to appropriate the socio-cultural line of thought and behaviour that is within its participatory view. However, the particular socio-cultural environment may not be the most direct influence on the child's numerical appropriations, the child's guided participation within that micro-environment could be expected to be the force that structures the child's acquisition of numerical principles, language norms and value. As long as the micro-environment does not erect numerical information barriers, then a child may be expected to appropriate, use, and psychologically embody the idea of number if guided.
Past research, (especially Tough, 1977) has shown that peer interaction may promote young children's cognitive and social psychological development. It is through such interactions that young children learn to understand the feelings of others, wait their turn, cooperate with others, share materials and discuss experiences, and develop affective relationships. Most young children's peer interactions occur within play situations involving language use, and from a Vygotskian perspective, such linguistic interaction can only be expected to impinge upon young children's mediated cognitive development, including that of number meaning.

Consequently a study of the socially mediated numerical utterance that takes place in under-5 playgroups/nurseries is important to this thesis, since these linguistic interactions may be expected to impinge upon a child's use and practice of number.

8.2 The Munn & Schaffer Categories of Interactive Analysis

It has been reported by Munn & Schaffer (1993), that 'intuitive' beliefs amongst trained nursery staff, concerning young children's 'readiness' to understand number, may be inhibiting the promotion of preschool numerical activity and interaction amongst staff and children. In contrast, Munn & Schaffer argue that parents have few inhibitions about correcting children's mistakes in counting, suggesting that parents see informal maths teaching at home as an important intellectual development, indeed a development in which they can successfully contribute to:

> We can't ignore the facts that children count, that parents push counting
> (Greenberg, 1993, p79).

In the home, (see chapter 5) numerical learning is usually unplanned but highly interactive in terms of adult-child rhetorical-responsive participation, and it is this character and nature that probably accounts for its effectiveness. Past research has shown that children are normally, and often quite unintentionally, brought up in a world where they *are provided by other people with daily experiences of number,* leading young children to gradually see the world in quantitative terms (Durkin et al, 1986; Saxe et al, 1987). As long as the counting is contextually embedded in everyday activity, adults are likely to mediate number to their child apprentices. It is only the removal of number from the sphere of everyday common-sense and into the realm of de-contextualized individual numerical activity to develop sensory-motor intuition (nursery school activity; see Chapter 9) which is likely to reduce this active participation of adults, and adult mediation.

Both Greenberg (1994) and Munn & Schaffer (1993) have recognized that adult activity often leads young children into numerical experiences, where adults appear to encourage and motivate children to participate in numerical activity:

> highly context-dependent and related to adult input
> (Munn & Schaffer, 1993, p76);
> Play money (or real money), especially coins, is marvellous sets-learning material. Most children are motivated to manage money - very likely because it's so meaningful to their grownups! (Greenberg, 1994, p14).

Greenberg suggests that children's interest in money develops from adult use, and my research would support that view. Young children do appear to love playing with money, but for social interactional appropriation reasons, not because it is set material. In the Munn & Schaffer (1993) study, observations of nurseries showed that young children's numeracy experiences were infrequent by comparison to literacy experiences:

> The most striking feature of the frequency data was the relative scarcity of numeracy experiences in all ten nurseries (Munn & Schaffer, 1993, p76).

Initial observations by Munn & Schaffer revealed that literacy/numeracy events occurred very rarely during peer interactions, but that when they did occur it was usually during adult-child interaction. The kinds of nursery activities in which elements of literacy or numeracy appeared to be featured were:

songs or action sequences (32%)
stories, books and pictures (26%)
model-making or constructions (16%)
drawing or painting (10%)
jigsaw puzzles (6%)
games and structured play (6%)
conversations involving quantitative language (3%)
children's television programmes (1%)

Munn & Schaffer interpret their findings as showing how important adult-child interaction and socialization is to the cultural development of a young child's early learning experiences.

In their observational study of preschool playgroups and nurseries, Munn & Schaffer were only interested in the occurrence of literacy and numeracy events, consequently all 20sec. intervals of pre-recorded observations were coded according to whether they contained elements conceptually related to literacy or numeracy:

> we were interested not only in whether literacy or numeracy events occurred, but also in the interactive contexts in which these events were embedded.

They theorized that interactive adult behaviour that supported and motivated young children to engage in literacy/numeracy would be conducive to young children's learning, and a lack of, or negative, adult interaction would be non-conducive to young children's learning.

Results of the Munn & Schaffer study show that during periods of interaction in which adults are supportive, accounted for approximately three-quarters (**78%**) of all literacy/numeracy events in the nurseries that they studied. Munn & Schaffer also found that the stability, over days, of the frequency of all literacy and numeracy events yielded, "a considerable degree of consistency when the nurseries (rather than the children) were compared with each other".

Munn & Schaffer's analysis of adult-child interaction during literacy/numeracy events was effected by classifying their data within a six categorizational *coded* scheme based on, "whether the interaction showed evidence of *adult support, child activity, both,* or *neither*".

My study of numeracy in nursery/preschool is similar to the Munn & Schaffer study in that it is a study of adult-child socialization interaction, and on first inspection, this six category analytical coding mechanism outlined by Munn & Schaffer (1993), concerning the nature and character of adult-child interaction, appeared as a suitable tool to effect an analysis of numerical interaction in preschool settings. However, my theoretical social constructivist argument is not just concerned with the importance of numerical interaction, it is also concerned with the rhetorical-responsive nature of a child's numerical appropriation. My argument revolves around the mediational effect of interactive utterance that may be associated with adult-child interaction, and this would require a numerical language utterance analysis of the adult-child interaction to take place, consequently Munn & Schaffer's coding is not categorically suitable.

Amongst Munn & Schaffer's six categories, the role of an adult always appears to be either participatively supportive, negative or not present. No account has been taken of the case where an adult may be present, but acting in a passive observational role (the P sub-categories of my coding outlined in chapter 5). An analysis of the data in chapter 5 led to the conclusion that the P sub-categories, numerical performance in the presence of an adult are an important feature of a child's social performance with number. In this case, numerical interaction with an adult may be deemed to have taken place in the course of casual numerical utterance, where no participation in the form of support is expected or required, eg. the role of a listener, attentive or otherwise; or an adult reprimand involving number directed towards children, eg. "You three stop fighting"; or numerical comment by a child to an adult, eg. "I've got four sweets". Adults and children often 'perform' with number without the direct participation of the other. Often the mere presence of an adult or social other may contribute to the child's construction of numerical utterance without that adult or social other encouraging, guiding, prompting or directing the course of the child's numerical utterance. The absence of the equivalence of a P category in the Munn & Schaffer categories appears to me to be a weakness of this particular coding mechanism with regard to its application to effect an adequate analysis of the nature of mediated numerical interactive utterance in preschool settings.

8.3 The Dickinson & Smith Categories of Interactive analysis

A study by Dickinson and Smith (1991), of preschool children's language and literacy experiences has also shown that adults have a profound influence on the nature and course of young children's talk, and this adult led influence may also be present in numeracy (as is suggested by Munn & Schaffer).

From their study of twenty-five 3-year old, and thirty-seven 4-year old children, Dickinson and Smith reported that they observed three patterns:

a) when children spend time with other children they often engage in pretend talk

b) when children relate to adults the topic often has to do with skills related issues

c) from age 3yrs to 4yrs, there is a general trend of adults focusing on print related issues

The role of adult contribution to young children's socializational talk is reported by Dickinson and Smith as one of gradual enculturation:

> During the three-year old year, many types of talk and a variety of activities are fostered. During the four-year old year, the focus shifts to incorporate more small group experiences and literacy-related activities
> (Dickinson and Smith, 1991, p29).

The most important aspect of the Dickinson and Smith (1991) study here is their research methodology and data analysis. Their methodology was ethnographically framed, and similar in nature to that carried out in this study. The ethnographically obtained data was separated into three aspects: the *activities*, *talk* and *interactions*; then sub-categorized within those aspects.

8.4 Pre-school Playgroups/Nurseries Analysis Procedure

My research interest in observing preschool settings is to shed light on the social contextual mediation of number by adults to young children through classifying the forms of numerical activity, the nature of the numerical talk, and with whom numerical interaction takes place (adult, self, or in the presence of a social other). Consequently, my analyses do not need to represent the preschool interaction in terms of Munn & Schaffer's six categories of interactive social activity, nor do they require the entire nature of the participants talk to be interactively categorized as has been attempted by Dickinson & Smith (1991). My interest is only in the interactive numerical talk and the interactive numerical activity, therefore I shall not make use of the Dickinson & Smith interactive talk categories to classify the social contextual and circumstantial use of talk in preschool settings, but instead focus attention directly on the nature of the numerical activity/talk observed in preschool settings.

Any interactive numerical talk analysis necessitates that the focus be mainly on the nature of the linguistic interactions, the contextual rhetorical-responsive utterances that may lead a child to appropriate socially regulated numerical meaning through interactive mediation. The theoretical framework already outlined recognizes that numerical language appropriation and numerical meaning are part of the same process. The child's appropriation and use of number is being interpreted as an act of social engineering, through an adult-child apprenticeship scheme, where adult language use and meanings are being mediated in social context to the child apprentices. This Bakhtinian perspective, involving a "chain of speech communication" (Bakhtin, 1986, p94), recognizes the inextricable intertwinedness of cognition and linguistic interaction, and this must be reflected in the mode of analysis by specifying language use, the genre of utterance, in the interactive numerical socialization processes. Language socialization, which focuses on, "socialization through the use of language and socialization to use language" (Schieffin & Ochs, 1986, p163), may also reflect cultural loading, that is, the frequency of numerical events may be seen to be culturally loaded and reflected in the extent of socialization involving numerical language use.

To effect an adequate analysis of the research data concerning mediated numerical utterance within preschool settings I shall once again resort to the use of the 7 coded sub-categories outlined in chapter 5, and the nature of interactive talk during the numerical incidents will then be interpreted in terms of the three sub-divisions: S-, P-, and A-. The use of these previously outlined 21 categories will focus attention directly on the form and interactive nature of the numerical utterance that has been observed in preschool settings, and enable comparisons to be drawn between the numerical activity/talk in preschool settings and home. The frequency of numerical talk in each sub-division, S-, P-, A-, and the seven sub-categories with respect to the total occurrence of numerical talk will be calculated and expressed as percentages.

I shall review all the transcribed text from the video recordings of each preschool setting and note the nature of all the activity and talk recorded, but codify only the nature of the numerical utterance occurring during numerical incidents. Activity will be deemed to have given rise to a numerical incident when number words are used by either of the interactive participants (children or adults) during an activity, or where printed number symbols are being used or referred to by the interactive participants.

It must be pointed out that Kirk and Ashley attended all these preschool settings, accompanied by Dad, acting in the dual roles of parent and researcher (see Methodology - Chapter 4). However, for the purposes of this analysis, all numerical talk between Kirk/Ashley and Dad (researcher) will be ignored, since the nature of their talk has already been dealt with in Chapter 5. Any distortion of the nature of the preschool interaction in terms of numerical utterance due to the talk of Kirk, Ashley and researcher will be minimized by this exclusion in the analysis. This chapter analysis will focus exclusively on the utterances of other participants in the pre-school settings, parents, teachers, and nursery assistants for it is their contribution to possible numerical mediative practices which may socially structure young children's numerical appropriations that is under study.

In order to develop a taxonomy of the forms of preschool activity in which numerical interaction appears to take place, the numerical episodes will be categorized according to categories developed by Munn & Schaffer (1993), but adding or subtracting to these categories as appropriate. The Munn & Schaffer category 'Children's television programmes' will not be used, but five additional categories have been introduced, namely: 'Craft activity'; 'Casual play'; 'Adult numerical comment'; and 'Deliberate counting'. In the case of the Primary school nursery class 'Computer activity' will also be included. The full classification of the forms of activity in which numerical language features will be:

Songs or action sequences (S); stories, books and pictures (SB); model making or constructions (M); drawing or painting (D); jigsaw puzzles (J); games and structured play (G); conversations involving quantitative language (C); Deliberate counting (DC); Casual play (CP); Craft activity (CA); Adult numerical comment (AC); Computer activity (CMP).

Once the numerical episode is identified, its temporal duration will be measured and the number of child participants noted. The total number episodes for all the days on which recordings took place will then be calculated, and then expressed as a rate of numerical incidence.

From the these analyses I shall report:

1) whether or not communication of a numerical nature appears to be taking place between children or between children and adults;
2) the average number of numerical episodes that may be expected on any single day in a preschool setting and the number of children involved in these;
3) a taxonomy of the forms of activities in which aspects of number feature (based upon Munn & Schaffer's (1993) taxonomy of songs, models and construction toys, puzzles, games, stories, books, conversations, etc. but adding or subtracting as appropriate, eg. no television programmes, but computer use);
4) the nature of the numerical talk observed in pre-school settings, as is expressed by the 21 coded mediation/number categories
6) a description of the nature of numerical mediation that appears to be contextually taking place through the presentation of detailed transcriptions.

A comparative discussion surrounding each under-5 playgroup/nursery, both with each other and with the home case study, is also discussed in the analyses sections.

A complete description of the numerical interaction in terms of activity and talk that has taken place in each under-5 playgroup/nursery has been presented, in the order of analysis, in Appendix D.

8.5 ANALYSIS OF NUMERICAL INTERACTION IN A COLLEGE CRECHE:A PILOT STUDY

Introduction and Methodology

A period of two days per week over three weeks was spent in the creche of a Community College for Adult Education, where the under-5 children of adult learners pursuing courses in the college classes were normally looked after. This short period served as a pilot study to test the ethnographic methodology to be employed throughout this study (see chapter 4). Diary notes of the daily numerical interactions were made, and video recordings of the children's interactions were carried out. The creche operated two sessions, one in the morning (2½ hrs) and one in the afternoon (2hrs), and children normally attended for an entire morning or afternoon or both, they were looked after by trained nursery nurses, usually four in number. Parents who attended full time classes were given preference in the allocation of creche places, and so most children attended both morning and afternoon sessions. There was a gap of 1½ hrs between each session and parents collected their children at lunch-time.

Although permission to make video recordings within the college creche was readily available from the nursery nurse in charge of the daily operation of the creche, and she was quite unconcerned about signing a Video Permission Agreement declaration, there was some reluctance to give permission and sign the agreement on the part of the local borough creche administrator (the person responsible for the operation of all borough creches), claiming that she could not speak for all parents who had children in the creche. Video recordings were consequently suspended after the first day, despite both morning and afternoon sessions of that first day being recorded with on-site permission. Despite the planned video recordings being suspended, this was not a set back, a lesson had been learned, namely tread carefully when making video recordings, and approach only those persons directly in charge of daily playgroup routine for permission! In the event, research data was not lost, it was just gathered in a more conventional way, diary notes. The two sessions that were video recorded on the first day gave an indication as to the very low incidence of mediated numerical interaction that could be expected on future video recordings in preschool playgroups. In fact the morning session which lasted 2½ hours provided no incidence of mediated numerical interaction between adults (4 nursery nurses) and children. However, the afternoon session did provide an example, but only one example, and this was partly developed due to my presence as a researcher (but it did not arise because of researcher presence, see Video example in Appendix D1).

The two sessions video recorded also provided experiential insight into the best way to operate the video camera to ensure the steady capture of picture detail and satisfactory audio levels while monitoring young children's playful activity and their mediated interactions with adults.

The diary entries on the other days observed also reveal only one numerical incident per day, (see table 8.1) and usually involved only one or two children out of fifteen. The time length of the numerical mediating interchange usually only lasting seconds. This pilot study had revealed a pattern that was consistent with the findings of Munn & Schaffer (1993), that the numerical experiences of young children in preschool settings are very few and almost entirely limited to categories that involve supportive adult mediated interaction (78% in the Munn & Schaffer study, 76.9% in this pilot study, see table 8.2).

In my pilot study, the total coded numerical interaction is summarized in the table 8.1

TOTAL CODED NUMERICAL DATA - TABLE 8.1

	Numerical Utterance Codes		Activity
forms			
23/2/93 (V)	Codes	IIIA, IIIA, IIS, IIP, IA, IIIA, IIIA, IIA	(C)
26-02-93 (D)	Codes	IIIA	(CA)
02-03-93 (D)	Codes	IP	(J)
05-03-93 (D)	Codes	IIIA	(CP)
09-03-93 (D)	Codes	VIA	(C)
12-03-93 (D)	Codes	IA	(AC)

Table 8.2

Codes by Sub-division	No.	% of Total
S-	1	7.7
P-	2	15.4
A-	10	76.9

The sample is far too small to draw any conclusions as to the nature and extent of mediated numerical interaction in terms of the prominence of utterances in any single or group of sub-categories, but the prominence of the A- sub-division is obvious. The sample is also too small to develop a forms of activity taxonomy, but *General Conversation* involving quantitative language occurs twice, and is therefore the most common in this sample.

8.6 NUMERICAL UTTERANCE IN A COUNCIL UNDER-5 PLAY AND STAY PLAYGROUP

Introduction and Research Methodology

The first full ethnographic study of numerical utterance was carried out at a local council operated preschool Play and Stay parent and toddler group. A parent (usually the mother) was obliged to remain on the premises with her child or children, and approximately 16 children and their parents attended the group each afternoon for 1½-2½ hours. There were usually three under-5 play assistants responsible for the daily operation of the group, and the full particulars of the set-up has already been outlined in chapter 4.

Permission to video record the daily interaction was readily obtained from the coordinator of the group after the research activity had been fully explained. The coordinator declined to sign a video permission declaration, but she and the other staff members expressed no reservations about the video recording, and they were all quite interested in the objectives of the research, as were many of the parents. Most of the parents were interviewed about their child's number competence and their answers to interview questions have already been analyzed in Chapter 7.

The research data gathered from this under-5 playgroup was begun on 21-09-93 and it ended on 17-12-93, a period of approximately three months, and I attended three or four days per week, a total of 45 days were logged. My presence was readily accepted and made easier by my dual role as parent as well as researcher (I was accompanied on every occasion by both Kirk and Ashley). All data pertaining to the numerical interactions of Kirk and Ashley with the researcher (Dad) within this playgroup have been excluded, as has all deliberate numerical mediation or tutoring on the part of staff members towards Kirk or Ashley (bias).

Initially for the first three weeks only diary notes were kept until staff, parents and children became accustomed to the presence of a researcher. Once the video camera was introduced, the diary accounts gradually ceased. The video camera was generally kept running throughout the session, capturing as much activity and variety as possible. All video recordings were subsequently transcribed, and from the transcriptions, all numerical utterances were coded according to the 21 categories already outlined in chapter 5.

Appendix D2 reports both examples and the total numerical utterance observed and recorded.

8.7 ANALYSIS OF THE TOTAL NUMERICAL UTTERANCE IN THE COUNCIL UNDER-5 PLAYGROUP

TOTAL CODING (V+D) NUMERICAL ANALYSIS

Table 8.3

		Sub-categories							
No. of Codes	126	I	II	III	IV	V	VI	VII	Total
Sub-Division	S	2	2	0	1	2	0	0	7
	P	10	13	18	8	4	6	0	59
	A	18	11	21	0	1	9	0	60
	Total	30	26	39	9	7	15	0	**126**

TOTAL CODING (V+D) PERCENTAGE ANALYSIS

Table 8.4

		Sub-categories							
	% Codes	I	II	III	IV	V	VI	VII	Total
Sub-Division	S	1.6	1.6	0	0.8	1.6	0	0	**5.6**
	P	7.9	10.6	14.3	6.3	3.2	4.8	0	**47.1**
	A	14.3	8.7	16.7	0	0.8	7.1	0	**47.6**
	Total	**23.8**	**20.9**	**31.0**	**7.1**	**5.6**	**11.9**	**0**	**100.3%**

8.8 DISCUSSION OF THE RESULTS FROM THE COUNCIL UNDER-5 PLAYGROUP

The total codings of numerical interchanges at this playgroup (reported in Appendix D2) are displayed in Table 8.3, and they have been converted into percentages in table 8.4. There are four main points to note from these tabulated coded analyses.

1) The incidence of numerical utterance appears to be quite rare, there are 61 recorded incidents spread over a period of 45 days, an average of **1.36** incidents per day - spread over at least 16 children per day. The number of children involved in numerical utterance varies, but the modal class is 1, with the range 1-5 being most common. This rate of numerical utterance appears low on first inspection, but the proportional rate is not much different from that in the home of Kirk and Ashley. This rate, 1.36 per day, is based upon 1½ hrs of recorded interaction, and it would produce a total of: $12 \div 1\frac{1}{2} \times 1.36 = 10.88$, for a 12 hour period among 16 children. This quantity gives rise to a rate of **0.68** per child; whereas Kirk and Ashley had a home rate of two incidents in three days, or 0.67 per day, based upon 12 hrs of interaction. Consequently it may be noted that there is not much difference between the numerical interactional rates, 0.68 for the playgroup, and 0.67 for Kirk and Ashley's home.

2) Unlike Kirk & Ashley's home data, the mean time length of numerical incidence is very low, the linguistic interaction involving number often lasts no longer than a few seconds, and the numerical incident average time length is 1.67 minutes. The prevalence of short numerical incidents is reflected in the nature of these numerical utterances, most commonly a single comment by a staff member, parent or child. There are very few prolonged rhetorical-responsive numerical interactions, only 5 incidents exceed 3 minutes. In terms of coding these playgroup numerical utterances tend to be slightly shallower in their interactive nature, no doubt this is also due to their short time period, a total of 126 codes spread over 61 numerical incidents, giving rise to an average of **2.07** codes per incident. Kirk and Ashley's numerical interactional coding rate was 1573 codes per 625 incidents, a rate of 2.51 codes per incident.

3) Although the number of incidents in the playgroup is low, and the coding more shallow, the range of incidents across the seven sub-categories appears to be well balanced, and quite similar in scope to the range present in Kirk and Ashley's home data. The three principle sub-categories are I, II, & III, (as was the case in the data gathered from Kirk and Ashley at home) and these account for 75.7% of the total numerical utterances. Once again the sub-category III appears to be the most common, where cardinal number is commonly being used in linguistic description (often adult comment). In this playgroup, number recital, sub-category I, features more prominently than in the home data of Kirk and Ashley. It is interesting to note that although sub-category VII was very low in the case of Kirk and Ashley's home data, sub-category VII in this playgroup is entirely non-existent amongst all three mediational sub-divisions. Neither parents or staff members were using or introducing children to number sums, number divisions, or number multiples, in their play activity.

4) The percentages of P- and A- sub-divisions are evenly matched, and account for over 94% of all the numerical interactions, whereas the S- sub-division, number spoken for oneself, is very low (5.6%). In terms of the three sub-divisions, the number coding profile is again very similar to that produced by the data analyzed from the home case study of Kirk and Ashley. In this playgroup the S- sub-division is 5.6% (K & A, 6.7%), while the P- sub-division is 47.1% (K & A, 48.1%), and the A- sub-division 47.6% (K & A, 45.3%). Each sub-divisional percentage in this playgroup lies within a few percentages of that produced by the data gathered from the home case study of Kirk and Ashley.

It could be concluded from these four points that what is happening in terms of mediated numerical interaction in this playgroup is very similar to what is happening in the home of Kirk and Ashley, both in terms of the nature of the numerical interaction, and the quantity of interaction. However, the quality rate (the number of codes per incident), of mediated numerical interaction appears to be slightly less in this playgroup 2.07 as compared to the home of Kirk and Ashley with a rate of 2.51

In terms of the forms of activities in which mediated number utterances occurred, the total analysis produced the following taxonomy:

Table 8.5

activity:	No. of incidents:	Percentage:
Songs or action sequences (S);	0	0%
Jigsaw puzzles (J);	0	0%
Drawing or painting (D)	0	0%
Craft activity (CA);	1	1.6%
Model making or constructions (M);	2	3.3%
Deliberate counting (DC);	3	4.9%
Stories, books and pictures (SB);	4	6.5%
Casual play (CP);	6	9.8%
Conversations involving quantitative language (C);	13	21.3%
Adult numerical comment (AC);	15	24.6%
Games and structured play (G);	17	27.9%
	61	100.1

8.9 NUMERICAL UTTERANCE IN A PARENT & CHILD PRE-SCHOOL PLAYGROUP

Introduction and Methodology

This playgroup was affiliated to the Pre-school Playgroups Association, and parents contributed a modest attendance fee. The playgroup met in a church hall three times per week, twice in the morning and once in the afternoon, each session lasted 1¾ hours. It was often very well attended, usually there were at least twenty children with a parent or guardian, and it was not unusual for parents and children to be turned away because of externally imposed number restrictions. Both parents and children appeared to come from a variety of backgrounds, there was a reasonable presence of ethnic minority groups, and languages other than English were overheard. The children's ages were often low, only about four 4-year old children attended regularly, children were mostly aged 2- or 3-years old, and there were some babies attending as well.

The children played with an assortment of toys, and although parents mostly sat around the edge of the hall area talking to one another, some parents did spend a substantial amount of time playing with their children, but apparently, as can be seen from the analyses, rarely mediating or using number language.

The playgroup had a single administrator and she was regularly assisted in the organization and operation of the playgroup by some parents. The playgroup leader readily welcomed the proposed research activity and she informed all the parents. Permission to video record the activity was granted, although no-one appeared to be interested in signing a video consent agreement form. Some parents also agreed to keep a diary account of their child's numerical activity at home, the results of which have already been discussed in chapter 6.

I attended this playgroup from 23-09-93 until 27-01-94, a period of 4 months, usually two or three times per week, a total of 32 days were logged. However, one week was missed, one week the playgroup was closed, and there was a two week break over the Christmas period.

Initially for the first two weeks only diary notes were kept until staff, parents and children became accustomed to the presence of a researcher. Once the video camera was introduced, the diary accounts gradually ceased. The video camera was generally kept running throughout the session, capturing as much activity and variety as possible. All video recordings were subsequently transcribed, and from the transcriptions, all numerical utterances were coded according to the 21 categories already outlined in chapter 5. The following examples indicate the nature and extent of numerical interactive utterance in this Parent & Child playgroup (all numerical utterance between researcher and Ashley & Kirk have been ignored). The total coded analysis of the Diary notes and Video recording transcripts of the numerical utterances are listed in Appendix D3, together with specific examples.

8.10 ANALYSIS OF THE TOTAL NUMERICAL UTTERANCES IN A PRE-SCHOOL PARENT & CHILD PLAYGROUP

The results of the total socially mediated numerical utterance from the Parent & Child Pre-school playgroup which are listed in Appendix D3, are tabulated in tables 8.6 and 8.7.

TOTAL CODING (V+D) NUMERICAL ANALYSIS

Table 8.6

Sub-categories

No. of Codes 30		I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	0	0	0	0	0	0	0
	P	3	0	3	0	0	1	0	6
	A	1	6	9	0	5	2	0	24
Total		4	6	12	0	5	3	0	30

TOTAL CODING (V+D) PERCENTAGE ANALYSIS

Table 8.7

Sub-categories

% Codes		I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	0	0	0	0	0	0	**0**
	P	10.0	0	10.0	0	0	3.3	0	**23.3**
	A	3.3	20.0	30.0	0	16.7	6.7	0	**76.7**
Total		**13.3**	**20.0**	**40.0**	**0**	**16.7**	**10.0**	**0**	**100**

8.11 DISCUSSION OF THE RESULTS IN A PRE-SCHOOL PARENT & CHILD PLAYGROUP

The total number of days which gave rise to the data was 32, and the quantity of incidents which contained numerical utterance was 21, producing an average of 0.66 incidents per day among 20 children over 1¾ hours. Proportionally, this rate of numerical incidence for a 12 hour period would be $21 \div 32 \times 12 \div 1\frac{3}{4} = 4.52$ for 20 children, or **0.23** incidents per child per 12 hour period. This compares very unfavourably with the previously analyzed council Play & Stay Playgroup, which had an average rate of 0.68, and Kirk & Ashley's home data which produced an average rate of 0.67. It is quite obvious from this low rate of numerical incidence, 0.23, that in this Parent & Child Playgroup there is not much numerical mediation taking place through numerical utterance, merely a third of that compared to the previous council Play & Stay playgroup, or a third of that taking place in Kirk & Ashley's home.

In terms of the quality of the numerical mediation through utterance, there were 30 codes listed throughout the 21 incidents, producing a rate of **1.43** codes per incident. Once again this rate compares unfavourably with the council Play & Stay playgroup, which had a rate of 2.07, and Kirk & Ashley's home data with a rate of 2.51 codes per incident. Numerical mediation does not appear to be taking place either in terms of quantity or quality.

The tabulated percentages of sub-divisions reveals quite an interesting picture. No Self-regulating numerical utterance appears to be taking place, 0% in the S-sub-division. However, this is not surprising, considering the generally low quantity and quality rate of numerical utterance in this playgroup, and the normally low rate in this sub-divisional category in previous analyses (usually around 5%). But what is very interesting in this playgroup is the high proportion of A- sub-divisional incidents, 76.7% from the analysis. This is very similar to the A- sub-divisional percentage in the pilot study, which was 76.9%, and quite consistent with Munn & Schaffer's (1993) interactive adult assisted literacy/numeracy percentage of 78%.

What appeared to be happening was that parents and the playgroup leader acted as adult catalysts, their presence was necessary to initiate, assist, guide, instruct or prompt numerical utterance. The children themselves did not usually spontaneously use numerical utterance to any great extent, only 23.3% in the P- sub-divisional category, and usually when this did happen it was by a 4-year old child, Francis, Ivan or Mark. The high percentage of A-, and the low proportion of P- sub-divisions may be due to the lower average age of children attending this playgroup (although there were 3- and 4-year olds, the majority were 2-years of age). Most children had not yet assumed responsibility for their own practice of numerical utterance use, and they were still very much dependent upon the adult mediation of number use in play.

Adults are more able to introduce number into play, and they often do, hence the high proportion of A- sub-categories and the low proportion of P- sub-categories in this playgroup. However, children tend to conform to parental expectations, and here parents expected their children to play, and the children played; numerical utterances just did not tend to feature highly in that play.

In terms of the spread of numerical utterance amongst the seven sub-categories, the spread is very similar to previous analyses. The category III is once again the most common, at 40%, slightly higher than the 31.0% of the council operated Play & Stay playgroup, and 31.7% in the case of Kirk and Ashley's home data. Category II, at 20.0% is very similar to the council operated playgroup, where category II was 20.9%; and Category I in this playgroup is 13.3% which is very similar to Kirk & Ashley's home data case, where Category I was 13.6%.
In this playgroup the total percentage of the first three categories is 73.3%, compared to 75.7% for the council operated playgroup and 64.1% in the case of Kirk & Ashley's home data (no comparison with the pilot study is possible due to the low sample of that data).

In terms of the forms of activities in which mediated number utterances occurred, an analysis produced the taxonomy in table 8.8 (overleaf):

Table 8.8

Activity:	No. of incidence	Percentage
Songs or action sequences (S);	0	0%
Jigsaw puzzles (J);	0	0%
Craft activity (CA);	0	0%
Model making or constructions (M);	0	0%
Stories, books and pictures (SB);	0	0%
Drawing or painting (D)	2	9.5%
Games and structured play (G);	2	9.5%
Deliberate counting (DC);	3	14.3%
Adult numerical comment (AC)	4	19.0%
Casual play (CP);	5	23.8%
Conversations involving quantitative language (C);	5	23.8%

8.12 NUMERICAL UTTERANCE IN A PRIVATE UNDER-5 DROP-IN NURSERY

Introduction and Methodology

The children attending this playgroup mostly came from ethnic minority social groups, and the playgroup was located in a Community Centre in a poor inner city district of London.

This playgroup catered mainly for the children of parents who worked. Parents were not expected to stay, although one or two occasionally did. The playgroup met in a large hall and it was privately operated, parents paid a weekly fee. The children, usually 15-20, were supervised by two nursery nurses and the proprietor (who acted as the nursery supervisor - she also was a trained nursery nurse). The children played with an assortment of toys, and indoor playground equipment (eg. trampoline & climbing frame, model cars which children could drive around the hall). There were books on a bookshelf which children could easily reach, there was always a painting easel set up, toy cars/garage, lego and sticky-bricks, and a variety of other constructional toys, there were dolls prams and push-chairs, a toy kitchen area with pots, cups and cutlery, there was usually play-dough available, and always a variety of jigsaw puzzles. The children played with toys for approximately 1½ hours each day, and then there was a period of tidying up (usually 15 minutes), the children always participated in the tidying up process, packing and carrying toys and equipment to the cupboard where they were kept. This tidying up process was followed by a half-hour period of sitting of sitting on a small chair, arranged in a long line. During this sitting period the children drank a cup of milk, they ate a biscuit and an apple slice, and then they would always sing action nursery rhymes organized by the proprietor and nursery nurses. This daily routine was standard.

I attended this privately run drop-in playgroup from 19-01-94 until 11-03-94, usually 3 days per week. Permission to video record the children's activity was readily granted and all the days were video recorded, excepting one (when the camera was malfunctioning). The nursery supervisor declined to sign a Video Consent Agreement form, preferring to give a personal oral agreement, an amicable agreement, as opposed to a formally written, possibly legally binding agreement. Once again, the nursery supervisor was very interested in the research and she was given a copy of the aims of the research.

Initial observations gave the impression that the three adult nursery nurses were very interactive with the children, continually talking and playing with the children. and it seemed likely that numerical utterance would be featured in the course of that interaction.

Examples of the rhetorical-responsive interchanges involving numerical utterance in this private under-5 drop-in nursery together with the total numerical utterance monitored is listed with its coding in Appendix D4.

8.13 ANALYSIS OF THE TOTAL NUMERICAL UTTERANCE IN A PRIVATE UNDER-5 DROP-IN NURSERY

The total coded utterance listed in Appendix D4 is analytically presented in the following tables 8.9 & 8.10

TOTAL CODING (V+D) NUMBER ANALYSIS

Table 8.9

		Sub-categories							
No. of Codes	**235**	I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	1	0	0	0	0	0	**1**
	P	5	4	3	0	6	0	0	**18**
	A	33	63	61	0	53	6	0	**216**
Total		**38**	**68**	**64**	**0**	**59**	**6**	**0**	**235**

TOTAL CODING (V+D) PERCENTAGE ANALYSIS

Table 8.10

		Sub-categories							
% Codes		I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	0.4	0	0	0	0	0	**0.4**
	P	2.1	1.7	1.3	0	2.6	0	0	**7.7**
	A	14.0	26.8	26.0	0	22.6	2.6	0	**92.0**
Total		**16.1**	**28.9**	**27.3**	**0**	**25.2**	**2.6**	**0**	**100.1%**

8.14 DISCUSSION OF THE RESULTS FROM THE PRIVATE UNDER-5 DROP-IN NURSERY

In the total list of 88 episodes (see Appendix D4) involving numerical utterance, there were 13 that could be directly attributed to researcher presence and interaction, consequently these will be discounted during the analysis. The total number of episodes involving numerical utterance will be taken as being 75, spread over a period of 21 days, producing a daily average of 3.57 incidents per day, amongst an average of 18 children. This is a substantially higher quantity than the previous preschool playgroups. This average of 3.57 incidents per 2¼ hour period amongst 18 children produces a 12 hour proportion of: $3.57 \times 12 \div 2\frac{1}{4} \div 18 = \mathbf{1.05}$. This proportional rate is much higher than the 0.67 for Kirk & Ashley's home data, 0.68 for the council under-5 Play & Stay, and 0.23 in the case of the Parent & Child Pre-school playgroup. The reasons why this rate of 1.05 should be so high will be investigated later, however, for the present analysis it is sufficient to note that in this privately run under-5 nursery there is a high rate of mediated numerical interaction.

To investigate the quality of that interaction, the coding density needs to be calculated, that is the number of sub-category codes per incident. The calculation reveals that there were 235 codes spread over the 75 incidents, producing a density of **3.13** codes per incident. Once again this appears remarkably high. It compares very favourably with the council Play & Stay playgroup, which had a rate of 2.07, and Kirk & Ashley's home data with a rate of 2.51 codes per incident. In this nursery, numerical mediation does appear to be taking place both in terms of quantity and quality.

A closer examination of the data reveals why there is a high level of numerical mediation taking place, there are two main sources, and these are revealed by the Forms of Activity coding of the numerical utterance. An analysis of the total Forms of Activity produces a numerical episode taxonomy for this drop-in nursery shown in the table 8.11 overleaf:

Table 8.11

FORMS OF ACTIVITY

occurrence	No. of incidence	Percentage
Craft activity (CA);	0	0
Drawing or painting (D)	0	0
Games and structured play (G);	0	0
Model making or constructions (M);	4	5.3%
Casual play (CP);	6	8%
Stories, books and pictures (SB);	7	9.3%
Conversations involving quantitative language (C);	7	9.3%
Deliberate counting (DC);	9	12%
Jigsaw puzzles (J);	12	16%
Adult numerical comment (AC)	14	18.7%
Songs or action sequences (S);	16	21.3%

This drop-in nursery is more structured than the other under-5 playgroups in the study, in that the children are involved by adults in the singing of action nursery rhymes, many of which involve numerical utterance. Not only is this form of activity present, it is in fact the principle category in which numerical utterance features, causing a comparative disparity between the other case studies. Also, the interactive use of a number jigsaw puzzle featured prominently, producing a relatively high percentage in the Jigsaw puzzles (J) category.

The Forms of Activity, see table 8.11, show that Songs (21.3%) and Jigsaw puzzles (16%), form a very high proportion of the numerical incidents, and they are forms of activity which do not appear in the analyses of previous playgroups to any great extent. Consequently, these two forms of activity, Songs and Jigsaw puzzles (in this particular nursery it was action nursery rhymes involving numerical utterance on the part of the children, and a number jigsaw puzzle that was being interactively used), not only form a high proportion of the numerical utterance in this nursery, but they distort the total coding to a certain extent.

Of the total number of codes, 235, there are 146 directly attributable to *number utterance* in Songs and during the construction of the number jigsaw puzzle, leaving a balance of only 89 codes spread amongst the remaining forms of activity. If the Songs and Jigsaw puzzle codings are 'taken out' a more 'normal' analysis results, see tables 8.12 and 8.13

Table 8.12 **Total coding analysis - minus the coding due to Songs and a Number Jigsaw puzzle**

	89 Codes	Sub-categories I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	1	0	0	0	0	0	1
	P	3	3	2	0	4	0	0	12
	A	16	24	32	0	0	4	0	76
	Total	19	28	34	0	4	4	0	**89**

Table 8.13 **Total percentage analysis - minus the coding due to Songs and a Number Jigsaw puzzle**

	% Codes	Sub-categories I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0	1.1	0	0	0	0	0	**1.1**
	P	3.4	3.4	2.2	0	4.5	0	0	**13.5**
	A	18.0	27.0	36.0	0	0	4.5	0	**85.5**
	Total	**21.4**	**31.5**	**38.2**	**0**	**4.5**	**4.5**	**0**	**100.1**

When the coding due to Songs and Jigsaw puzzles are 'taken out', what remains is 89 codes spread over 48 incidents in 21 days. The proportional rate resulting in this case would be $48 \div 21 = 2.28$ incidents per day amongst 18 children, giving a 12 hour proportion of: $2.28 \times 12 \div 2\frac{1}{4} \div 18 =$ **0.68**. This figure is much more in line with some previous rates of numerical utterance, 0.67 for Kirk and Ashley's home data, 0.68 for the council under-5 playgroup.

When the coding, minus that due to Songs and Jigsaw puzzles, is analyzed to determine the quality of the remaining numerical utterance, it is found that the density falls to 89 codes per 48 incidents, giving a rate of **1.85** codes per incident. Again, this is much more in line with that found in the other analyses, (the density being 1.43 codes per incident in the Parent & Child Playgroup, 2.07 in the council Play & Stay playgroup). It may be concluded then that the singing of Songs/Action Nursery Rhymes which contain numerical genre, and the interactive use of a number jigsaw puzzle, *dramatically raises* the level of numerical utterance in this nursery, both in terms of quantity (a possible **0.68** with no (S) or (J), up to **1.05** with (S) & (J)), and quality (a possible **1.85** with no (S) or (J) up to **3.13** with (S) & (J)).

The total coding analysis indicates that a very high proportion of the numerical utterance in this nursery falls within the A- sub-divisional grouping, suggesting a high level of adult mediated numerical utterance. The 92% in the A sub-division is much higher than the other under-5 playgroups, (47.6% in the council under-5 playgroup, 76.7% in the Parent & Child under-5 playgroup, 76.9% in the pilot study) and much higher than in the case of Kirk and Ashley's home data (45.1%). The high percentage does not even fall after the (S) & (J) forms of activity are eliminated, it still remains high, at 85.5%, in that case. This high rate of A- sub-division categories however is not simply due to 'extra' input by the staff, since the no (S) & (J) episode quantity (0.68) or quality (1.85) is not markedly different from the previous studies.

The high A- Sub-category percentage may possibly be due to less 'performance' (the presence of P- sub-categories) by the children attending the nursery. There are 18 codings in the P- sub-division over 75 incidents, a rate of **0.24** per incident, which is even lower than the Parent & Child playgroup where there were 7 P-codes per 21 incidents, a rate of 0.33; and very low compared to the council Play & Stay playgroup which had 59 P- codings for 61 incidents, a rate of 0.97 per incident; and in the case of Kirk and Ashley's home data 48.2% of 2.52 codes per incident were P- sub-categories, or 1.21 per incident. The levels of child number 'performance', the P- sub-divisional categories, number being used in the presence of social others, may be related to a child's application of their social appropriation of number use, in which case it may be surmised that Kirk and Ashley appear to have readily appropriated number for they appear to readily apply its use in their play. However in this particular under-5 drop-in nursery, children do not appear to be using number in their play (with the exception of one 4-year old girl, Kaye, to whom the majority of the P-codings may be attributed).

This lack of number use by the children in the presence of social others (0.24 per incident) may be partly due to their insufficient social appropriation of the possible applications of number in their play, and it may be surmised that this situation could lead be a first step along the road towards a lack of confidence in using number later on in life. This apparent absence amongst children of number appropriation may also be substantiated by the very low level of S- sub-divisional categories, a mere 0.4%.

This analysis of an inner city drop-in nursery appears to show that many of the young children have yet to step along the road towards confident demonstration of their appropriation of number uses. However, the children do appear to be receiving considerable adult assistance to achieve their own 'performance' involving the application of the use of number in play. The inclusion of a daily diet of action nursery rhymes involving numerical utterance, and substantial interactive assistance in their efforts to complete a number jigsaw puzzle results in the children receiving higher than average levels of mediation of number through numerical utterance, both in terms of quality and quantity, (even more than in the home case of Kirk and Ashley).

From a social constructivist perspective, this high level of numerical utterance, imparted mainly by the adult staff (92% A-), would be expected to influence the developmental rate of the young children's appropriation of number, in terms of utterance and its use in play, and spur the children's self-confidence in their practices of number use. Development would only be acknowledged to have taken place if the analyses later demonstrate a rise in the performance of numerical utterance within P- or S- sub-divisional categories.

From the total coding analysis, it can be determined that the first three sub-categories, I, II, & III, account for 72.3% of the total numerical utterances, this is a percentage quite in line with previous cases (73.3% in the Parent & Child playgroup, 75.7% in the council under-5 playgroup).

However, in the present analysis it should be noted that, for the first time, the sub-category II is the most frequent, and once again this principly due to the presence of Songs (S) and Jigsaw puzzle (J) forms of activity. When these are discounted, as is shown in table 8.11, then category III reappears as the most frequent category (although the total of the three sub-categories then become slightly distorted, accounting for 91.1% of the total in that case).

In the total coding analysis, the category V also appears to be distorted in terms of representation due to the (S) & (J) forms of activity. It is usually in the range ~10% ± 5%, but it appears to account for 25.2% of the total utterance in this drop-in nursery, yet when the (S) & (J) forms of activity are removed, sub-category V reverts to a more 'normal' level, although low, at 4.5% (compared to 5.6% in the council under-5 playgroup). Once again, the influence of the (S) & (J) forms of activity, and in particular the interactive use of a number jigsaw puzzle, appears to positively influence the mediational practices of number in this drop-in nursery. Children may be expected to socially appropriate 'number figure' recognition from this high level of numerical utterance associated with the construction of the number jigsaw, which is mainly concentrated in the interactive A- sub-division. The (S) & (J) are all useful practices that are initiated by adults, they lead young children to become interactively involved with number utterance and activity, and other children attending under-5 nurseries/playgroups could benefit from such practices.

It is not just the presence of counting books and number jigsaw puzzles, but the rhetorical-responsive adult 'reading' of counting books, and the rhetorical-responsive 'doing' of number puzzles, that will *lead* young children to appropriate aspects of number, they all involve *the use of numerical utterance* and will encourage numerical utterance performance among young children:

> The children are brought up to perform these actions, to use these words as they do so, and to react in this way to the words of others
>
> (Wittgenstein, 1953, p4).

8.15 NUMERICAL UTTERANCE IN A PRIMARY SCHOOL UNDER-5 NURSERY CLASS

This chapter on the extent of socially mediated numerical utterance in formal under-5 social institutions such as playgroups and drop-in nurseries will be completed by analysing the numerical utterance that takes place within a primary school nursery class.

As has already been outlined in chapter 4, the primary school that was selected readily offered research access to its nursery class due to the fact that Kirk had began to attend this class, and I as a parent was 'known'. The school was set in an inner city borough of London, and the children came from a rich variety of ethnic backgrounds. The nursery admitted pupils from the age of 3 and they remained in the nursery until they began the reception class at age 5 years. The 3-year old children attended either a morning or an afternoon session, whereas the 4-year old children attended both the morning and afternoon sessions. There were two classrooms joined together and the 3- and 4-year old boys and girls mixed freely. There were normally two nursery teachers and a nursery assistant in the class.

The nature of the research was explained to the headmistress and the principle nursery teacher. Permission to video record the morning session was granted for a short period of three weeks so that it did not disrupt normal classroom activity. The period was sufficient to capture the nature and form of the numerical utterance that took place in the nursery, since much of what happened during the three week period appeared to be standard routine. I attended two days per week.

Each day the teachers set out both classrooms with a range of activities related to a weekly 'theme', but invariably there was always a play-dough table, a constructional toy table, a puzzles table, painting easels, a drawing/writing table, a craft table usually set out with coloured paper/shapes & glue, there was also a selection of 'educational' toys related to number and alphabet letters, and there was a computer.

The computer appeared to be programmed and used mainly for the purpose of enhancing children's number skills, and it was to become a principal source of the numerical utterance observed in this nursery class. The children's use of the computer was not restricted, they were free to use it whenever they wished, and not all of their computer activity was supervised. Those children who were novices to the computer programme, mainly the younger children, were 'tutored', sometimes by the teachers, but mostly by the nursery assistant. No child ever appeared to use the computer against their wishes, it always appeared that it was the child who asked for the computer to be switched on, or requested to play with it.

Children were entirely free to engage in any activity set up within the two classrooms, and the nursery teachers and their assistant spent their time interacting with different children at different tables. The nursery began at 9 am, and the children 'played' with various activities until 10.30, at which time the children would all sit together on a floor mat, and then the principle nursery teacher would speak to the children about the weekly theme. The children had a milk break between 11.00 and 11.30, during which time they could play outside with various outdoor equipment, climbing frames, tricycles, balls, sand-bin, etc. (their play outside was always under the supervision of a teacher). At 11.30 the children gathered indoors again to listen to a story. The children separated into two groups, one in each classroom, and each teacher would read the children a story from a book. The children were always involved by the teachers in the stories through rhetorical-responsive interaction, usually the children participated by answering the teacher's questions, or by telling a story of their own.

At 12.45 the morning session ended. It was usual for the 4-year old children to eat their lunch together, set out on tables inside the nursery class, and the setting out of the tables with chairs, table mats and cutlery, to match the daily number of children eating lunch, was a duty carried out by a few of the children, on a volunteer basis, during the milk-break under *the watchful guidance of the nursery assistant.*

The examples taken from the video transcripts indicate the extent and nature of the numerical interaction that was observed. The total coded utterance is listed in Appendix D5, together with specific examples.

8.16 ANALYSIS OF THE TOTAL NUMERICAL UTTERANCE IN A PRIMARY SCHOOL NURSERY CLASS

The total coded utterance is listed in Appendix D5, and is collated in the following tables, 8.14 and 8.15

TOTAL CODING (V) NUMBER ANALYSIS

Table 8.14

Sub-categories

No. of Codes 280		I	II	III	IV	V	VI	VII	Total
Sub-Division	S	1	10	0	3	4	0	0	**18**
	P	1	20	13	7	10	5	0	**56**
	A	3	69	64	10	45	11	4	**206**
TOTAL		**5**	**99**	**77**	**20**	**59**	**16**	**4**	**280**

TOTAL CODING (V) PERCENTAGE ANALYSIS

Table 8.15

Sub-categories

% Codes		I	II	III	IV	V	VI	VII	Total
Sub-Division	S	0.4	3.6	0	1.1	1.4	0	0	**6.5**
	P	0.4	7.1	4.6	2.5	3.6	1.8	0	**20.0**
	A	1.1	24.6	22.9	3.6	16.1	3.9	1.4	**73.6**
TOTAL		**1.9**	**35.3**	**27.5**	**7.2**	**21.1**	**5.7**	**1.4**	**100.1**

8.17 DISCUSSION OF THE RESULTS FROM THE PRIMARY SCHOOL NURSERY CLASS

There were 8 incidents that could be directly attributed to researcher presence and these have been discounted in the total analyses (see Appendix D5).

There were 47 incidents involving the use of numerical utterance over a period of 6 days, producing a rate of 7.83 per day, and it quickly became apparent that the primary school nursery classroom was a rich source of numerical talk. The incidents occurred over a 2¾ hour period during the morning session, and were spread among 20 children. The 12 hourly proportional measure per child is calculated as being: $7.83 \times 12 \div 2\frac{3}{4} \div 20 = \mathbf{1.71}$, a comparatively high figure relative to the other studies. In the Parent & Child preschool playgroup, the rate was only 0.23, it was 0.68 for the council under-5 Play & Stay, 0.67 for Kirk & Ashley's home data, and 1.05 for the drop-in nursery. This primary school nursery class proportional rate is much higher than the others, indicating that a large quantity of numerical utterance was taking place in that institutional class.

To determine the richness of the quality of that numerical talk, the coding density revealed that there were 280 codes spread among the 47 incidents, producing a rate of **5.96** codes per incident. Once again this figure is extraordinarily high, it compares extremely well in relation to the drop-in nursery with 3.13 codes per incident, the council Play & Stay playgroup with a rate of 2.07, and with Kirk & Ashley's home data which had a rate of 2.51 codes per incident.

This primary school classroom was not only rich in the quantity of numerical utterance, but it was also rich in the quality of that utterance. Here was an institution that apparently provided its young nursery pupils with a comparatively wealthy source of rhetorical-responsive numerical utterance from which they could appropriate numerical meaning.

It should be noted that the source of much of this rich numerical discourse occurred during the children's interaction with an adult, often a teacher/nursery assistant providing tutorial guidance in the operation of various computer number game programmes. The computer was the central focus of much of the counting that went on in this classroom, accounting for some 38.3% of the numerical utterance (see table

8.18). Children always appeared to be playing with the computer number games, and usually a teacher or nursery assistant was available to provide assistance. In one instance, the episode dated 22-10-93 and timed at 09.45, involved a single child being tutored for 18 minutes, and it generated 57 codes. It may be surmised that this single episode may have distorted the total episodic quality, but this is not the case, as can be seen from tables 8.16 & 8.17. The computer usage was so central to classroom activity that its use among different children was spread throughout the day, and over days, so that the codings that it generated were not limited to any single case. However, the incident of 22-10-93/09.45 is extreme, and it is worth examining the effects on the total utterance had it never taken place, this is shown in the tables 8.16 & 8.17 (overleaf). Of course the total quantity of numerical episodic utterance would have remained almost the same, excepting 46 instead of 47 incidents. However the quality of the utterance would have dropped to a rate of 223 codes per 46 incidents, a rate of 4.84 instead of the high 5.96, but this 4.84 would have still been higher than all the previous case studies.

It may be seen from a comparison of the actual total percentage coded analysis (Table 8.15 totals), with the hypothetical case where incident 22-10-93/09.45 is excluded (Table 8.17 totals), that the overall effect of this single incident on the total analysis is marginal. The principle effect of the incident 22-10-93/09.45, is to reduce the percentage of P- sub-divisional categories by raising the percentage of adult guided categories.

Table 8. 16 **Total Coded Utterance minus the incident of 22-10-93/ 09.45**

No. of Codes 223		Sub-categories I	II	III	IV	V	VI	VII	Total
Sub-Division	S	1	10	0	3	4	0	0	**18**
	P	1	20	13	7	10	5	0	**56**
	A	3	39	56	10	28	10	3	**149**
TOTAL		**5**	**69**	**69**	**20**	**42**	**15**	**3**	**223**

Total Coded Percentage Analysis minus the case of 22-10-93/ 09.45

Table 8.17

% Codes		Sub-categories I	II	III	IV	V	VI	VII	Total	
Sub-Division	S	0.4	4.5	0	1.3	1.8	0	0	**8.1**	(6.5)
	P	0.4	9.0	5.8	3.1	4.5	2.2	0	**25.1**	(20)
	A	1.3	17.5	25.1	4.5	12.6	4.5	1.3	**66.8**	(73.6)
TOTAL		**2.2**	**30.9**	**30.9**	**9.0**	**18.8**	**6.7**	**1.3**	**100.0**	

Compared to the actual:

from table 8.15	(1.9)	(35.3)	(27.5)	(7.2)	(21.1)	(5.7)	(1.4)	100.1

Having noted the marginal effect on the total analysis by the largest coded incident, it may be safe to assume that the total percentage analysis (Table 8.15), to be fairly representational of the total incidence of numerical utterance in this nursery class. The sub-divisional categories of the total percentage analysis reveals a pattern that seems to reflect the possible existence among some children of a 'yet to be developed' use of number as a cultural tool in their play, this is interpreted from the very low incidence of numerical utterance being performed in the presence of social others, examples of P- sub-divisional categories. The 20% in this nursery is in fact almost similar to the Parent and Child playgroup, where P- sub-divisions formed 23.3% of the total, and where the average age of the children was very low (the majority being two-years old). This 20% contrasts sharply with the home data of Kirk and Ashley, and some of the other home diary studies, where P-sub-divisional categories represented almost half of all numerical utterance; and with the council under-5 Play & Stay where P- codings represented 47.1% of the total numerical utterance.

It was noted that in the privately operated Drop-in Nursery P-codings were rare (forming only 7.7% of the total), the children appeared not to have appropriated its application for use in their play, and in that case it was surmised that the lack of P-sub-divisional codings was possibly due to an absence of adult mediated use of number to any great extent in the childrens' micro-environment. However a more in-depth analysis reveals that this is not the case here, and that in fact the level of P-categories is quite similar to the cases of the council under-5 playgroup, Kirk & Ashley's home data and other home diary studies, and quite distinct from the level in the Private Drop-in Nursery and the Parent and Child playgroup.

It must be borne in mind that in this Primary school nursery, the comparative quantity of numerical utterance is measured to be 1.71, whereas in the Council under-5 playgroup the rate is only 0.68, and for Kirk & Ashley's home data 0.67. If the P- sub-divisional percentages of these rates are evaluated to give a comparative measure of P- sub-divisional category rate, then we see that for this Primary school nursery the rate of P-codes is: 20.0% of 1.71 = **0.342**, and in the case of the Council under-5 Playgroup: 47.1% of 0.68 = **0.320**, and Kirk & Ashley's home data: 48.2% of 0.67 = **0.323**. Whereas the Private Drop-in Nursery has a P-code rating occurrence of only: 7.7% of 1.05 = 0.081, and the Parent & Child Playgroup: 23.3% of 0.23 = 0.054.

It can be clearly seen then, that the children attending this Primary school nursery class do perform their number skills to others to the same extent as Kirk & Ashley at home, and to the same extent as children attending the Council under-5 Playgroup. In fact, the Primary school nursery class comes out slightly ahead of both of these two cases; and the children attending this Primary school Nursery are in quite a different league from children attending the Private Drop-in Nursery and the Parent and Child Playgroup.

The relatively high percentage of S- sub-divisional categories (6.5%) confirms that many children in this nursery appear to have appropriated number for their own use (quite unlike the children attending the Parent & Child playgroup who displayed 0% in the S sub-division). This 6.5% percentage of S- codes is very similar to the level displayed by Kirk & Ashley in their home data, which was 6.6% (based upon 1573 codes); and also quite similar to the level measured in the council under-5 Playgroup, which was 5.6%. Once again these three studies all show similar measures of sub-divisional numerical performance on the part of the children, whereas in the Private Drop-in Nursery and in the Parent & Child Playgroup, the P- sub-divisional totals and code rating were very low, and it can also be seen that their S- sub-divisional categories are extremely low, 0.4% and 0% respectively. *Children's appropriation of number for their own use, appears to filter through from A- to P- to S- sub-divisional categories.*

An inspection of Table 8.15 shows that in this nursery class there is a surprisingly low level of number recitation (1.9%), involving number string utterance for its own sake. Most number utterance appears to be functional, especially in the form of one-to-one correspondence counting, cardinal use and number figure reading/recognition. The low level of number utterance may be due to the presence of more structured forms of play, and greater control over the children's play on the part of teachers. Number string utterance in the other studies has been noted to mainly occur during casual free play, possibly involving jumping, sliding down a chute, or throwing a paper aeroplane into the air. This lack of casual free play in the primary school classroom has probably caused this low number recitation percentage.

The high percentage of one-to-one correspondence counting, which forms 35.3% of the total, and number figure reading/recognition is partially explained by the extensive use of the computer in the nursery. Children were encouraged to count objects displayed on the computer monitor, and recognize the number figures printed on the keys of the computer keyboard, indeed children often counted along the row of number keys until they reached the figure that they were required to press.

The use of the computer also completely explains the unusually high percentage of the IV sub-category, subitization or number estimation, resulting from rhetorical-responsive utterance interaction during an angle estimation programme. Also, the presence of category VII, utterance associated with number sums, is mostly accounted for by the extensive use of the computer (when a programme was being run that involved the addition of two sets of items). This category VII is present only in the adult mediated A- sub-division, and the teacher/nursery assistant always vocalized the sum for the child.

Both categories IV and VII are rare, and usually non-existent, in the other nursery/playgroups studied. The use of the computer in this nursery classroom appears to engage young children in the use of aspects of number that are normally deemed 'beyond' their developmental stage. The computer has enabled the children attending this nursery class to appropriate and practise *the use* for numerical utterance associated with subitization and number sums.

It has already been noted that the focus for much of the number discourse in this nursery appeared during instructive interaction with the computer. The full tabulation of the Forms of Activity now includes a computer category, a category that was not present in the previous analyses. The tabulated forms of activity shows that general conversation involving numerical language was an important source from which children experienced, and possibly appropriated, the use of number language. The drawing of candles for a Diwali decoration often gave rise to one-to-one correspondence counting, this is reflected in the high (D) category.

Table 8.18 FORMS OF ACTIVITY

	No. of incidence	**% occurrence**
Craft activity (CA);	0	0
Model making or constructions (M);	0	0
Jigsaw puzzles (J);	0	0
Songs or action sequences (S);	0	0
Casual play (CP);	1	2.1
Games and structured play (G);	2	4.3
Deliberate counting (DC);	3	6.4
Stories, books and pictures (SB);	4	8.5
Adult numerical comment (AC)	4	8.5
Drawing or painting (D)	5	10.6
Conversations involving quantitative language (C)	10	21.3
Computer Activity (CMP)	18	38.3

8.18 CHAPTER SUMMARY

The various studies of different under-5 playgroups and nurseries has provided an insight into the extent of the use of number language by adults to young children, and by children to themselves and others in their play. The picture sketched appears to be consistent with previous research, especially that by Munn & Schaffer (1993). Numerical activity involving mediated language use appears to be a rare occurrence in under-5 playgroups and nurseries, often no more than a few incidents per day spread among up to 20 children, and the incidents usually involve a brief numerical comment by a child or adult, often lasting only a minute or less.

The rate of occurrence (per child per 12 hour period) may or may not be more than home, depending upon the playgroup or nursery in question. Two of the case studies, the Private Drop-in Nursery (1.05) and the Primary School nursery class (1.71) indicated a relatively higher rate of mediated numerical utterance compared to Kirk & Ashley's home rate (0.67), and the Council Play & Stay Playgroup indicated almost an identical rate of occurrence (0.68), but the Parent and Child Playgroup showed up a much poorer rate of mediated numerical utterance (0.23).

The *average* rate of incidence of numerical utterance between all the Playgroups and nurseries studied (with the exception of the pilot study whose data was too limited to consider), is **0.92** incidents per child per 12 hour period, notably a rate that is higher than Kirk & Ashley's home rate, and higher than the home rates determined from the parental diary studies.

In terms of the quality of the mediated numerical interaction taking place in under-5 playgroups and nurseries, once again this depends upon the particular playgroup or nursery. The relative coding density rate provides a comparative measure of the quality of the numerical mediation, and in the case of the Primary school nursery this rate was 5.96, the Private Drop-in nursery was rated 3.13, the council Play & Stay Playgroup 2.07, and the Parent and Child Playgroup 1.43. These quality rates may be compared to that of Kirk and Ashley's home rate of 2.56, and once again it can be seen that two of the playgroups/nurseries are providing a higher quality of mediated numerical utterance than the home case study, and the two others are providing a lower quality of mediated numerical utterance.

The overall average density of coding, between all the playgroups/nurseries, reflecting the average quality of numerical utterance, is **3.15** codes per incident, a rate that is also higher than the parental home diary study average quality rate, 2.10.

If young children appropriate numerical meaning from mediated numerical utterance, then both the quantity and quality of that numerical utterance are important indicators of the social contribution of others to children's possible appropriation of number use. The term 'Mediated Numerical Utterance Momentum' (MNUM) may be coined to express the product of the frequency quantity (**F1**) and the frequency quality (**F2**) of mediated numerical utterance. Such a measure offers the possibility of gauging the relative contribution of a micro-environment to a child's appropriation of number through mediated numerical utterance. The calculations of Mediated Numerical Utterance Momentum for the Playgroups/nurseries studied are listed together in a league table 8.19, together with the value for the home case study of Kirk and Ashley, and the hypothetical average pre-school playgroup/nursery.

Table 8.19

Playgroup/Nursery	**F1 × F2**	**MNUM**
Primary School Nursery	5.96 × 1.71	**10.19**
Private Drop-in Nursery	3.13 × 1.05	**3.29**
Average Playgroup/nursery	3.15 × 0.92	**2.90**
Kirk & Ashley at Home	2.56 × 0.67	**1.72**
Council under-5 Playgroup	2.07 × 0.68	**1.41**
Parent & Child Playgroup	1.43 × 0.23	**0.33**

This league table clearly shows that the Primary school nursery class studied appeared to be providing the best opportunity for young children to appropriate number through interactive numerical utterance. It also shows that the Parent and Child playgroup studied did not appear to be providing the best possible micro-environment from which young children could appropriate number through mediated utterance, the rate being well below that of the home case study. However, it should also be noted that there were far more 4-year old children in the Primary school nursery class as compared to the Parent & Child playgroup.

When the total utterance from all the pre-school playgroups/nurseries are combined to evaluate the percentage occurrence within each of the three sub-divisions and the seven sub-categories, an average picture of the nature of mediated numerical utterance is developed.

The average percentage of ***S***-codes, self-regulated numerical utterance by the child, is very low **3.2%**; and the average ***P***-codes, performance for social others is **24.5%**. However, the average percentage of ***A***-codes, adult assisted, guided or instructive numerical utterance, developed in interaction, is much higher than the other two mediational sub-divisions, **72.5%** (and this is quite consistent with Munn & Schaffer's (1993) measure of 78% for children's interaction with literacy/numeracy events). The average sub-divisional mediational figures are shown in tables 8.20 and 8.21 overleaf. These average percentage totals displayed in table 8.21 give an indication of the overall nature of the mediated numerical utterance in pre-school playgroups and nurseries.

Table 8.20

Sub-Division % S-codes	I	II	III	IV	V	VI	VII	Total
				Sub-categories				
Council under-5	1.6	1.6	0	0.8	1.6	0	0	5.6
Parent & Child	0	0	0	0	0	0	0	0
Private Drop-in	0	0.4	0	0	0	0	0	0.4
Primary nursery	0.4	3.6	0	1.1	1.4	0	0	6.5
Total	2.0	5.6	0	1.9	3.0	0	0	12.5
Average % S-codes	**0.5**	**1.4**	**0**	**0.5**	**0.8**	**0**	**0**	**3.2**

Sub-Division % P-codes	I	II	III	IV	V	VI	VII	Total
				Sub-categories				
Council under-5	7.9	10.6	14.3	6.3	3.2	4.8	0	47.1
Parent & Child	10.0	0	10.0	0	0	3.3	0	23.3
Private Drop-in	2.1	1.7	1.3	0	2.6	0	0	7.7
Primary nursery	0.4	7.1	4.6	2.5	3.6	1.8	0	20.0
Total	20.4	19.4	30.2	8.8	9.4	9.9	0	98.1
Average % P-codes	**5.1**	**4.9**	**7.6**	**2.2**	**2.4**	**2.5**	**0**	**24.5**

Sub-Division % A-codes	I	II	III	IV	V	VI	VII	Total
				Sub-categories				
Council under-5	14.3	8.7	16.7	0	0.8	7.1	0	47.6
Parent & Child	3.3	20.0	30.0	0	16.7	6.7	0	76.7
Private Drop-in	14.0	26.8	26.0	0	22.6	2.6	0	92.0
Primary nursery	1.1	24.6	22.9	3.6	16.1	3.9	1.4	73.6
Total	32.7	80.1	95.6	3.6	56.2	20.3	1.4	289.9
Average % A-codes	**8.2**	**20.0**	**23.9**	**0.9**	**14.1**	**5.1**	**0.4**	**72.5**

Table 8. 21 Total Average Percentage Coded Utterance from Playgroups/nurseries

Average % of Codes		Sub-categories I	II	III	IV	V	VI	VII	Total
	S	0.5	1.4	0	0.5	0.8	0	0	**3.1**
Sub-Division	P	5.1	4.9	7.6	2.2	2.4	2.5	0	**24.5**
	A	8.2	20.0	23.9	0.9	14.1	5.1	0.4	**72.5**
% TOTAL		**13.8**	**26.3**	**31.5**	**3.6**	**17.3**	**7.6**	**0.4**	**100.1**

The spread of the numerical utterance in pre-school playgroups/nurseries throughout the seven sub-categories is very similar in percentage quantity to the home case of *Kirk and Ashley*, with the exception of category *VII*, number sums.

Kirk and Ashley's mediated numerical utterance at home produced the following pattern:

	Sub-categories I	II	III	IV	V	VI	VII
% of Codes	**13.6**	**18.8**	**31.7**	**5.1**	**13.2**	**9.5**	**8.0**

It appears from the data that number sums are almost never mediated to young children in under-5 preschool playgroups/nurseries (see tables 8.20 and 8.21). Where this category does feature, which is only in the primary school nursery class, it appears in the adult assisted A- sub-division (most of Kirk and Ashley's category VII appeared also in the A- sub-division). It is hardly surprising then that young children are not skilled in their performance of number sums, for they appear to receive so little assistance in terms of numerical utterance associated with number sums from their playgroup/nursery micro-environments (0.4% on average).

With the exception then of the coded category VII, this study of pre-school playgroups and nurseries has produced average results that are reasonably consistent with the Chapter 5 home study of the nature and extent of socially mediated numerical utterance.

The forms of activity which appear to be associated with incidence of numerical utterance are shown below in table 8.22.

Table 8.22 **FORMS OF ACTIVITY**

	Average % numerical utterance occurrence				
	Playgroup/nursery				%
	D2	**D3**	**D4**	**D5**	
Craft activity (CA);	0	1.6	0	0	**0.4**
Model making or constructions (M);	0	3.3	5.3	0	**2.2**
Jigsaw puzzles (J);	0	0	16.0	0	**4.0**
Stories, books and pictures (SB);	0	0	9.3	8.5	**4.5**
Drawing or painting (D)	9.5	0	0	10.6	**5.0**
Songs or action sequences (S);	0	0	21.3	0	**5.3**
Deliberate counting (DC);	14.3	4.9	12.0	6.4	**9.4**
Computer Activity (CMP)	0	0	0	38.3	**9.6**
Games and structured play (G);	9.5	27.9	0	4.3	**10.4**
Casual play (CP);	23.8	9.8	8.0	2.1	**10.9**
Adult numerical comment (AC)	19.0	24.6	18.7	8.5	**17.7**
Conversations involving quantitative language (C);	23.8	21.3	9.3	21.3	**18.9**

From this averaged out list of forms of activity in which numerical utterance occurred, it can be clearly seen that, 'Conversations involving quantitative language' and 'Adult numerical comment', together account for more than a third of the total occurrence of mediated numerical utterance in the pre-school playgroups and nurseries studied. This is a clear indication that an appropriation of number by young children is being supported through adult led rhetorical-responsive social communication, and young childrens' numerical meanings are being dialogically developed through social communication.

8.19 CHAPTER CONCLUSION

This research supports the findings of Munn & Schaffer (1993), which have already been discussed, when they concluded that the numerical experiences of young children were infrequent:

> The most striking feature of the frequency data was the relative scarcity of numeracy experiences in all ten nurseries;

and

> highly context-dependent and related to adult input
>
> (Munn & Schaffer, 1993, p76).

The quantity and quality of numerical utterance varied from playgroup to playgroup, and from nursery to nursery, but appeared to be on average 0.92 incidents per child per 12 hour period, with an average coding density of 3.15 per incident. Both of these measured average rates are higher than the home case study.

In pre-school environments, the numerical utterance that takes place appears to be very much dependent upon the nature of the Forms of Activity. In the Private Drop-in nursery a number jigsaw puzzle appeared to be a major source of interactive numerical discussion, often involving number figure recognition, whereas in the Primary School Nursery the computer was the focus of much of the numerical talk. The absence of a focal activity involving number use appears to result in a low measure of numerical utterance, as was the case in the Parent and Child playgroup. The Forms of Activity taxonomy also suggests that adults contribute extensively to young children's interactions with number language, with 'adult numerical comment' and 'conversations involving numerical language' being the principle sources of young children's interactions with numerical utterance.

The prominence of the quantity of numerical utterance present in 'adult comment' and 'conversations involving numerical language' supports Munn & Shaffer's findings concerning the importance of adult input. The infrequency of numerical utterance, and hence numerical mediated activity, however must be qualified. This infrequency of mediated numerical utterance in nurseries takes place at often no less a rate than that of the home, and in some cases the rate may be more than home.

The data presented in this chapter also leads to the conclusion that the Primary school nursery classroom studied provided young children with a micro-environment rich in rhetorical-responsive numerical utterance, and this contrasted sharply with the Parent & Child Playgroup studied, which did not appear to be providing a micro-environment that was adequately rich in rhetorical-responsive numerical utterance.

CHAPTER 9

NURSERY TEACHER INTERVIEWS

NURSERY TEACHER INTERVIEWS

9.1 Introduction

> Arithmetic performance - that is, number manipulation - can be assured if children are guided in their building of an adequate arithmetic vocabulary. The teaching of arithmetic has more in common with the teaching of reading than many teachers realize (Steiss & Baxter, 1943, p128).

It has been noted from the conclusion to the last chapter that a primary school nursery appeared to have the greatest influence in terms of both the quality and quantity of linguistically structured mediation of numerical meaning to a young child, but the possibility of this being a general conclusion needs to be backed up by further research.

One aspect of nursery school mediation that has not yet been considered is that the contextual nature of number use in the school may be different from number use in the context of home, or daily life. Aubrey (1993, p30) recognizes this difference in 'number learning' at school:

> The implication of this for school learning are that since the child's mathematical knowledge cannot be separated from the situations in which it was acquired, mathematics will need to be embedded in the context of known situations and authentic activities.

Therefore, if a comparison is to be made between home and nursery school mediational practices, then the nature of the 'mediation' of number to young children in school needs to be investigated further to note the similarities and the differences. The research already presented in this thesis, would tend to suggest that young children may be expected to display a wide range of numerical competencies on entry to primary school, due entirely to social mediational influences and the development of situated cognition. Aubrey (1993), has investigated the mathematical knowledge and numerical competencies which young children bring into school, and she has noted from her research that such knowledge and competencies do indeed vary widely from child to child. Aubrey (1993) also recognizes the contribution of young children's social world to the development of their numerical cognition:

> thinking about and knowing mathematics for young children is built up through transactions within the physical and social world (Aubrey, 1993, p30).

Aubrey (1993), tested the mathematical knowledge of 16 young children in a primary school reception class through the administration of pre-designed mathematical tasks. In Aubrey's research, the apparent recitational ability of the sixteen young children was noted to be widespread: five children could recite up to ten, five children between 11 and 20, one child between 21 and 30, three children between 31 and 40, one child between 51 and 60, and one child between 101 and 110. In tasks that required the young children to add or subtract, Aubrey (1993, p36) reports:

> For simple addition, five children gained 10 out of 10, five gained five or six, four gained two or three, and two gained nil. For subtraction, eight gained a total of nine out of nine, one gained eight. Four gained five or six, one gained three and two gained nil

The addition and subtraction competencies then of young children appear to be already differentiated in reception. The question that must be asked is, "Why?", and the answer may be sought in the interactive socio-historical experience of the child during pre-school years. The research in this thesis has already demonstrated that for different children, the interactions in which aspects of number culture are socially mediated are different, both in quantity and quality.

In Aubrey's (1993) research, the four children who recited the number sequence to the greatest extent (101, 59, 40, 39) also scored highly on the other task assessments involving number and algebra tests, including number figure recognition and counting one number forwards and backwards. Aubrey also noted that:

> Other children, who showed a low attainment across the number tests, seemed to be still in a stage of transition from early pattern recognition for numbers up to six, to rational object counting, and showed competence in operations, such as addition and subtraction and social sharing, with small numbers only. The two non-counters repeatedly gained nil scores for tasks presented
> (Aubrey, 1993, p39).

In her conclusion, Aubrey (1993) notes:

> The high attaining children were well towards mastery of level 1 of the National Mathematics Attainment Target 2 for Number on school entry. The low attaining children brought into school a range of informal competencies and a less stable, conventional knowledge (Aubrey, 1993, p39).

Aubrey (1994), has pursued further research into the teaching and learning of mathematics in reception classrooms. In Aubrey's (1994) research, she examined the mathematical competencies that 48 young children brought into the reception classes of four schools, two infant and two primary schools. The mean age of her subjects were 4 yrs 4 months.

In terms of number recitation, the young children's abilities ranged from 1 to 4, and from 1 to 70, with a mean sequence length of 16; 48% of children recited within the range of 11-20, 31% within the range of 1-10, and 15% within the range of 21-30; one child recited to 40, one to 45, and one to 70.

The findings in Aubrey's (1994) study also revealed that the number and mathematical skills of all the young children were developed to a different extent: 50% of the children were able to count both 3 and 7 toy animals that had been set out in a line and in a circle, another 21% of children succeeded in counting the 3 and 7 toy animals either in a line or a circle, 21% succeeded in counting 3 animals only, and 8% had nil scores. Aubrey (1994, p112), reports:

> For reading randomly presented numerals (1-10, 12, 15 and 27), scores were again spread ...... There was no pattern associated with the particular numbers being recognized.

As part her research, Aubrey (1994) conducted four reception teacher interviews, and although her interviews were unstructured, there was usually some reference to pre-school number experience. From the teacher interviews, Aubrey noted that:

> With respect to pre-school experience, for children who had attended nursery school, nursery records were available. None of the four teachers mentioned making use of the information in the records as a basis for the planning of their reception class curriculum. Neither was consultation with parents mentioned
> (Aubrey, 1994, p113).

Aubrey's research would appear to suggest that nursery/reception class teachers impose a number curriculum on young children that does not fully take into account the already developed numerical skills of young children, nor the numerical mediative practices of caregivers at home. In the conclusion to her 1994 study, Aubrey writes:

> Perhaps one of the most challenging findings from the study was the diversity of knowledge, competence and strategies both across mathematical areas and across children involved, and the sheer amount of time required to access this. In order for such rich material to be made available to the busy classroom teacher, parents and pre-school personnel might need to be closely involved, both in supplying existing information and taking part in the assessment carried out (Aubrey,C. 1994, p114).

Young children only 'live' part of their day in the context of the school, therefore children may be expected to contextually appropriate aspects of 'school number' use more slowly. It is in this respect that communication between caregivers and nursery teachers is important (and which Aubrey (1994) has noted is absent), to ensure that young children are supported in any transfer from the home use of number (developed in the company of caregivers), to number use in school activities.

It seems likely that if a child is lacking in any aspect of number from social micro-environmental interaction, then that child may be completely dependant upon the school teacher to initiate the mediation of that aspect of number, and in the absence of direct teacher mediation, the child's numerical development may be stunted. This is also evident from some of the parental interviews and diary studies, where parents did indicate that they expected certain aspects of number, especially number figure recognition, to be a mediated activity of 'school number' rather than mediated at home. Yet from the teacher interviews, the mediation of number figure recognition did not appear to feature highly on the school curriculum, teachers were far more concerned about children developing aspects of number through 'hands on activities'. In this regard, Aubrey (1993) hints that a more instructive pedagogy should be considered in reception classrooms:

> Thus it may be equally important for more advanced procedures to be directly taught. Cockcroft (1982) noted that children do not benefit enough from teacher exposition related to mathematical content (Aubrey, 1993, p40).

The main finding of Aubrey's (1993;1994) research is that the school curriculum often takes no account of a child's pre-school number competencies:

> The demonstration of such early competencies poses challenges to the conventional reception class curriculum which follows a sequence of sorting, matching and classifying, joining and separating of sets, counting and ordering, recognizing and writing numbers 0-10, where simple mathematical relationships may be demonstrated through the use of concrete material, and topics such as measurement, shape and pictorial representation run alongside. Whilst they may not possess the formal conventions for representing it, reception-age children clearly enter school having already acquired much of this mathematical content (Aubrey, 1993, p39).

In order to investigate further the impact that nursery teachers, operating with number in the context of school use, may have on the social mediation of number to young children, six nursery teachers were interviewed about their views on young children's development of number skills and the mediating practices which they put into effect in their classrooms. These interviews were intended to shed light on three things:

1) Nursery teachers expectations of the role of caregivers in assisting young children to develop number skills;
2) Whether or not the practice of mediating numerical meaning in nursery classrooms is similar or different to the mediated practices of caregivers;
3) The different extent to which young children's numerical skills are already developed prior to entering a primary school nursery class.

9.2 <u>Methodology</u>

A semi-structured interview schedule was pre-prepared to ensure a degree of uniformity during each interview, and to aid the recording of the results of the interviews. The semi-structured interview schedule consisted of a series of thirteen questions (the schedule is displayed in Appendix E).

Each of the six nursery teachers interviewed, all female, were assured of complete confidentiality in regard to their interview answers. Teachers were interviewed off school premises during a period of INSET, they were all interviewed on a voluntary basis, in private, and on a one-to-one basis. All six interviews were audio recorded and a summary of the interviews are presented in Appendix E.

9.3 ANALYSIS AND DISCUSSION

Even although the interview sample is small (but larger than Aubrey's), there are some very striking consistencies in numerical beliefs, practices and expectations.

First of all it may be inferred from the teachers' interview statements that the learning of number involved both practices at home as well as at school, and that one without the other, would result in a stunted or skewed development. Teacher 5 clearly acknowledges that a partnership between home and school is important to assist young children to transfer their already developed number skills to the contextual use of number in school.

Although each teacher's expectations of the contribution of caregivers to a child's numerical development varied, they were all unanimous in saying that a caregiver could mediate aspects of number to a young child just as effectively as a teacher could. In the view of the teachers' that were interviewed, the caregiver had more 'time', they could readily interact on a one-to-one basis, and they could be expected to be more sensitive to the child's current needs in terms of number mediation. This implies that they hold a view of learning that is either not practised in the classroom, or difficult to practice; and this is confirmed when they all independently say that caregivers and teachers, *'each have something different to offer'*. In other words, all these nursery teachers believe that they are offering young children a different type of *'learning experience'* concerning aspects of number, compared to that which they would have received at the hands of their caregivers. All this would suggest that nursery teachers hold a view of school 'number learning' that is different from home 'number learning'. This is borne out by some of the nursery classroom practices of number.

Whereas, at home, aspects of number tend to be mediated through daily routine, classroom practices are often artificially instigated, and often make use of 'materials' and resources that are not available (or never used) at home. Nursery classroom practices of number then, are acknowledged by nursery teachers to be *'different'* from children's home practices. In regard to the curriculum content of 'number work' that takes place in a reception class, Aubrey (1994, p114) reported that from her interviews with reception class teachers:

> All teachers claimed to plan integrated topic work and stressed the importance of play, flexibility and choice of activity. All stressed sorting and matching and counting, and the development of measurement language through the use of sand and water play, constructional activity and 2-D and 3-D shapes.

This certainly does appear to be different from home. In all of the home studies, not one parent ever indicated that they mediated aspects of number to their child through 'water', 'sand', 'bead-threading', 'hands on activities', or 2-D & 3-D shapes, and very few involved their children in number puzzles (2.5% of parents interviewed). Whereas 85% of parents (see chapter 7) said that they mediated aspects of number through the use of counting books, not one teacher in the six interviews mentioned this! (nor did the four teachers interviewed in Aubrey's (1994) research). Caregivers often used nursery rhymes (87.5%) to mediate aspects of the number sequence, but only one teacher in six (16.7%) indicated this as a resource. The use of money did not appear to feature in classroom practices, yet this is a very common practice at home, and to paraphrase Greenberg (1994), 'children love playing with money'.

The numerical practices reported to take place in the nursery classroom appear to contrast sharply with young children's home practices of number, and they also contrast sharply with common historical practices. The following is an account of how aspects of number use were mediated to nursery children prior to the adoption of Piagetian theory concerning how young children come to 'understand' number:

> We began with the known (supposedly). We looked for numbers, first our house numbers, then numbers on the street, on and on, until we had discovered Arabic numbers on:
>
> clocks scales typewriters rulers ash-cans pages houses
> buses phone-books schools carriers bombs order-sheets
> file-cards badges electric-signs trophies bikes etc.
>
> Many children became aware of numbers for the first time in their lives. Numbers were our 'friends'. We discovered them in stories - 'The Three Little Bears'; in songs - 'The Little Indians', 'Sing a Song of Sixpence'; in poems and nursery rhymes - 'Baa, Baa, Black Sheep', 'Simple Simon', 'Half-way up'; in our own bank books, in recipes, in games, in stories. We learned what it meant to be the first or second in line in contrast to the first or last. We used a 'number language'. For instance, we raised the shade on the 'fourth' window or passed papers in the 'second' row (Steiss & Baxter, 1943, p116).

This historical practice of numeracy in the nursery classroom appears to have far more in common with home practices than present day nursery classroom practices.

In the case of a young child at home, number recitation is a feature of play, and it is often subconsciously incorporated into play by caregivers and others (even by nursery nurses), eg. while children jump on a trampoline, or slide down a chute, or while children play Hide-and-Seek; and counting practices appear to take place regularly at home, eg. packing away toys, eating sausages and chips, biscuits or sandwiches, even getting dressed - counting buttons on shirt, badges on jumper, ribbons in hair, sweets, or reading number figures on a remote control panel etc.. But these number skills by a child will not feature in any school assessment of 'number competence' (often nursery schools employ the Keele Pre-school Assessment guide commercially produced by NFER-Nelson). The assessment procedures that are utilised in nursery school to measure young children's 'number competence' are commonly based upon number 'understanding' practices pertaining to 'school activities', and these may be contextually strange to both parents and children. Nursery teacher 4 clearly indicated that she did not favour number recitation and counting practices in the classroom as means by which young children may 'learn' about number, and teacher 6 indicated that the abstract manipulation of number for children was difficult and ineffective (and therefore to be avoided?).

Drawing on their experience, most nursery teachers did not explicitly link young children's number development and their language development, although many teachers intuitively suspected the possibility of there being a link, especially when the children were very young. The nursery teachers interviewed did not appear to consider language an important developmental tool in respect of a child's development of number skill.

Throughout their interview rhetoric, all of the nursery teachers appeared to acknowledge 'motor activity' on the part of children as being important for number development, implying that the child's individual experience was important, and not the experience of others, teachers or adults. To quote teacher 3, number is a skill that is "guided by experience", and for teacher 2, "each child was getting something different from the activities", and for teacher 1, who viewed the content of young children's play as being mathematical, "play is meaningful". Despite their Piagetian founded rhetoric concerning the individual and staged development of number in young children (beginning with motor activity), the majority of teachers appeared to envy the caregiver's position, which has already been shown to fit in with Vygotskian theory concerning psychological learning. Caregivers tend to lead and instruct young children through social interaction, matching number use with language use.

It may be noted that in the interview with teacher 1, her interview rhetoric indicated that she invited the children to discuss their play experiences, suggesting a child-centred Piagetian psychological approach. The teacher did not say that she discussed the child's experiences with the child, which would have been a Vygotskian approach, where the adult leads the child through language, to appropriate the language associated with the experience. However, the Piagetian psychological rhetoric of teacher 1 appears to be mismatched with her actual practice. She does appear to practice the social interaction that is so fundamental to Vygotskian theory, since her concluding remarks concerning what produces effective number learning are, "sensitive to what the child is finding out", and when, "the teacher intervenes at the right moment". These remarks appear to indicate that she attempts to work with the children in a 'zone of proximal development', and so acknowledging that the child's learning requires adult intervention and sensitivity to the child's present experiential appropriations (a Vygotskian perspective). In the case of teacher 3, she also appears to be working in a 'zone of proximal development' with children, since she indicated that during children's activities, she "draws out number". Teacher 3, is thus *leading* children to appropriate aspects of number through social interaction involving language use. Teacher 3 indicates that the presence of the adult teacher is the most vital ingredient in the development of young children's numerical skills, saying that the "teacher needs to point out the 'purpose'; the reason 'why' ", and for both teachers 5 and 6, the verbal usage of number in the nursery classroom is seen as an effective means by which young children appropriate number meaning. Thus, some nursery teachers appear to have experientially developed the insight of Steiss & Baxter (which is summed up in a quote at the beginning of this chapter).

Despite much of their acquired learning theory dogma, and rhetoric, the Piagetian based school practices are seeped in adult guidance, assistance, interpretation and instruction, all supplemented and augmented by home practices that are similarly framed. These interview statements by nursery teachers would suggest that, despite the constraints of their classrooms in terms of numbers of children and time, the nursery teachers intuitively recognize the importance of adult interaction in the classroom to mediate aspects of number. In other words, nursery teachers conform to Vygotskian theory, while using Piagetian rhetoric.

Nursery teacher expectations of young children in terms of already acquired number skills appears to be very similar in range and extent to that of caregivers (chapter 7), normally: the ability to recite up to twenty; count in one-to-one correspondence between ten and twenty; understand the meaning of small cardinal number labels; and recognize printed number figures up to '10'. These already acquired number skills by young children were unanimously acknowledged, by the nursery teachers interviewed, to vary from child to child. In addition, all of the nursery teachers interviewed indicated that on entry to nursery school, young children displayed a *wide range* of number skill ability, one nursery teacher classified her experiential observation with the expression, "a very wide range". The results of these interviews with nursery teachers appears to be in line with the research findings by Aubrey (1993;1994). The numerical skills that young children bring into the school classroom are often very varied from a developmental point of view, and nursery teachers are well aware of these differences. Aubrey (1994) notes that reception teachers sooner or later begin to group children in terms of numerical skill to fit in with school plans for a number curriculum. There can be no doubt that the numerical skills that young children bring into school with them plays a role in influencing any teacher decision on grouping, and hence the individual child's progression through the number curriculum. This may set a pattern for the young children in terms of future numerical development within the context of school. If nursery teachers begin to recognize individual differences in young children's already developed ability in the use of number, and begin grouping at age 5-years old, then it comes as no surprise that numerical skill is often seen from an individual developmental viewpoint. Individual development also appears to be entrenched and compounded by teacher rhetoric and school practices. Yet, if we look deeper, into the home and micro-environmental influences (see chapters 5, 6, 7 and 8), then we see that it is the numerical practices of others, including nursery teachers which interests, supports, leads and develops individual children's numerical practices, and which in time, through the effect of linguistic social interaction on the child's psyche, leads to a self-regulation of number by the child (Vološinov, 1973).

9.4 CHAPTER SUMMARY and CONCLUSION

These observations by nursery teachers would appear to confirm the conclusions drawn from the research on home mediated practices of number, that young children are subjected to a numerical apprenticeship, albeit a different numerical apprenticeship. In the earlier chapters it has been shown that caregivers have different expectations for their young children in terms of number skill development, some mediate number figures intentionally, but some do not (although they may still do this unintentionally). Some caregivers expect their young children to 'pick-up' aspects of number use, others consider it a 'school subject', and they consequently do not often mediate aspects of number, possibly less than two minutes per day, or only on somedays. Other caregivers have high expectations of their children's number skills, eg. reciting up to one hundred, one-to-one correspondence counting beyond twenty etc., and these caregivers spend time deliberately mediating aspects of number to their children during interactive play. Consequently, it is hardly surprising that some young children appear to start nursery school either better prepared, or worse, than other young children.

The research outlined in the past few chapters appears to indicate that caregiver's expectations of their children in terms of number skill development are usually met by their children, and the teacher interviews indicate that these expectations of the caregivers' tend to match the expectations of the nursery teachers. However, the research in previous chapters also shows that there is probably a small minority of caregivers who do not intentionally mediate aspects of number to their children to the standards expected by nursery teachers.

It is the caregiver mediation of number, which acts as the social psychological seed of number appropriation. It is that psychological seed, which may have either been fully, satisfactorily, or inadequately nourished by caregiver social interaction, which the individual child brings into school. The child does not bring him/herself as an individual psychological being, but brings measures of social appropriation, human otherness. It is the number appropriation dimension of that social otherness, which either meets teacher/school expectations and enables the child to participate in aspects of school number work, or fails to meet teacher/school expectations and subsequently the child may struggle to come to terms with school number work.

A child's numerical developmental pattern in school appears to be pre-programmed right from the start of nursery, through the rhetorical-responsive mediation of number during social interaction in their home/pre-school micro-environment.

The nursery teachers interviewed gave the impression that by acknowledging the role that caregivers played in the development of number skills in young children, they could, in return, expect caregivers to support school practices with home practices. There is a hint in the teacher interviews that nursery teachers are not able to spend too much time mediating aspects of number by interacting on a one-to-one basis during young children's nursery play. It would appear that school practices are possibly designed with the intention that young children may be able to appropriate aspects of number for themselves in the absence of teacher/adult mediation. In this respect, Piagetian learning theory or individual discovery learning (the child as a scientist idea) suits school practices which are more constrained in terms of teacher/adult interaction than home.

It has been noted that the mediation of number at school often takes place in isolation from the home mediation of number, since the use and situational nature of number appears to be different in school classrooms. At nursery school, young children are introduced to the use of number in a different context, in different sorts of activities from home. Resnick (1987, p15) makes the point that:

> The process of schooling seems to encourage the idea that the 'game of school' is to learn symbolic rules of various kinds, that there is not supposed to be much continuity between what one knows outside school and what one learns in school.

It appears that on entry to nursery school young children begin to take part in parallel mediational practices of numerical skill in two separate contextual domains, home and school, and not a unified domain through partnership. Aubrey (1994) has noted that teachers do not usually consult parents or pre-school records in their preparations for extending young children's number skills.

The rhetoric of nursery teachers concerning school mediational practices appear to imply that they rely on the child's efforts (child-centred approaches) to appropriate number from interactions with aspects of the physical world, through various activities that are set out in classrooms, eg. water, sand, constructional activities etc.; whereas at home, parents or caregivers appear to initiate aspects of numerical mediation, through social interaction involving linguistic communication with a child (in earlier chapters in this research it has been shown that 64.2% of numerical interactions in homes appears to be adult initiated). The nature of mediational practices at home and nursery school therefore appear to be different. Children appear to begin a 2nd numerical apprenticeship at nursery school, one that relies much more on their own performance and less on the adult led rhetorical-responsive mediation by others. In effect, nursery teachers appear to be saying that they hand over to the child, much of the responsibility for their own numerical mediation and appropriation.

However, much of what was said in the interviews may have been nursery teachers regurgitating the educational rhetoric that they are expected to use, eg. 'child-centred' rhetoric. According to those same nursery teachers, many of the effective practices of numeracy in the nursery classes appeared to depend upon the teachers' participation in mediating the aspects of number that may be interpreted from the children's activities. Teacher 3 indicated that young children's number skills are often best developed through activity in which the purpose is made explicit, where the reason 'why' is clear to the child, and "if the teacher points this out"; and in the opinion of teacher 4, young children's numerical skills are best developed through an adult being involved in a child's interests, through using different resources to practice "counting in lots of different ways". While accepting the responsibility for mediating aspects of number to young children, one of the nursery teachers interviewed thought that caregivers were the chief educators of pre-school children, and that they should 'teach' their young children aspects of number, "since it is usually accepted as a caregiver responsibility"; but, "the onus is not on parents", for a child's success at school.

The research here would appear to suggest that in fact the 'onus' is on parents and social others for a child's numerical success at school, since success may not depend on the 'cognitive development' of the individual child, but on the adult mediation that appears to lead development. Further research on the mediating role of parents, and social others, in connection with a child's appropriation of number use in the context of school use may shed more light on exactly where the 'onus' does lie (with the teacher or school activities?, or with parents and social others?).

CHAPTER 10

THESIS SUMMARY & CONCLUSION

10.1 THESIS SUMMARY

The research in this thesis has been interpreted from a social constructivist (Ernest, 1991) view of early number development. The social constructivist view was developed from the philosophies of Marx and Wittgenstein, from the psychology of Vygotsky, and from the linguistic theory concerning the structuring of thought in the individual through social rhetorical-responsive communication as has been suggested by Vološinov/Bakhtin, and Shotter. The social constructivist perspective that was developed has indicated that a young child's psychological development of number meaning does depend upon the child's social interactive appropriation of the language associated with cultural number use. Individual numerical appropriation was seen to be socially mediated by others and intrapsychologically structured by the child through social language use. The child's development of number was seen as a social appropriation, a development from social interactive participation in number language use. The development of number in a child was not viewed from an individual or cognitive maturational perspective, but it was being taken as axiomatic that the development of numerical meaning in a child stemmed from the social usages of number, and that meaning was mediated in a rhetorical-responsive manner to the individual child through linguistic interaction. The development of numerical skill by the child was seen to lie in the mediational practices of social others, and was therefore viewed as an enculturational development and not an individual cognitive development, a social accomplishment, and not an individual mental accomplishment. Young children were seen to be involved in a numerical apprenticeship with social others, and the development of their numerical skills depended upon situational practices, where number use and number language use could be meaningfully associated with one another.

Working from within this social constructivist theoretical framework, a programme of 'thick' ethnographic research was instigated, involving the triangulation of data from different sources, so that any possible socio-historical development of number use by young children, and mediated use by social others (caregivers) to young children, could be monitored. The research methodology was firmly grounded in social practice, and was expected to shed light on any possible rhetorical-responsive relationship between the child's use of number language and the mediated use by a social other. If the child's numerical development did appear to take place through social interactional practices that were linguistically framed in a rhetorical-responsive manner, then numerical mediation would appear to be supported or initiated by social environmental factors.

A 20 month long detailed case study of mediated numerical interaction and number use in the researcher's home was carried out by employing both a diary study methodology and a video-recording methodology. Six other case studies of young children appropriating aspects of number use in their own homes were investigated through parental diary studies. Forty parents were interviewed about their young children's number developments, the expected developments, and the parent's/child's numerical mediational practices at home. Bearing in mind that the home micro-environment may not be the total of a child's interactions with socially mediated number use, the numerical interactions of young children at five pre-school playgroups and nurseries were monitored for mediational practices, a video-recording technique was again used. Interviews with six nursery teachers were also carried out to determine their views and expectations of pre-school caregiver mediated practices of number to a child in relation to the child's development of numerical appropriations at school. Both the home case studies research data and the pre-school nurseries data was interpreted in terms of the nature of the mediational practices and the aspects of number mediated. A theoretically framed two dimensional coded analysis was developed and used in the interpretations. The mediational practice codes took account of three possible situations in which number use is socially situated and linguistically mediated:

1) an ***S***- sub-division: (Self-mediation or self-regulation), where number utterance was being used by a child, and the utterance appeared to be directed to the child's self.

2) a ***P***- sub-division: (Performance-mediation for a social other present, a listener, a possible commenter), where number utterance was being used by a child, and the rhetoric was intended to communicate numerical meaning, possibly to a social other present, without active participation of the other in any way other than listener.

3) an ***A***- sub-division: (Adult-mediation or other-regulation), where number utterance was being actively used by an adult to assist, guide, instruct or correct a child in

numerical meaning, or where an adult or social other questioningly prompted, causally coerced, or situationally created, numerical utterance to/from a child.

These three sub-divisional mediational categories were derived from considerations of Vygotskian theory concerning psychological development from the social to the individual, and are related to the four levels of inter-intra psychological transfer between external regulation by social others and self-regulation outlined by Wertsch (1979).

Analysis of the numerical utterances was also achieved by considering the nature of the number use in the mediational sub-divisions. From the data gathered during the case study of Kirk and Ashley (see chapter 5) it was readily apparent that all of their numerical utterances could be classified into one of seven sub-categories of number use. These seven sub-categories were:

I - number string recitation; **II** - one-to-one correspondence counting;
III - cardinal labelling; **IV** - number subitization;
V - number figure recognition;
VI - number labelling; **VII** - number sums/divisions/multiples

The mediated numerical utterances arising in the course of social interaction in homes and in pre-school playgroups/nurseries among young children were then analyzed in terms of mediational occurrence in the coded sub-divisions and the nature of number use according to the sub-category classification. The *quantity* and the *quality* of number mediational practices were also determined from temporal and density considerations of coding occurrence. Comparisons were made between the occurrence of numerical mediation in different homes and in different pre-school playgroups/nurseries, and between homes and pre-school playgroups/nurseries.
Forms of activity in which number use featured in a mediational capacity were also determined from the analyses of observations of pre-school playgroups/nurseries, and from parental/nursery teacher interviews.
Briefly, the research findings may be summarized by reviewing the analyses of the 5 sources of data:

1) Analysis of the 20 month home data case study of Kirk and Ashley revealed that they participated in mediated numerical interaction at a mean rate of 0.67 incidents per 12hr period, and that the quality of that interaction could be represented in terms of 2.51 numerical codes per incident. The broad spectrum of that coded interaction was sub-divisional represented in S-codes by 6.6%; P-codes by 48.2%; A-codes by 45.1%. Analysis of the aspects of number use, represented by the sub-categories produced the following spectrum:

code	I	II	III	IV	V	VI	VII
%	13.6	18.8	31.7	5.1	13.2	9.5	8.0

A socio-historical analysis was carried out by dividing the accumulated data into four quarters and analysing the data in each quarter to note any gradual progression. No overall sub-divisional progression was conclusively detected, there was a slight hint of decrease in A- codes and an increase in P-codes. The mean quarterly sub-division rates were: S-codes 5.9% (σ 1.9); P-codes 50.2% (σ 4.8); A-codes 44.0% (σ 3.0). A more detailed socio-historical analysis of the separate sub-categories of number use in each sub-division did indicate some socio-historical progression. In the S-codes, which accounted for the smallest percentages, some aspects of the self-regulated use of number were quite constant, eg.

cardinal labelling:

quarter	1st	2nd	3rd	4th
%	0.7	0.7	0.8	0.7

In the P-codes, the socio-historical analysis revealed a gradual increase in the Kirk & Ashley's performance of number sums/divisions/multiples, sub-category VII:

number sums:

quarter	1st	2nd	3rd	4th
%	0	1.1	2.3	3.7

In the P-codes, a more rapid increase in number figure recognition was detected:

number figure recognition:

quarter	1st	2nd	3rd	4th
%	2.8	4.6	4.2	8.7

Also in the P-codes, an increase in the practice of number subitization appeared to be taking place:

number subitization: quarter	1st	2nd	3rd	4th
%	1.4	1.1	2.3	3.0

Practices of number recitation appeared to occur haphazardly, they did not appear to be constant, nor did the analysis show increase or decrease. On the other hand one-to-one correspondence counting practices involving P-codes appeared to haphazardly increase.

While Kirk & Ashley's performance in number sums begins to increase in the P- sub-division, the socio-historical analysis of the A-codes indicated the adult or social other also appeared to increase their quantity of mediation related to number sums:

A-codes,	quarter	1st	2nd	3rd	4th
number sums:	%	0	1.1	7.7	7.2

A similar pattern was also noted with cardinal labelling, while Kirk & Ashley's performance of cardinal labelling utterance appeared to decrease in terms of P-codes over the four quarters, a decrease in the Adult/social other mediation of cardinal labelling also appeared to take place (but this decrease may be superficial, it may be linked to the increase in the percentage representation of number figure recognition, number subitization, and number sums):

P-codes,	quarter	1st	2nd	3rd	4th
cardinal labelling:	%	20.7	15.7	15.9	12.4

A-codes,	quarter	1st	2nd	3rd	4th
cardinal labelling:	%	22.1	15.3	16.9	10.7

No other quarterly trends in the adult/social other mediation of the use of number utterance, in relation to the seven sub-categories of number outlined, was detected. The adult/social other mediation in each of the other seven sub-categories appeared to be less well defined, and appeared to be reasonably constant in proportion to each other over the quarterly periods. In each of the seven sub-categories, the proportion of adult/social other mediation (A-codes), to the child performance (P-codes) also appeared to be well balanced over the four quarters, suggesting that much of what was taking place in terms of number mediation was a constant feature of Kirk & Ashley's social interactions.

2) In order to find out if the case study of Kirk & Ashley's numerical interactions at home were similar to other children's, six diary studies of other children were carried out with the cooperation of their parents. Although not all of these diary studies provided a rich source of data on which to base an interpretive judgement, some did, but more so, they gave an indication of how caregiver perceptions of number 'use' translates into child accomplishment 'expectations'; and notions of use and expectations then enter into the child's numerical apprenticeship. It emerged that some parents appeared to spend more time than others in mediating aspects of number to their children, they interpreted the 'use' of number from a variety of different sources, and at the same time they were implicitly conveying to their young children parental social 'expectation' of the child's number use. One mother did not appear to mediate aspects of number to her child as often as the others in the diary studies, or as often as in the case of Kirk & Ashley. However, in terms of the quantity and quality of numerical mediation most of the diary studies produced rates that were reasonably consistent with the rates in the case study of Kirk & Ashley:

Diary study case	B1	B2	B3	B4	B5	B6
quantity (incidents per 12hrs)	0.54	0.58	-	0.63	0.13	0.75
quality (codes per incident)	1.80	1.64	-	2.42	2.1	2.36

The mean quantity rate was 0.53, compared to 0.67 for Kirk & Ashley, and the mean quality rate was 2.1, compared to 2.51 for Kirk and Ashley.

Two of the diary studies produced very similar sub-divisional coding distributions to that of the case study of Kirk & Ashley: a relatively balanced distribution between A- and P- sub-divisions around 44-49% and a low percentage of S-codes. In the four other diary studies, adult/social other mediation occurred more frequently than child performance in the presence of social others, but this may be partly explained by over zealousness on the part of parents. Overall, the rate of adult/social other mediation (A-codes), appeared to account for 64.2% of all numerical mediation.

In all of the diary studies, the levels of S-codes, self mediation or self-regulation of number usage was very low, always under 10%, the mean rate was 5.2%, and this was consistent with the case study of Kirk & Ashley who had a mean rate of 6.6% mediation through S-codes.

In terms of the mediated sub-categories of number, the diary studies were also generally consistent with the home case study of Kirk & Ashley. Although all of the diary studies demonstrated that young children's micro-environments provide them with varying rates of quantity and quality of numerical interaction related to their social experiences of number use, generally the aspects of number that were mediated were proportionally similar. The mean figures produced in most of the categories from the home diary studies (see table 6.17) would suggest that the figures resulting from the detailed home study of Kirk & Ashley are not unusual, but may reflect a normal pattern of numerical mediation for a child. A direct comparison is show in the table below:

Total Percentages	I	II	III	IV	V	VI	VII
Mean diary study	11.9	22.0	29.4	2.9	16.4	15.1	3.0
σ	9.9	9.5	8.8	1.6	10.9	11.5	3.8
Kirk & Ashley	13.6	18.8	31.7	5.1	13.2	9.5	8.0

The differing percentages among the various sub-categories of number in the diary studies suggests that parents mediate aspects of number to a different extent during number interaction with their children. Cardinal labelling (III) is the most common (mean 29.4%) closely followed by one-to-one correspondence counting (II) (mean 22.0%). Number recitation (I) does not appear to be a prominent sub-category, however, for some parents number figure recognition (V) appears to be important (the high standard deviation indicates that this aspect of number was not important for all parents). Where it does occur in the diary case studies, in four of the cases, it often appears to be more important than in the home case study of Kirk & Ashley, and number figure reading/recognition in these cases was two-thirds concentrated in the A- sub-division (just as are approximately 64.2% of all mediated numerical interactions). It is important to note that two of the parents appeared not to mediate number figure reading/recognition to any significantly measurable extent, and when this was not mediated by parents it did not feature in the child's P sub-division either. In one case the 0% in the A sub-division for number figure recognition was mirrored by 0% in the P sub-division, and in the other case 3.7% in the A sub-division still produced 0% in the P sub-division. This pattern is also true of number labelling, sub-category VI. It was shown that there was a wide disparity in the percentages associated with number labelling, and once again this was directly attributed to the extent of adult mediational practices. The comparative analysis of the categories of aspects of number in the home diary studies indicated that parents do not readily mediate number sums/divisions or multiples to young children, nor do they find it easy to involve their young children in number subitization.

3) The six diary studies were followed up by interviewing a wider cohort of parents about their child's numerical skills and their mediational practices at home.

The interviews clearly indicated that caregivers do spend time socially mediating aspects of the cultural uses of number to young children, however this time is variable, it may vary from less than 2 minutes some days to 20 minutes everyday. When the child is less than 2-years old, the time spent by a caregiver mediating aspects of number is at its shortest, but the mediational time does not necessarily increase with a child's age, it varies from caregiver to caregiver and appears to be tied up with caregiver expectations.

Young children's number skills appear to emerge around the age of 2-years old, and by that time most caregivers will have spent a considerable period of time socially mediating aspects of number through talk. Caregivers first concentrate on mediating number recitation, one-to-one correspondence counting and cardinal labelling, all using small numbers. Caregivers tend to mediate aspects of number through interaction in the child's play, by encouraging the children to participate in singing nursery rhymes involving number strings, counting fingers, and on many occasions reading/interpreting counting books to their children. During the period 2-4 years of age, a child tends to master the recitational order of the first twenty number words, with adult mediational assistance, and the child is usually reported to be able to count in one-to-one correspondence with small numbers up to ten+, as well as cardinally label these quantities. A child may also be able to recognize some printed number figures, since many of the 2-4 year olds are being 'tutored' in number figure recognition, usually from counting books, but also from printed figures on aspects of their social world, eg. toy & real telephones, other numerically labelled toys, remote control panels, house numbers, bus numbers, car registration digits etc.

Young children appear to continue receiving caregiver mediation in aspects of number during the age period 2-4 years, but the mediational role tends to subside after the caregiver senses that the child has reached 'expectations'. The numerical skills expected by most parents of pre-school children were achieved, or appeared to be achievable by their children, during the period 3-4 years of age. It appeared that when a child had accomplished a degree of number skill that the caregiver expected the child to achieve, the child tended to take over the responsibility for initiating numerical mediational practice. The interviews suggested that the social development of young children's numerical skills initially lay with the caregiver, all caregivers appeared to accept the responsibility for the development of their young children's number skills and most appeared to take pride in their child's accomplishments. However, a few caregivers did give the impression that they were not overly concerned about assisting their child to appropriate aspects of number use, and not surprisingly, their children were not well accomplished in number. This was particularly true especially of number figure recognition. Many parent abdicated responsibility for mediating number figure recognition until their child was older, and for some caregivers this responsibility was seen to lie mainly with the school.

In general, the interviews supported the findings of the diary studies, the quantity and the quality of caregiver mediation appeared to vary, and the young children's already developed numerical skills also varied, both appeared to be tied to caregiver expectations.

An analysis the home activities through which aspects of number were said to be socially mediated to young children, produced a taxonomy which indicated that the seven most important activities were:

songs/verses/rhymes	87.5% of caregivers
counting books	85%
play/bricks/toys	82.5%
up/down stairs	80%
finger counting	75%
other body parts	67.5%
money discussions	65%

4) In order to find out if a child's mediation of number at home by caregivers was being supplemented by other social micro-environmental interaction, a detailed study of pre-school playgroups/nurseries was carried out. Young children's social interactions in five pre-school playgroups/nurseries was video-recorded and all the transcriptions pertaining to numerical interaction/mediation were analyzed by coding them into mediative sub-divisions and aspects of number, as was the case for all the other analyses so that comparisons could be drawn. The pilot study initially revealed that a low incidence of numerical mediation through social interaction should be expected in a pre-school setting, and this suggested that prolonged periods would be required to amass sufficient data.

An analysis of the various pre-school settings revealed that in fact the quantity and quality of interactive numerical mediation occurrence varied from setting to setting, and that it was often no less than the home rates, and could be higher. Excepting the pilot study, where the data was insufficient to generalize, the four other settings had the following quantity and quality rates:

pre-school setting:	D2	D3	D4	D5	mean
quantity (incidents per 12hrs)	0.68	0.23	1.05	1.71	0.92
quality (codes per incident)	2.07	1.43	3.13	5.96	3.15

These quantity and quality rates may be compared to the home case study of Kirk & Ashley and the home diary rates, which are indicated above in sections 1 and 2 respectively. In the D3 pre-school setting the quantity and quality rates appear to be below the home rates, in the D2 pre-school setting the calculated rates were comparable to home, whereas in the settings D4 and D5 the rates appear to be higher than home. The pre-school setting D5 was in fact a primary school nursery class, and it appears to be approximately *three times as rich in both quantity and quality of* mediated numerical interaction compared to an average home (0.53 incidents per 12hrs, 2.1 codes per incident). *Hour for hour, the average pre-school setting appeared to offer the child a higher rate of numerical mediation than the average diary study home.*

In terms of the nature of that sub-divisional mediation, in comparison to some of the home cases, the preschool settings all tended to indicate high percentages of adult/social other mediation, (A-codes) and usually low percentages of child performance (P-codes).

setting	D2	D3	D4	D5
% total P-codes	47.1	23.3	13.5	25.1
% total A-codes	47.6	76.7	85.5	73.6

However, once again, there was variation between the different pre-school settings, and it was noted that these percentage occurrences had to be viewed not as absolute comparative figures, but moderated by considerations of quantity and quality (eg. In the case of setting D3, adult/social other mediation at 76.7% of a quantity rate of 0.23, is less than the adult mediation in setting D2 where a rate at 47.6% of 0.68 was measured, etc.).

Over all the pre-school settings, the mean percentage rate of A-codes was 72.5% compared to the mean home rate which was 64.2%; the mean percentage of P-codes was 24.5% compared to 30.6% at home; and the mean percentage of S-codes was 3.1% compared to 5.2% at home. These figures must be modulated in relation to quantity and quality, and bearing mind that the mean pre-school setting has a quantity rate of 0.92 and a quality rate of 3.13, then it can be seen that in terms of A-coding, 72.5% of 0.92 is far greater than 64.2% of 0.53. It may be surmised from these figures then, that numerical mediation in an average pre-school setting involves more adult mediation than the average home setting. In terms of child performance, the P-codings, 24.5% of 0.92 in an average pre-school setting, is also greater than 30.6% of 0.53 at home. In terms of self-regulation of number by the child, there is no real difference between home and the preschool setting, both are very low, 5.2% of 0.53 compared to 3.1% of 0.92 respectively. All these figures have not taken quality considerations into account, but it may be noted that the mean quality rate of the average pre-school setting was higher than the mean quality rate of a home setting.

In relation to the aspects of number mediated in pre-school settings, when all the three sub-divisional mediation categories are totalled for each pre-school setting, then averaged out, the spectrum produced for aspects of number mediated takes the form below:

Total Average Percentage Coded Utterance from Pre-school Playgroups/nurseries

	Sub-categories						
ALL CODES (S-, P-, & A-)	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
TOTAL %	13.8	26.3	31.5	3.6	17.3	7.6	0.4

This spread of the numerical utterance in pre-school playgroups/nurseries throughout the seven sub-categories is very similar in percentage quantity to the home case study of Kirk and Ashley, and the average diary case study, with the exception of category VII, number sums:

ALL CODES (S-, P-, & A-)	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Mean diary study	11.9	22.0	29.4	2.9	16.4	15.1	3.0
Kirk & Ashley	13.6	18.8	31.7	5.1	13.2	9.5	8.0
Average Pre-school setting	13.8	26.3	31.5	3.6	17.3	7.6	0.4

It would appear from comparing the aspects of number that are mediated at home and in pre-school settings, that they are proportionally very similar, with the exception of number sums, sub-category VII, which seems to be rarely mediated in pre-school settings, despite any allowance being made for the higher quantity and quality rates of some preschool settings.

5) In order to compare young children's apprenticeship in number, through mediational practices of number use at home/pre-school, with nursery school use, the nature of number use in school nurseries was investigated by conducting semi-structured interviews with six nursery teachers. They were questioned about contributional expectations of parents (caregivers) in relation to mediating aspects of number to young children prior to the child's entry into school. The nursery teachers were also questioned about the extent of young children's already developed number skills when they enter school, and about the nature of mediational number practices in their nursery classrooms. All the nursery teachers indicated that a parent or caregiver could mediate aspects of number to a child as easily as a teacher. Nursery teachers' reasons for saying this was usually that the caregiver had more time, and knew the child better. Nursery teachers appeared to value the importance of a close or warm relationship in the mediational process, in other words they appeared to acknowledge that 'affect' impinges upon a child's learning.
Although teachers' did not explicitly link aspects of number appropriation to language use, all nursery teachers indicated that they encouraged and valued social interaction and talk in their classrooms. The interviews suggested that the mediational practices of number in nursery classrooms was different in form from that at home. At home, counting books were commonly used by parents, there was casual one-to-one correspondence counting of toys and household items, and the child practised his/her appropriation of number figures on a variety of items, but at nursery school, the numerical activities appeared to take on a different disguise. The activities in nursery classrooms through which aspects of number were said to be mediated usually involved the child in perceptual motor experience, 'hands on activities'. At nursery school teachers appeared to value a child's individual practical activity with the physical environment as a source of individual development of number, and one

teacher is quoted as saying "they all get something different from the activities". The rhetoric of the nursery teachers appeared to suggest that they valued individual 'child-centred' approaches, which implied that the child's activity interests were seen to lead the child to individual competencies. Nursery teachers tended to view a child's numerical development from an individual perspective, and they all recognized that young children entered nursery school with a wide range of already developed number skills. The individual developmental perspective expressed by the nursery teachers, and apparently practised in their nursery classrooms, suggested that individual development of a child's numerical skills is promoted by the nursery school curriculum. Consequently, the wide gap in young children's already developed number skills on entry to school (which this thesis has suggested is contingent upon home mediational practices) appeared to be further compounded by nursery school numerical mediational practices, and it was surmised that this may lead to a widening of the numerical skill gap amongst young children while at school.

It was also noted from the nursery teacher interviews that their expectations of young children's numerical skills appeared to be in line with those of parents, and that most young children appear to attain these expectations. Prior to formally entering school, most nursery teachers expected young children to be able to recite the number sequence up to twenty, count items in one-to-one correspondence up to ten, determine a cardinal quantity of five, and recognize the first ten number figures. The question of who constructs these expectations of nursery teachers and caregivers could not be answered from this research, but would be a suitable topic for further research on the development of young children's social appropriations of number. It was hypothesised that the 'social expectations' were jointly constructed between parents, teachers and children, to prepare young children for the demands of social numerical intercourse at school.

When asked to consider what was the principle ingredient which might lead young children to appropriate aspects of number, most nursery teachers replied activities that involved practical experience, although they also acknowledged the importance of language in interpreting that practical experience. Nursery teachers also indicated that teacher *intervention* and *sensitivity* to the child's present numerical appropriations were of vital importance.

It emerged from these interviews that while the teachers' rhetoric suggested that they practised a Piagetian based theory (Piaget, 1952) in the classroom, where the importance of individual perceptual motor experience was recognized as a foundational basis for the child's numerical psychological development of number, in fact the rhetoric of Vygotsky would have served them better since they often indicated that they used, and promoted the use of, language (to 'socially regulate' aspects of number meaning/use), while working '*with*' children (possibly in a 'zone of proximal development'). Despite their Piagetian rhetoric, the interviews suggested that nursery teachers were practising a socially based interactive Vygotskian theory of learning, where the numerical knowledge of the child was being linguistically structured by the teacher and appropriated by children during teacher interaction in the children's classroom activities.

10.2 THESIS CONCLUSION

The research methodology that was adopted enabled the data from one source to be 'triangulated' with data from other sources, and this has been important with respect to drawing conclusions from the data analyses. From the triangulated comparisons of data from different sources, intuitive deductions concerning the validity and reliability of mediational practices were also established. The parental interviews appeared to support the diary studies, which in turn supported the video-recorded home case study. The analyses of the pre-school settings that were observed were compared to each other, to the diary studies and the home case study, in order to establish their mediational validity and reliability. The parental interviews and the nursery teacher interviews both established similar expectations in terms of young children's number skills, and the parental diary studies appeared to support the view that young children usually achieved these expectations. Consequently, it may be concluded that this 'thick' ethnography was important to 'triangulate' reliability, validity, and draw conclusions about the quantity and quality of numerical mediational practices.

The rhetorical-responsive research data was analyzed through the use of a two dimensional coding schedule, which was based upon the social constructivist theoretical stance adopted. The coding schedule has been used as a tool to probe the socio-historical development of numerical mediation. This coding schedule probed three observed practices of the social rhetorical-responsive mediation of number related to 'the use - the meaning':

1. Adult/social other practices;
2. Child performances in the presence of adults/social others;
3. Child self-regulative practices

From the application of this coding schedule, it has been shown that the socio-historical development of numerical mediational practices stems from adult/social other led practices to child performances in the presence of adults/social others, and eventually to the child's self-regulated use of number. This progressive development of number 'use-meaning' was observed to occur in several different sub-categories of number usage, and it is concluded that a development of number 'use-meaning' begins with Adult/social other mediational practices. This conclusion is consistent with Vygotskian theory.

The two dimensional coding mechanism has been a powerful tool in unveiling the social-individual relationship between numerical mediational practices. The coded analyses of transcripts of number use by young children suggests that this is a social enculturational practice, an imitative social development, a socio-historical legacy of rhetorical-responsive interaction with others.

The thesis research was expected to provide answers to four questions concerning young children's apprenticeship in number at the hands of social others:

1) Do the mediative practices of parents, nursery teachers or other children act to enable young children to reciprocally self-mediate numerical meaning and produce skilled numerical performances?
2) Are there any discernible relationships between a child's spontaneous use of number language and number skills and the quantity/quality of external mediation concerning numerical matters?
3) Is numerical mediation culturally visible only in the sense that practice is influenced by socio-cultural need and usefulness, and hence laden with socio-cultural value?
4) Can successful numerical mediation be defined? If so, what are its characteristics?

Answer to Question 1:

The first question may be answered from examining the mediative practices of adults in comparison to the socio-historical development of young children's numerical practices. The sub-divisional coding provided some insight to this relationship. The A-codes represented the adult/social other structuration of mediation, whereas the P-codes and S-codes represented the child's spontaneous numerical performances. The P-codes involved the child in self-mediation, but in a practice that may have been for others, not just for the self, as in the case of S-codes. Consequently, both P- and S- codes may be viewed as representing self-mediation by the child.

In the socio-historical analysis of the home case study of Kirk and Ashley, although the overall quarterly analysis only revealed a slight decrease in the proportion of A-codes, and a reciprocally slight increase in the P- and S-codes, the proportion of some individual sub-categories of number use did reveal sub-divisional changes from A- to P- and S- codes. Of particular note was the steadily increase the four quarterly periods in number sums, in number figure recognition, and in number subitization after adult mediation. The fact that there was a steady increase in child practice of these aspects of number use after adult mediation would suggest that adult mediation did act to enable young children to self-mediate aspects of number. Further evidence to support this conclusion comes from the diary studies, and from the parental interviews.

The parental interviews revealed that some parents do not contemplate mediating number figure recognition, and they usually reported that their child was not accomplished in this number skill. In the case of those parents who did admit to mediating number figure recognition, often when the child was around 3-years of age, the parents usually indicated that their child was able to recognize number figures, or they expected their child to recognize number figures during the age period 3-4 years. It may also be noted that most parents did not tend to mediate number sums to their young children, and their children were not accomplished in this number skill.

From the interviews, parents also indicated that they often began mediating the number sequence and one-to-one correspondence counting, in one form or another, to young children from the age of 1-2-years old, and that their children usually developed these number skills a year later. This would certainly suggest that the adult/social other mediation of number, in the form of an apprenticeship relationship, does lead young children to acquire number skills.

Q. 2) Are there any discernible relationships between a child's spontaneous use of number language and number skills and the quantity/quality of external mediation concerning numerical matters?

The answer to this question is related to the last answer, it concerns the quantity/quality relationship of numerical mediation, between the percentage of A-codes and the development of P- & S-codes.

In the socio-historical case study of Kirk & Ashley, it has already been noted that there was a gradual developmental use by Kirk & Ashley, of number sums, number subitization and number recognition, after adult/social other mediation of these aspects of number. Other sources of data also suggested that young children gradually begin to use aspects of number after a period of adult mediation, and that without this mediation the number use by the child does not appear to develop. Under these circumstances, the importance of quantity and quality of adult mediation must be considered to have some bearing on the developmental use by the child.

The research data suggests that rhetorical-responsive numerical mediation does emanate initially from an external source, and that it sensitively drops in quantity/quality in response to an increase in the child's social performances (characterized by a growth in S- & P- sub-divisions) In some of the case studies, the caregivers' appeared to have 'handed over' a certain amount of responsibility to their children for numerical performance, while in some of the case studies it was noted that much of the control for numerical performance still lay in the hands of caregivers.

The parental interviews also suggested that varying rates of quantity and quality of numerical mediational interaction were probably widespread, and young children's accomplishments with number use did appear to be linked to the quantity and quality of numerical mediated interaction by a caregiver.

All the nursery teachers interviewed unanimously indicated that young children enter school with a wide range of already developed number skill, and this has been linked by the teachers to caregiver numerical mediation, where time, affect and sensitivity to the child's present appropriations were deemed to be important. The nursery teacher interviews support the conclusion that there is a discernible relationship between a child's spontaneous use of number and the quantity/quality of external mediation.

Q.3) Is numerical mediation culturally visible only in the sense that practice is influenced by socio-cultural need and usefulness, and hence laden with socio-cultural value?

The research would certainly appear to indicate that numerical need and usefulness are important in determining which aspects of number are socially mediated and individually appropriated. Parents and nursery teachers generally appeared to have the same expectations in terms of the number skills that young children should develop, and the children broadly developed these skills.

The research indicates that the numerical accomplishment of some 3-year olds may not be much different from some 4-year olds, however 4-year old children appeared to be more likely to practice these number skills in a P- or S- sub-division. The usefulness of number in play appeared to develop during the age period 3-4 years old, but often only the older children in the pre-school playgroups practised or performed aspects of number use. The socio-cultural need of number in play for a young child also appeared to develop through interaction with adults or social others. Children playing a jumping game, were noted to 'imitate' other children reciting the number sequence before jumping, a child playing on a trampoline was seen to 'imitate' an adult counting rhythmically with her jumps, and a child has been observed to 'imitate' an adult/social other mediative practice of counting stairs while climbing or descending. Children were also noted to later perform these socio-cultural aspects of number use for themselves or others. The value and usefulness of number to a child appeared to be developed from the value and use of number by social others.

For a young child need and usefulness do appear to be tied up with individual performance of aspects of number. Young children did not appear to have any real need or use for large numbers (just as some primitive tribes have no separate need or usefulness for large numbers (Zaslavsky, 1973), and so being able to recite up to twenty, count in one-to-one correspondence up to ten or beyond, cardinally label using small numbers, and possibly recognize the first ten digits is all that a young child appears to need, and all that is expected of them, in the view of caregivers or nursery teachers. In the case of some caregivers, pre-school children are seen not to need all of these number skills, especially number figure recognition, in which case some of the number skills are not intentionally mediated by the caregivers. It is not surprising then that previous researchers (eg. Durkin et al, 1986; Fuson, 1991; Wynn, 1992; and others) have indicated that young children first appropriate the meaning of, and practice the use of, small numbers, since this is related to their socio-cultural need and use.

Another example of how socio-cultural need and usefulness influences adult mediation and child appropriation of number, is number sums/divisions/multiples. These do not appear to be mediated to young children at home or in pre-school settings, even although young children may have already developed the number skills that would permit these to be carried out. The reason for not mediating number sums to young children may be that it is sensitively perceived by adults that young children have no need to perform number sums/divisions/multiples in their play or daily routine. At nursery school it has been shown that number sums/divisions/multiples are gradually mediated to young children. The socio-cultural context of number use and practice has changed, school makes different demands on young children's number skills, and it appears that they undergo a second numerical apprenticeship, a more intensive and numerically deeper apprenticeship, and differently structured in terms of the activities through which that numerical mediation will be managed.

It is therefore concluded that the mediation and appropriation of number to and by young children is laden with socio-cultural value, the socio-cultural need and usefulness of number is culturally visible.

Q.4) Can successful numerical mediation be defined? If so, what are its characteristics?

The successful mediation of aspects of number may be defined in terms of child practice. The object of any caregiver's or social other's numerical mediation is to enable a child to appropriate numerical meaning through use. Successful mediation is therefore characterized by child appropriation and subsequent useful practice.

It has been shown that numerical mediation appears to take place through adult/social other rhetoric accompanying practical ostensive demonstration (eg.counting stairs while climbing those stairs), and the child is usually expected to respond by imitating that rhetoric in the context of demonstrated use to appropriate meaning. If a child is noted to be practising the social use of number, then it must be assumed that the child has appropriated social 'use-meaning', and successful mediation will have been deemed to have taken place.

Whether the contextual setting was home, or a pre-school playgroup/nursery, successful mediation always appeared to take place when the adult involved her/his self in the child's activities or play, and developing the play situation to mediate aspects of number. For example, when a child was jumping on a trampoline, jumping off a wall or climbing stairs, the adult could successfully introduce number sequence recitation. When a child was playing with dominoes, subitization could be mediated and practised; when the child was being dressed the buttons on a garment may be counted in one-to-one correspondence; when television channels were being switched, number figures could be mediated; consequently all numerical mediation appeared to occur during periods of social interaction. Successful mediation then, may be characterized by rhetorical-responsive interaction with social others.

The characteristics that often appeared to be important to achieve successful mediation were:

a) the child's interest

b) the child's needs

c) adult/social other participation

By triangulating a variety of ethnographic methods, this research has clearly shown that caregivers begin to develop their young child's numerical functioning from a very young age, almost as soon as the child is able to talk, through a variety of mediative practices. The research in this thesis has consistently shown that a child's numerical performances may be linked to the mediated practices of social others. The caregiver plants the social seed of number use in the child, and the caregiver nourishes that seed by leading the child to socially appropriate aspects of number use.

This research has clearly shown that young children are apparently involved with adults in practices of number meaning surrounding social use, demonstrating that a numerical apprenticeship relationship between a caregiver and child does occur. It may be viewed as an apprenticeship that leads the child to acquire cultural number skill through socially mediated *'use-meaning'*, and to quote Wittgenstein (1953, p14, R30):

> So one might say: the ostensive definition explains the use -the meaning- of the word when the overall role of the word in language is clear.

It has also been shown that young children's socially mediated practices of number commonly involve the rhetorical-responsive use of language as a 'tool' in the process of developing numerical meaning through a 'language game'.

The numerical apprenticeship controls, through rhetorical-responsive communication, the mediational situations that may structure what a child will gradually appropriate in terms of number 'use-meaning', and the writings of Bakhtin/Vološinov (1986:1973) would suggest that this use of language, in the form of rhetorical-responsive utterance (Shotter, 1993), may structure the numerical thought of the individual child from a social interpsychological perspective.

The research outlined in this thesis, suggests that social others mediate numerical meaning to young children through social intercourse involving language usage, and this is consistent with Vygotsky's (1978) theory:

> The child does not choose the meaning of his words. He is not free to form complexes at will. The meaning of the words are given to him in his conversations with adults. The child receives all the elements of his complexes in a ready-made form, from the speech of others. .... He only follows the practice already established by adults. In a word, he does not create his own speech, but acquires the speech of adults. The latter fact explains everything, particularly the coincidence between the child's complexes and the concepts of adults. Complexes corresponding to word meanings were never invented by a child, but were found by him in ready-made generalizations and general names
> (Vygotsky, 1986, p122-3);

> What the child can do in cooperation today he can do alone tomorrow. Therefore the only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as at the ripening functions. It remains necessary to determine the lowest threshold at which instruction in, say, arithmetic may begin, since a certain minimal ripeness of functions is required. But we must consider the upper threshold as well; instruction must be oriented toward the future, not the past
> (Vygotsky, 1986, p188-9).

The cognitive development of numerical meaning for young children in this thesis has drawn on the ideas of social constructivist theory, and the interpretations have all been viewed from this perspective. The research in this thesis suggests that a child's numerical functioning is an enculturational process, where a child is *'talked into'* the cultural uses of number through rhetorical-responsive social communication that is structured from within a numerical apprenticeship.

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APPENDIX A

NUMERICAL PRACTICES IN THE HOME: THE CASE STUDY OF KIRK & ASHLEY

Subjects:

(1) Kirk Young (M) born 24/9/90,
age at the start of this study 2-years 4 months
age at the end of this study 4-years 0 months

(2) Ashley Young (M) born 21/8/91,
age at the start of this study 1-year 5 months
age at the end of this study 3-years 1 month

APPENDIX A I

DATE	No.	VIDEO CODES
14-02-93 (V)	(2)	VIP, IIP, IIIP, IIIP, IIP, IP, VIP, VIP VIA, VIA,VIP, VIA, VIA,,VIA
15-02-93 (V)		VIP, VIA
18-02-93 (V)		IIIP
20-02-93 (V)		VIA, VIP, IIIA, IIIA
28-02-93 (V)		IIIA, IIIA, IIIP, IIIA, IIIP, IIA, IIIA, IIP, IIIP, IIIA
04-03-93 (V)	(2)	IIA, IIIA, IIIP, IIIA, IVA, IIIA, IIIA
06-03-93 (V)		IIIP, IIIA
06-03-93 (V)		IIIP, IIIP
06-03-93 (V)		IIIA
14-03-93 (V)		VIA
20-03-93 (V)		IVA, IIIA, IIA, IIIA
11-04-93 (V)		IIIA
12-04-93 (V)	(2)	IP, IS
12-04-93 (V)		IIIP
22-04-93 (V)		IP
01-05-93 (V)	(2)	IIA, IIIA, IP, IIP, VIP
01-05-93 (V)		IVA, IIIA, IA, IP
10-05-93 (V)	(2)	IIIA, IIP, IIA
10-05-93 (V)		VA, VA
12-05-93 (V)		VIA
12-05-93 (V)		IIIA
12-05-93 (V)		IIIP
13-05-93 (V)		IIP, IIIP
14-05-93 (V)		IIIA
14-05-93 (V)		IIIP, IIIP, IIIA, VIA, IIIP, IIIA, VIP, IIIP, VIP, IIIP, IIIA, IIIP
16-05-93 (V)		VS
22-05-93 (V)	(2)	IIIP, IIP, IIIP, IIIA, IP, IIIA
24-05-93 (V)		IIIA, IIA, IIIP, IIIA
28-05-93 (V)	(2)	IIP, IIIP, IP, VP, VA, VA
30-05-93 (V)	(2)	IIS, IIIP, IA, IIIA, IIA, IIA
31-05-93 (V)		VP, VP, VA
01-06-93 (V)		VA
02-06-93 (V)		IS
26-06-93 (V)		IIIA
28-06-93 (V)		IIIS, VS
30-06-93 (V)		IP
03-07-93 (V)	(2)	IP, IA, IP
08-08-93 (V)		VA, IIIP, IP
06-08-93 (V)		VA
08-08-93 (V)		IP
18-08-93 (V)	(2)	IIP, IP, IIIA, IIIA, IS, IS

DATE	No.	VIDEO CODES
19-08-93 (V)		VA
21-08-93 (V)	(2)	VIA, VIA, IA, VIP, IIIP
26-08-93 (V)		IP, VA
26-08-93 (V)		VIA, VA
27-08-93 (V)		VA
28-08-93 (V)	(2)	IP, IIP, IIP,VIP, IIP, IP,IP
12-09-93 (V)		VP, VA, VA
12-09-93 (V)		IIA, IIIP, IP
12-09-93 (V)		IIIA, IIP, IP, IA
12-09-93 (V)	(2)	IIIP, IIIA, IP, IP, IA, IP, IP, IA, IP
16-09-93 (V)	(2)	IIIP
17-09-93 (V)		IP
30-09-93 (V)	(2)	IIIP
23-09-93 (V)		VIP, IP, IIA, IIIA
24-09-93 (V)		IIIP
24-09-93 (V)	(2)	IIA, IIIA, VIA, VIP
03-10-93 (V)		IIIP
03-10-93 (V)		IP
04-10-93 (V)		IIIA, IIIP
04-10-93 (V)		VP, VA
04-10-93 (V)		VA, IIA
08-10-93 (V)		IIIA, VIA
08-10-93 (V)		IIIA
08-10-93 (V)		VIA
09-10-93 (V)		VA
09-10-93 (V)		IP
09-10-93 (V)		VA
10-10-93 (V)	(2)	IIIA
10-10-93 (V)		IP
11-10-93 (V)		IIIP
13-10-93 (V)		IA, IIA, IA, IIA, IIIA, IIA, IA, IA, IIA, IA, IA
19-10-93 (V)		IIIA, IIIP, IIIA
23-10-93 (V)	(2)	IP, IIIA, VP, VA
24-10-93 (V)		IIIP
24-10-93 (V)		VP
22-10-93 (V)		VA, IIIA
23-10-93 (V)		IIIS, IIIP
25-10-93 (V)	(2)	VA, VA, IIIA, IIIA, IP, IIIA, IVP, VA
25-10-93 (V)		IIIA
28-10-93 (V)		VA
28-10-93 (V)		VIA
29-10-93 (V)		VS
30-10-93 (V)	(2)	IIP, IP, IIIP, IP
31-10-93 (V)	(2)	VA
31-10-93 (V)		VA
07-11-93 (V)	(2)	VA, VP, VA, VP, IIIP, IA, VP, IIIA

DATE	No.	VIDEO CODES
10-11-93 (V)		VIA
10-11-93 (V)	(2)	IIIA, IIIP, IIP, IIP, IIIA, IIA, IIIA, IIIA, IA, IIIP, IIIP, IIIP
11-11-93 (V)		IIP
12-11-93 (V)	(2)	IIIA, IIA, IIIA, IIP, IIIP, IIP
12-11-93 (V)	(2)	IIA, IIIA, IP
12-11-93 (V)		IIIP, IIA
13-11-93 (V)	(2)	VIP, VIA, VIP, IIIP
13-11-93 (V)	(2)	VIP, VIP, IIIP, VIP, IP, IP, IIIA
13-11-93 (V)		IIP, IIIP, IIIA, IIIP, IIIA, IIA, IP, IIA, IP, IIIA,IP
14-11-93 (V)	(2)	IIIP, IP, IIIP
15-11-93 (V)	(2)	IIP, IP, IIIP, IP
18-11-93 (V)	(2)	VIP, VA, IIIA, VA
21-11-93 (V)		VP
22-11-93 (V)		VA
23-11-93 (V)		IP, IIP
24-11-93 (V)		VS, VP
24-11-93 (V)		VA
26-11-93 (V)		VIS
06-12-93 (V)		IIIP
27-11-93 (V)		IIIA
07-12-93 (V)		IIIA, VIIP, VIIA
27-11-93 (V)		IIS
28-11-93 (V)	(2)	VP
29-11-93 (V)		VIA
10-12-93 (V)		VIP, IP, VIP
11-12-93 (V)		IIP, IIA, IIIA, IIP, IIA, VP
01-12-93 (V)	(2)	VIP, IIA, IIIA, IIP, VIIP, VIIA, VIA, VIIA, IIIA, IIP, IIA, IIIA, IIP, VIIA, VIA, VIP, VIP
02-12-93 (V)	(2)	IP, VIP
04-12-93 (V)		IIIA, VP
10-12-93 (V)		VIP, IP
12-12-93 (V)	(2)	VP, VIP, VIA, VA
12-12-93 (V)		IP, IP, IIIP
14-12-93 (V)	(2)	IIIA, IIP, IIIP, IIP
14-12-93 (V)		IIA, IIIA, VIP, VP, IIP, IIIP, IP, IIIP, VA, VA, VIA, VA, IIIA, VIIA, IIIA, IP, IIIA, IIIA, VIA, VP
18-12-93 (V)	(2)	IIP, IP, IIIA, IIA, IIIA, VIA
05-01-94 (V)		IIIP, IIP, IIIP, IIIA, IIIP
07-01-94 (V)		VA, IA
08-01-94 (V)	(2)	IIP, IIA, IIIA, IIP, IIP, IIIA, IIA, VA, IA, VP
09-01-94 (V)		VS, IIS
10-01-94 (V)		VIP
10-01-94 (V)		IIIP
12-01-94 (V)	(2)	IIIA, IVA
12-01-94 (V)		VIA, VP
13-01-94 (V)		IA

DATE	No.	VIDEO CODES
13-01-94 (V)		IIIP, IIIA, IIIP
13-01-94 (V)		IIIP, IIP, IIIP
14-01-94 (V)	(2)	VA, VIIP, VP, IVA, IIIA
15-01-94 (V)		VIP
15-01-94 (V)	(2)	VA, IA, VIA, VA, VIA, VA, IIIP
15-01-94 (V)		VA
17-01-94 (V)	(2)	IIIP, VIP, IIP, IIIP
17-01-94 (V)		VP, VIIA, VA, VIIA
17-01-94 (V)		VA, IVP, IIP, IIIP
18-01-94 (V)	(2)	IIIP, VIP, VP, VP, IP, VP, IIIP, VP, VIIP, VP, VIP
18-01-94 (V)		VIP
18-01-94 (V)		IIIA, VIA
19-01-94 (V)	(2)	IS, IIIA, IIIA, VIIA, IIP, IVA, VIIA
20-01-94 (V)		IIIA, IIA, IVA, IVA, IIIA, IIA, IVA, VIIA, IIIA
21-01-94 (V)	(2)	VS, IIS, VA, IA, VA
21-01-94 (V)	(2)	IVA, IIIA, IP, IIIP, IIIA, IIIP, IIIA
21-01-94 (V)		IIIA
24-01-94 (V)	(2)	VIP, IIIA, IVA, VIIA, IIIA, IIIP, IIIP
24-01-94 (V)		VIP
24-01-94 (V)		VS
25-01-94 (V)		IIIA, VA, IA, IIIA
25-01-94 (V)		VA, VIA
25-01-94 (V)		IIIA
25-01-94 (V)		IIIA
26-01-94 (V)		IA, VA, VIIA
27-01-94 (V)		IVA, IVP
08-02-94 (V)	(2)	VA, IVP, IIIA, IVS, VIIS, IIIA, IIIA, IIIA
12-02-94 (V)		VS
13-02-94 (V)		IIIA, IIA, IIIA, IIIA
13-02-94 (V)		VA
14-02-94 (V)		IVA, IVP
14-02-94 (V)	(2)	VIP, VP
14-02-94 (V)	(2)	IIIP
14-02-94 (V)		IVA, VIIA, IIIA, IA, IIA
14-02-94 (V)		IIA, IIP, IA
14-02-94 (V)	(2)	IVA, VA, IVA, IVP, IIIA, IIA, IIA, IVA, VA, IIA, IIIA, IVA, IVA, VA, IIA
14-02-94 (V)		IA
16-02-94 (V)		IIIP, VIA
16-02-94 (V)		VIP
16-02-94 (V)		VA
16-02-94 (V)		IIIP
16-02-94 (V)		VA, IIA, IIIA
16-02-94 (V)		IIIP, IIIA, IIIP
17-02-94 (V)		IVA, VIIA, IIA, VIIA, IIA, VIIA
17-02-94 (V)		IVA, IIIA

DATE	No.	VIDEO CODES
17-02-94 (V)		IIIA
18-02-94 (V)	(2)	IIIP, IIP, VIP, VIP, VIA, IIIP, IIIA, IIP, IIIA, VIIA, IIA, IIIA, VIIA
18-02-94 (V)		IS, IIIA, VIIA, IIA, IA, IIIA
19-02-94 (V)		VS, VIA
20-02-94 (V)		IP
20-02-94 (V)	(2)	IIIA, IP, IIIA, IVA, VIIA, IIA, IIIA, VIIA, IIA, VIIA, VIA
21-02-94 (V)	(2)	VIIA, IIA, IIIA, IIA, IIIA, IIIA
21-02-94 (V)		VA, VA
22-02-94 (V)		VA, IIA, IIIA
25-02-94 (V)	(2)	IIS, IA, IP, IA, IP
25-02-94 (V)		VIA, VIS
25-02-94 (V)		VIA
26-02-94 (V)		VP, VA, IIP, IIIP
26-02-94 (V)		IIIP, IIIA
26-02-94 (V)	(2)	IP, IIIP
28-02-94 (V)		IIIA, IIIA
28-02-94 (V)		IIIA, IIIP, VIIA, IIIA
01-03-94 (V)		IP
02-03-94 (V)		IS
03-03-94 (V)	(2)	IIIP, IIIA, IIP, IIIA
03-03-94 (V)	(2)	IIIP
03-03-94 (V)	(2)	IP, VA, IIIP, VIP, IIIP
03-03-94 (V)	(2)	IS, IIIA, VIA
03-03-94 (V)	(2)	IP, IA, IP, IA
05-03-94 (V)		VS
05-03-94 (V)		IIIP
05-03-94 (V)	(2)	VIP, VIA, VIP
06-03-94 (V)	(2)	VIP, IIIP
06-03-94 (V)	(2)	IIIP, IIIP, IIIP
06-03-94 (V)		IIIS, IVS
06-03-94 (V)		IIP, IP, IIIP
06-03-94 (V)		IIS
06-03-94 (V)		IS
07-03-94 (V)	(2)	IP
08-03-94 (V)	(2)	VIP
08-03-94 (V)		IIIP, IIIA
08-03-94 (V)	(2)	VIA, VP
09-03-94 (V)	(2)	IP, IA
10-03-94 (V)		IIP
09-03-94 (V)		IP
10-03-94 (V)		IIIA, IIA, IIIA, IIA, IA, IIIA, IA, IIA, IA, IIIA
10-03-94 (V)		IIIP
11-03-94 (V)	(2)	IIA, IIP, VIP
11-03-94 (V)		VA
11-03-94 (V)	(2)	VIP

DATE	No.	VIDEO CODES
15-03-94 (V)		VP, VIP
11-03-94 (V)		IIIP
12-03-94 (V)	(2)	IIIP, IIP, IIIP, IIP, IP
12-03-94 (V)	(2)	IIIP, VA, IIIA, IIIA, IIIP, IIIA, IIIA, VIA, IIIA, VIIP, IIIP, IIIP, IIS, IIIS, IIIA, IIIA
12-03-94 (V)		IVA, IIIA, VIIA, IIIP, VIP, IIIP, VIP
12-04-94 (V)		IA, IIA, IIIA, IIIA
13-03-94 (V)		IS
13-03-94 (V)	(2)	VS
13-03-94 (V)	(2)	VIP, VIP
13-03-94 (V)	(2)	IIIA, IIIP, IIIP
13-03-94 (V)		VA
13-03-94 (V)	(2)	IIIP, IIIP, IIIA, VIA
13-03-94 (V)		IP, IP
14-03-94 (V)	(2)	IIIP, IIP, IIIP, IIP, IIIP, IIP, IIIP
14-03-94 (V)	(2)	IIS, IIIA, IIIP, IIIP
14-03-94 (V)		IIA, IIIA
14-03-94 (V)		IIIS
15-03-94 (V)		VA, IP, VP, IIIA, IIIP, VIIA
15-03-94 (V)	(2)	IIA, IIIA
15-03-94 (V)	(2)	IIIA, VIIA, IIA, IIIA, IIIP, IIP, IIIA, IIIP
15-03-94 (V)	(2)	IP, IP, IP
15-03-94 (V)		IIIP, IIIA, IIP, IIIP
15-03-94 (V)	(2)	IIIP, VP, VIP, IVA, IIA, IIA, VIP, VIP, IIIA, IVP
15-03-94 (V)		VIA
15-03-94 (V)		VIP
15-03-94 (V)		VA
15-03-94 (V)		VS
15-03-94 (V)		IIA, IIIA
15-03-94 (V)		IIA
15-03-94 (V)	(2)	IIIA, IIA, IIA, IP
16-03-94 (V)	(2)	IIIP
16-03-94 (V)	(2)	IIIP, IIIA
16-03-94 (V)	(2)	VA, IA, VA, IA
16-03-94 (V)		IIS, IIIA
16-03-94 (V)	(2)	IS, VIP
16-03-94 (V)		IIIP
16-03-94 (V)		IIIP
16-03-94 (V)		VIA
16-03-94 (V)		IIIP
16-03-94 (V)		IS
30-06-94 (V)	(2)	IIP, IP, IIIP
11-08-94 (V)	(2)	IIP, IIP, IIIP, IIIP, IIP, IIIP, IP
12-08-94 (V)	(2)	IP, IP
13-08-94 (V)		IIA, IIIA, IIIP, IIIA, IIA, IIIA

DATE	No.	VIDEO CODES
13-08-94 (V)	(2)	VP, VA, VP, VIIA, VIIP, VP, VIIA, VIIA, VP, VA, VP, VIIA, VA, VIIP, VA, VIIP, VP, IIIA, VA, VIP, IP, IP, VP, VIA, IP, VIA, IP, VIA,IP, IA
13-08-94 (V)		VP, VP, VIP
14-08-94 (V)		IIIP, IIA, IIIA, IIP, IIIP, IIIA, IIA, IIIA, IIIA, IIP, IIIP, IIP, IIIP, IA, IIIA, IP, IIIP
15-08-94 (V)		IIP, IIIP
15-08-94 (V)		IIP, IIIP, IIP
15-08-94 (V)	(2)	VA, VIIP, VIIA, VA, VIIP, VIP, VIIA, VIIA, VP, VIIA, VIIP, VA, VP, VP, VP, VP, VIP, IP, IP, IIP, IP, VP, IP, IA, VP, VIIA, VIIA, VIIA
16-08-94 (V)		IP, IP
16-08-94 (V)	(2)	VP, VIP, VIIP, VIIP, VP, VIIA, VP, VIIA, IIP, IIIP, VIIA, VIIP, VIIA, VP, VIIA, IIA, IIIA, IIIA
18-08-94 (V)		VIA, IIA, IIP, IIA, IIA, IIA, IIIA, IIA, IIIA, IIP, IIA
18-08-94 (V)		IVP, IIP, IIIP, IIIA, IIIP, IIA, IIIA, IIA, IIIA, IIIP, IIIA
18-08-94 (V)	(2)	IP, IIP, IIIP
18-08-94 (V)	(2)	IIIA, IVP, IIIP, IIIA, IIIA, VIP, IIP, IIP, IIIP, IIP, IIIP, IIP, IVA, IVA
18-08-94 (V)	(2)	VP, VIP, VIA, VIP, VIP, VIP, VIP
18-08-94 (V)		VP, VA
18-08-94 (V)	(2)	VP, VP
19-08-94 (V)	(2)	VIA, VIA
19-08-94 (V)	(2)	VIA, IIP, IP, IIP, IA, IIA, IA, IIIP, IP, IIP
19-08-94 (V)		IVA, VIIA, IVA
20-08-94 (V)		VIP, VIA, VP, IA, IIP, IIIP
20-08-94 (V)	(2)	VIA, IIP
20-08-94 (V)		VA
21-08-94 (V)		IIIP
22-08-94 (V)	(2)	IIP, IIA, IP
22-08-94 (V)	(2)	IVP, VP, VIA, VP, IVA, IVP, IVP, IVA
22-08-94 (V)	(2)	IIP, IIP, IIIP, IIP, IIP, VIIP, IIIA, IIA, IIIA, IIIP, IIIP
22-08-94 (V)		IVP, IIIP, IVP, IIIA
24-08-94 (V)	(2)	IP, IIP, IIIP, IIA, IIP, IIP, IIIP, IIP, VP, VP, VP, VA, IIP
27-08-94 (V)		IIP, VA, VA, VP
27-08-94 (V)		VIA, VIIA
28-08-94 (V)	(2)	IP, VS
29-08-94 (V)		IP
29-08-94 (V)		IP
29-08-94 (V)	(2)	VP, VIIP, VIIA, VIIA, IIA, IIIA, VIIA, VA, IIA, IIIA, IIA, IIIA, IVA, VIIA
04-09-94 (V)		IIP, IIA, IP
04-09-94 (V)		IIA, IIP, IIIP, IIIP
05-09-94 (V)		VIIA, IIP, IIS
05-09-94 (V)		IIS
10-09-94 (V)		IIS, IIIS, IIIP

DATE	No.	VIDEO CODES
10-09-94 (V)		IIS, IIP
15-09-94 (V)		IVA, IIIA, VIIA, IIA, IIIA
16-09-94 (V)		VIIA, VP
16-09-94 (V)		IIIP
17-09-94 (V)		IIP, IIIP, IIA, IIIA
19-09-94 (V)	(2)	IVP, IVA, IVA, IIIP, IVP
19-09-94 (V)		VIP, VIP, IIIP
19-09-94 (V)		VA, VIA, IIIP, IVP, VIA, IIA, IIIA
19-09-94 (V)	(2)	VIP, IIA, IIIA, VIA, IP, IP
19-09-94 (V)		VIA
20-09-94 (V)		VIIA, VIIA
20-09-94 (V)	(2)	IS, IP, IIIA, IIA
21-09-94 (V)		IIIA
21-09-94 (V)		VA, VP, VIP
21-09-94 (V)		VIA
22-09-94 (V)		IIIP, IIA, IA, IIIA
23-09-94 (V)		VIIA
23-09-94 (V)	(2)	IIIA, IIA, VIA, IIA, IIIA, IIP, IP, IIIP
23-09-94 (V)		IP, IIP, IIP, IP
23-09-94 (V)		VP
23-09-94 (V)		IS
24-09-94 (V)	(2)	IIIA, VIP
24-09-94 (V)		IIIP
24-09-94 (V)	(2)	IIS, IIP, IA, IIS
24-09-94 (V)		IVS
24-09-94 (V)	(2)	IIIP, IIP, VIIP, IIIS, IIP, IIIP, IIIP, IIP, IP, IIIA, VIA
24-09-94 (V)		IS, IIIS, IIP, IIIP
24-09-94 (V)		IIP, IIIP, VIP
24-09-94 (V)	(2)	IIA, IA, IIIA, IA, IIIA, IIA, IIIA, IA, IIA, IIP
24-09-94 (V)		VIA

Total Episodes (446)   Total Codes (1204)

APPENDIX A2

DIARY ENTRIES

20-03-93	(D)	afternoon	CODED IIIP, IVP
22-03-93	(D)	early evening	CODED VIP, IIIP
04-04-93	(D)	morning	CODED IIIP
04-04-93	(D)	evening	CODED IIP
09-04-93	(D)	morning	CODED IP
10-04-93	(D)	early evening	CODED IP, IIIP
10-04-93	(D)	evening	CODED IVP
20-04-93	(D)	morning	CODED IIP
22-04-93	(D)	early morning	CODED IIP
15-05-93	(D)	afternoon	CODED VA
15-05-93	(D)	evening	CODED IP, IIIP
17-05-93	(D)	afternoon	CODED IIIA, IIA, IP, IIIA
27-05-93	(D)	evening	CODED IS
28-05-93	(D)	early morning	CODED IIP, IIIP
28-05-93	(D)	morning	CODED IP
28-05-93	(D)	mid-morning	CODED VP
30-05-93	(D)	afternoon	CODED IIA, IIP, IP
24-06-93	(D)	early morning	CODED IIP
26-07-93	(D)	evening	CODED IIIA
29-07-93	(D)	afternoon	CODED IIIP
09-08-93	(D)	morning	CODED IIP, IIIA
25-08-93	(D)	morning	CODED IIS
09-09-93	(D)	evening	CODED IIIP
10-09-93	(D)	morning	CODED IVP
15-09-93	(D)	morning	CODED IS, IIS, IIIS
26-09-93	(D)	morning	CODED IIIP
29-09-93	(D)	morning	CODED IIIA, VIIA
31-09-93	(D)	morning	CODED VIP
02-10-93	(D)	evening	CODED IIIA, IIA
03-10-93	(D)	morning	CODED IIIA, VIIP
04-10-93	(D)	morning	CODED IIIA, VIIA
07-10-93	(D)	afternoon	CODED IS
08-10-93	(D)	morning	CODED IIIP, IIA
14-10-93	(D)	afternoon	CODED VP
14-10-93	(D)	night	CODED IIIA, IIIA
15-10-93	(D)	evening	CODED IIP, IIIP, VIIP
16-10-93	(D)	morning	CODED IIP, IP
17-10-93	(D)	morning	CODED IVA
18-10-93	(D)	morning	CODED IIIP, IIP, VIIP
18-10-93	(D)	evening	CODED IIIP, IIP, IP
20-10-93	(D)	morning	CODED IIIP
21-10-93	(D)	morning	CODED VP
21-10-93	(D)	afternoon	CODED IP, IIIA

22-10-93	(D)	evening	CODED IIP, IIIP, VIP
28-10-93	(D)	morning	CODED IS
30-10-93	(D)	evening	CODED IIP, IIIP, IIIP
31-10-93	(D)	evening	CODED IS
04-11-93	(D)	afternoon	CODED IIS
06-11-93	(D)	morning	CODED IS, IIP, IIP
07-11-93	(D)	evening (50)	CODED IVP, IIP, IIIP
08-11-93	(D)	evening	CODED VS, VIA
10-11-93	(D)	afternoon	CODED IIP, IIP, IIA
11-11-93	(D)	evening	CODED IIIA, IIA
12-11-93	(D)	morning	CODED IIIP, IIP
13-11-93	(D)	afternoon	CODED IP
13-11-93	(D)	evening	CODED IIP
15-11-93	(D)	morning	CODED VIA, VA
16-11-93	(D)	evening	CODED VA
17-11-93	(D)	evening	CODED IIIP
22-11-93	(D)	morning	CODED VA
23-11-93	(D)	afternoon	CODED IIP
24-11-93	(D)	afternoon	CODED IIP
27-11-93	(D)	morning	CODED IIIP
29-11-93	(D)	morning	CODED IIIP, IIP
30-11-93	(D)	afternoon	CODED VP
30-11-93	(D)	evening	CODED VIIA
01-12-93	(D)	evening	CODED IIIP, IIP
02-12-93	(D)	noon	CODED VP, VA
03-12-93	(D)	evening	CODED IIIA, VIIA
04-12-93	(D)	morning	CODED IIP
06-12-93	(D)	morning	CODED VP, VS
06-12-93	(D)	afternoon	CODED IIP,
06-12-93	(D)	evening	CODED IIP
07-12-93	(D)	morning	CODED VP, IIIP, VIIA
07-12-93	(D)	late afternoon	CODED VA
08-12-93	(D)	morning	CODED VS
09-12-93	(D)	afternoon	CODED VP, VA
13-12-93	(D)	afternoon	CODED IS
13-12-93	(D)	evening	CODED IIIP
16-12-93	(D)	afternoon	CODED IIIP, IIIA, IIIP, IVP
16-12-93	(D)	evening	CODED IIIP, VIIP, IIIA, VIIA
17-12-93	(D)	afternoon	CODED VP, VA
20-12-93	(D)	evening	CODED IIIP, IIIA, IIP, VIIA
22-12-93	(D)	afternoon	CODED VIIA, VA
22-12-93	(D)	afternoon	CODED IP
24-12-93	(D)	evening	CODED IIIP, IIP
25-12-93	(D)	evening	CODED IIIA, VIIA, IVP, IIIA
27-12-93	(D)	afternoon	CODED IVA, IIIA, VIIP, VIIA
28-12-93	(D)	morning	CODED IIP, IA
29-12-93	(D)	morning	CODED VP, VIP
29-12-93	(D)	evening	CODED VIIP

29-12-93	(D)	evening		CODED IP, IIA
30-12-93	(D)	morning		CODED IIIP, IIIA, VIIA; IIP, IIIP
31-12-93	(D)	morning		CODED IIIP
31-12-93	(D)	afternoon		CODED VIIA, IIIP
31-12-93	(D)	evening		CODED VS
01-01-94	(D)	afternoon		CODED IVA, IVP, VS
01-01-94	(D)	evening	(100)	CODED IVP, IVA, IIA, IIIA, VS
02-01-94	(D)	evening		CODED VS, IVA
03-01-94	(D)	morning		CODED VIIP, IVP
04-01-94	(D)	evening		CODED IIIP
06-01-94	(D)	noon		CODED IIS
06-01-94	(D)	afternoon		CODED IVS, IIA, IIIA, VIIA
07-01-94	(D)	morning		CODED VA
07-01-94	(D)	afternoon		CODED IIIP, IIIP, VIIP, VIIA, IIIP
08-01-94	(D)	afternoon		CODED IVP, IIIA
08-01-94	(D)	evening		CODED IIP, IIIP
09-01-94	(D)	morning		CODED IVS, IIP, IIIP
10-01-94	(D)	morning		CODED VP
10-01-94	(D)	afternoon		CODED IIP, IIS, IIIP, IIP, IIIA, IIIP
10-01-94	(D)	late afternoon		CODED VIIP, VIIA, VIIA, VA, VA
10-01-94	(D)	evening		CODED VIIP, IIIA, VIIA
11-01-94	(D)	afternoon		CODED VA, VIIA
15-01-94	(D)	morning		CODED VA
15-01-94	(D	evening		CODED IIP, IIA, IIIA
17-01-94	(D)	noon		CODED IIS, IIIA, IIIA
18-01-94	(D)	afternoon		CODED VIIA
18-01-94	(D)	evening		CODED IIS
19-01-94	(D)	afternoon		CODED VS
19-01-94	(D)	lunch-time		CODED VA
19-01-94	(D)	afternoon		CODED IVS, VIIS, IIIA, VIIA, IIIP
19-01-94	(D)	afternoon		CODED IIP
19-01-94	(D)	evening		CODED IIS
21-01-94	(D)	afternoon		CODED IIIP, VIIP, IIIP, IIP, IIIP, VIIA
23-01-94	(D)	afternoon		CODED IIIP, IIIA; IVP, IIP, IIIP
24-01-94	(D)	morning		CODED IIIP
24-01-94	(D)	evening		CODED IIS, IS, IA
25-01-94	(D)	morning		CODED IIIP; IIIA
26-01-94	(D)	evening		CODED IIIA
27-01-94	(D)	evening		CODED IIIP, VIIP
28-01-94	(D)	evening		CODED IVS
30-01-94	(D)	evening		CODED IVP
31-01-94	(D)	evening		CODED IIIP
02-02-94	(D)	morning		CODED VIP, VIIA
03-02-94	(D)	afternoon		CODED IS
04-02-94	(D)	afternoon		CODED IIIP; IVP
05-02-94	(D)	afternoon		CODED IIIA,VIIA
05-02-94	(D)	evening		CODED IIIP, VIIA, IIA
06-02-94	(D)	evening		CODED VIIP, VP

07-02-94	(D)	morning		CODED IIA, IIIA
08-02-94	(D)	morning		CODED IIS, IP; IVA
10-02-94	(D)	morning		CODED IP
11-02-94	(D)	morning		CODED VP
11-02-94	(D)	afternoon		CODED VIIP, VIIA
12-02-94	(D)	morning		CODED IIIP
13-02-94	(D)	evening		CODED IA
16-02-94	(D)	afternoon		CODED IIP
17-02-94	(D)	afternoon		CODED VIIA, IIIP, VIIA
20-02-94	(D)	afternoon		CODED IIS, IIIS
20-02-94	(D)	evening	(150)	CODED IIIP, VIIA
24-02-94	(D)	afternoon		CODED VP, VA, IIIP, IIIA, IIIS, VS
26-02-94	(D)	afternoon		CODED IVP, VIIP, VIIA
27-02-94	(D)	afternoon		CODED IS, IP, IA
28-02-94	(D)	afternoon		CODED IP, IS, IA, IS
02-03-94	(D)	afternoon		CODED IP, IA, IS, IIS
04-03-94	(D)	afternoon		CODED IIIP
05-03-94	(D)	afternoon		CODED IVP, VIIA, IIIP, IIP, IIIP, IIA, IIIA,VIIA
06-03-94	(D)	morning		CODED IS
07-03-94	(D)	afternoon		CODED IIIP, IIIS
10-03-94	(D)	afternoon		CODED IA, VA
11-03-94	(D)	evening		CODED IIP, IIIP
12-03-94	(D)	evening		CODED VP
12-03-94	(D)	night		CODED IA, IIA, IS
13-03-94	(D)	evening		CODED IIS
13-03-94	(D)	evening		CODED IIIP
15-03-94	(D)	afternoon		CODED IIA, IIIA, IIP, VIIA
15-03-94	(D)	evening		CODED IIP
15-03-94	(D)	night		CODED VIIA
04-06-94	(D)	morning		CODED VIP
09-06-94	(D)	afternoon		CODED IIIP
27-06-94	(D)	evening		CODED IVP, IIP, IIIP, VIIP, VIIA, IIIP
28-06-94	(D)	evening		CODED IIP, IIIA, VIIP
11-07-94	(D)	afternoon		CODED IP, IS
12-07-94	(D)	afternoon		CODED IP, IA; IVP, VIIP, IIIP
30-07-94	(D)	morning		CODED IIP
13-08-94	(D)	afternoon		CODED IIP
20-08-94	(D)	afternoon		CODED IIP
06-09-94	(D)	evening		CODED IIP, IP, IS
11-09-94	(D)	afternoon	(179)	CODED IIA, IIIA, IIIP

Total Episodes (179) (Total Codes 369)

APPENDIX A3

DATE		EXAMPLE CODES
04-03-93	(V)	IA, IIA, IIIP, IIIA, IVA, IIIA, IIIA
06-03-93	(V)	IIIA
20-03-93	(D)	IIIP, IVP
22-03-93	(D)	VIP, IIIP
04-04-93	(D)	IIIP
04-04-93	(D)	IIP
09-04-93	(D)	IP
10-04-93	(D)	IP, IIIP
11-04-93	(V)	IIIA
20-04-93	(D)	IIP
22-04-93	(D)	IIP
01-05-93	(V)	IVA, IIIA, IA, IP
12-05-93	(V)	VIA
12-05-93	(V)	IIIA
14-05-93	(V)	IIIA
15-05-93	(D)	VA
15-05-93	(D)	IP, IIIP
17-05-93	(D)	IIIA, IIA, IP, IIIA
28-05-93	(D)	IIP, IIIP
28-05-93	(D)	IP
30-05-93	(D)	IIA, IIP, IP
24-06-93	(D)	IIP
26-06-93	(V)	IIIA
26-07-93	(D)	IIIA
29-07-93	(D)	IIIP
09-08-93	(D)	IIP, IIIA
21-08-93	(V)	VIA, VIA, IA, VIP, IIIP
09-09-93	(D)	IIIP
10-09-93	(D)	IVP
24-09-93	(V)	IIA, IIIA, VIA, VIP
29-09-93	(D)	IIIA, VIIA
31-09-93	(D)	VIP
02-10-93	(D)	IIIA, IIA
03-10-93	(D)	IIIA, VIIP
04-10-93	(D)	IIIA, VIIA
07-10-93	(D)	IS
08-10-93	(D)	IIIP, IIA
14-10-93	(D)	VP
14-10-93	(D)	IIIA, IIIA
16-10-93	(D)	IIP, IP
17-10-93	(D)	IVA
18-10-93	(D)	IIIP, IIP, IP

20-10-93	(D)	IIIP
21-10-93	(D)	VP
21-10-93	(D)	IP, IIIA
22-10-93	(D)	IIP, IIIP, VIP
30-10-93	(D)	IIP, IIIP, IIIP
08-11-93	(D)	VS, VIA
11-11-93	(D)	IIIA, IIA
12-11-93	(D)	IIIP, IIP
13-11-93	(V)	VIP, VIA, VIP, IIIP
13-11-93	(V)	VIP, VIP, IIIP, VIP, IP, IP, IIIA
15-11-93	(D)	VIA, VA
16-11-93	(D)	VA
17-11-93	(D)	IIIP
22-11-93	(D)	VA
27-11-93	(D)	IIIP
29-11-93	(D)	IIIP, IIP
29-11-93	(V)	VIA
01-12-93	(D)	IIIP, IIP
02-12-93	(D)	VP, VA
03-12-93	(D)	IIIA, VIIA
06-12-93	(D)	IIP
07-12-93	(D)	VA
08-12-93	(D)	VS
09-12-93	(D)	VP, VA
10-12-93	(V)	VIP, IP, VIP
13-12-93	(D)	IS
13-12-93	(D)	IIIP
17-12-93	(D)	VP, VA
20-12-93	(D)	IIIP, IIIA, IIP, VIIA
22-12-93	(D)	VIIA, VA
22-12-93	(D)	IP
24-12-93	(D)	IIIP, IIP
25-12-93	(D)	IIIA, VIIA, IVP, IIIA
28-12-93	(D)	IIP, IA
29-12-93	(D)	VP, VIP
31-12-93	(D)	IIIP
31-12-93	(D)	VS
01-01-94	(D)	IVA, IVP, VS
01-01-94	(D)	IVP, IVA, IIA, IIIA, VS
02-01-94	(D)	VS, IVA
04-01-94	(D)	IIIP
06-01-94	(D)	IVS, IIA, IIIA, VIIA
07-01-94	(D)	VA
08-01-94	(D)	IVP, IIIA
11-01-94	(D)	VA, VIIA
12-01-94	(V)	VIA, VP
15-01-94	(D)	VA
15-01-94	(D)	IIP, IIA, IIIA

17-01-94	(D)	IIS, IIIA, IIIA
19-01-94	(D)	VA
19-01-94	(D)	IVS, VIIS, IIIA, VIIA, IIIP
19-01-94	(D)	VS
23-01-94	(D)	IIIP, IIIA; IVP, IIP, IIIP
24-01-94	(D)	IIS, IS, IA
25-01-94	(D)	IIIP; IIIA
26-01-94	(D)	IIIA
27-01-94	(D)	IIIP, VIIP
31-01-94	(D)	IIIP
02-02-94	(D)	VIP, VIIA
04-02-94	(D)	IIIP; IVP
05-02-94	(D)	IIIA,VIIA
05-02-94	(D)	IIIP, VIIA, IIA
07-02-94	(D)	IIA, IIIA
08-02-94	(D)	IIS, IP; IVA
10-02-94	(D)	IP
11-02-94	(D)	VP
12-02-94	(D)	IIIP
13-02-94	(D)	IA
14-02-94	(V)	VIP, VP
16-02-94	(V)	VA, IIA, IIIA
17-02-94	(V)	IVA, IIIA
20-02-94	(D)	IIIP, VIIA
24-02-94	(D)	VP, VA, IIIP, IIIA, IIIS, VS
25-02-94	(V)	VIA, VIS
25-02-94	(V)	VIA
27-02-94	(D)	IS, IP, IA
28-02-94	(D)	IP, IS, IA, IS
02-03-94	(D)	IP, IA, IS, IIS
04-03-94	(D)	IIIP
05-03-94	(V)	VIP, VIA, VIP
06-03-94	(D)	IS
07-03-94	(D)	IIIP, IIIS
08-03-94	(V)	VIP
10-03-94	(D)	IA, VA
11-03-94	(D)	IIP, IIIP
12-03-94	(D)	IA, IIA, IS
13-03-94	(D)	IIS
13-03-94	(D)	IIIP
15-03-94	(D)	IIA, IIIA, IIP, VIIA
04-06-94	(D)	VIP
09-06-94	(D)	IIIP
28-06-94	(D)	IIP, IIIA, VIIP
11-07-94	(D)	IP, IS
12-07-94	(D)	IP, IA; IVP, VIIP, IIIP
30-07-94	(D)	IIP
13-08-94	(D)	IIP

13-08-94	(V)	VP, VA, VP, VIIA, VIIP, VP, VIIA, VIIA, VP, VA, VP, VIIA, VA, VIIP, VA, VIIP, VP, IIIA, VA, VIP, IP, IP, VP, VIA, IP, VIA, IP, VIA, IP, IA
14-08-94	(V)	IIIP, IIA, IIIA, IIP, IIIP, IIIA, IIA, IIIA, IIIA, IIP, IIIP, IIP, IIIP, IA, IIIA,IP, IIIP
15-08-94	(V)	IIP, IIIP
15-08-94	(V)	VA, VIIP, VIIA, VA, VIIP, VIP, VIIA, VIIA, VP, VIIA, VIIP, VA, VP, VP, VP, VP, VIP, IP, IP, IIP, IP, VP, IP, IA, VP, VIIA, VIIA
21-08-94	(V)	IIIP
22-08-94	(V)	IIP, IIA, IP
24-08-94	(V)	IP, IIP, IIIP, IIA, IIP, IIIP, VP, VP, VP, VA, IIP
29-08-94	(V)	IP
04-09-94	(V)	IIP, IIA; IIA, IIP, IIIP
10-09-94	(V)	IIS, IIIS, IIIP
11-09-94	(D)	IIA, IIIA, IIIP
15-09-94	(V)	IVA, IIIA,. VIIA, IIA, IIIA
17-09-94	(V)	IIP, IIIP, IIA, IIIA
22-09-94	(V)	IIIP, IIA, IA, IIIA
24-09-94	(V)	IIIA, VIP; IIIP; IIS, IA, IIP, IIS; IVS
24-09-94	(V)	IIIP, IIP, VIIP, IIIS, IIP, IIIP, IIIP, IIP, IS, IIIA; VIA

Total Examples (154) Total Codes (421)

APPENDIX B

SIX DIARY CASE STUDIES OF YOUNG CHILDREN IN THEIR OWN HOMES PRACTISING THE CULTURAL USE OF NUMBER THROUGH SOCIALLY MEDIATED NUMERICAL UTTERANCE

B1: Ruth McLaren

B2: Mark & Samantha Jackson

B3: Mark Smith

B4: Ivan Roberts

B5: Arthur Jones

B6: Charlotte Clarke

University of North London
School of Teaching Studies

Dear Parent,

I am conducting a study of children's numerical development, -their **use of number words**. In order to compare my children with others, I would like to know when, and under what circumstances, other parent's children ***talk about*** or ***use*** numbers, including ***repeating your or*** *other adult's usage.*

I would like to include your child in the study.

You could assist the study by simply telling me any stories about your child. They could include times when you or anyone else have talked about numbers to your child, *at home, out shopping, playing, absolutely anything.*

Your contributions could be important, they would certainly be valued, and kept confidential.

James Young B.Sc(Hons), M.A.(mathematics education)

APPENDIX B1

CASE 1 **<u>THE CASE STUDY OF RUTH McLAREN</u>**

Ruth lived in a medium sized town in Scotland, with two parents and seven brothers/sisters. She was born on 16/06/89, and at the time of this study, which began on the 14/10/93 and ended on 21/01/94, Ruth was aged ~ 4½-years old. Ruth's mother reported the following accounts of numerical interaction/language use:

14-01-93 CODED VA, IIA, IIIA

We were reading Postman Pat's 1 2 3 counting book

15-10-93 CODED VIP

She made a comment that you have to be 3 to do a puzzle I'd given her in the afternoon.

16-10-93 CODED IIIP

Do you want one book or two? she said.

17-10-93 CODED IP; VA, IIA, IIIA

"Mum, I counted up to eight", she said while waiting on tea-time.

We read Postman Pat's 1 2 3 storybook at night

18-10-93 CODED IIIP; IVP

Breakfast time, taking out the cereal, Ruth said, "This has got lots, and this has got hundreds"

Playing with dominoes, she noticed all the numbers and kept shouting them out.

22-10-93 CODED IA, IIIA; IIS

We were listening to records, some of them were children's songs like, "There was ten in the bed", and Ruth was singing along.

We were at Edinburgh the other day and Ruth has been playing with the old train tickets, so that means counting herself, though I've not actually heard them much.

25-10-93 CODED IIIP; VA, IIIA, IIA

Made a remark about doing something twice.

At night, one of her books that she chose to read was the Usborne book of counting.

27-10-93 CODED IIIP, IIIA; VA, VIA

Ruth gave me one raisin and said, "One raisin for you"; and when I said, "Half of the children are not in for tea, she said "Just put out half the plates then".

She also changed the television channels, when told what numbers to press.

29-10-93 CODED IIP

Ruth was counting the chips all by herself when she was helping me do the potatoes.

30-10-93 CODED IIS, IIIS; VA, IIA, IIIA; IIP

I heard her counting the plates and saying to herself, "One plate and three plates"

Been forgetting, but we did a game with numbers a few days ago;

and she helped with the potatoes one day, and was counting away to herself as she put them in the pot.

04-11-93 CODED IVP, IIIP

She was counting her smarties and said, "Two orange, two blue, and two brown"

05-11-93 CODED IP, IIP, VP, IP; IIIP, VIP, IIIP, VIP

She was counting stars. Playing a game with toy money and counted up to 13 in order.

She's been going around saying, "That's four, and here is a pound and seven"; and "One cake, two cakes and five cakes"; and "Two fifty"

06-11-93 CODED VS

She was playing with a calculator.

07-11-93 UNCODED

We were reading a book called, 'One crocodile smile' at bedtime.

09-11-93 CODED IS, IIS

I heard her playing with the cutlery at dinnertime and saying numbers to herself.

20-11-93 CODED IIIP; VA, IIA, IIIA; IIA, IVA; IIIP

Oh dear, I just seem to have been so busy. Yesterday I heard Ruth say, "I've got three sisters"

She has read counting books over the last week;

We played snakes & ladders a few days ago.

She said "Two" today, and there has been a number of incidents that I just can't recall the now.

21-11-93 UNCODED

Snow! Snow!

23-11-93 CODED IP, IP, IIIP

Ruth said, "Mum I can count up to five", and then she did;
then she counted up to twelve, then said, "I counted up to eighteen, didn't I"

24-11-93 CODED IIP; VS, VIS IIS; VA, IIA, IIIA

Ruth chose herself at the library a lift-the-flap and count book.
Gathering up objects in the kitchen she said, "One, two, three, four"

She was playing shopping herself and counting;

and at night she read her counting flap book again.

30-11-93 CODED IA, IIA; VIA, VA; IIA,VA; IP

Lots of talk. We played a game yesterday, so counting numbers.

Today she said, "Mummy where's my age?" (when looking at the new advent calender).

Yesterday we played shops with the toy food;

and in the bath, Helen & Ruth were seeing how far they could count without making a mistake.

04-12-93 CODED IIP

Counting out her own Christmas cards today.

07-12-94 CODED VP, IIP, IIIP

Read a counting book by herself almost.

10-12-93 CODED IIA; IA, IIA; VIA, VA, VA; VP, IIP

Sorry, I had moved the pad, and then seemed to be busy. There has been lots of numbers said.
Counting the potatoes one day;

Games with brothers and sisters;

Looking for her age on the advent calender, and opening up the numbers and saying what they are;

Yesterday she was playing shops with toy money.

22-12-93 CODED IIIP; IP

Sorry! There is always a number of things.
Today she said, "Look Mum, two books the same".

Yesterday she said, "Three is after four isn't it!", and she wanted a counting book from the library.

18-01-94 CODED IP; IIP, VIP

Sorry, we've not been keeping up to date. Got your letter yesterday and when I told her, she said, "One, two, three, four, five" !

Today she counted my cakes I was making, - herself;

and later on I was at the clinic and a nurse asked her how old she was now, and she said, "Four". I'll keep going a few more days and then send the book back to you.

19-01-94 CODED IA, IIA, IIIA, VA

Ruth was playing and counting the play pieces today. Sesame Street had counting on it, and she was counting with them.

20-01-94 CODED IIIP

Singing a song she'd heard at nursery called, 'Ati the camel has one hump etc.', she just went up to two.

21-01-94 CODED VIP; IIP

We were playing 'What's the time Mr Wolf', and she can say up to 5 O'Clock herself, then she says 10 O'Clock.

She counted the Beef-burgers I'd put out for dinner today.

APPENDIX B 2

CASE 2 **<u>THE CASE STUDY OF PAUL AND SAMANTHA</u>**

<u>Introduction</u>

Paul and Samantha, are brother and sister, they are the only two children in their family, (a black single parent family, living in an inner city borough of London). Paul was born on 03/07/91 and Samantha on 11/05/90; and at the time of study Paul was approximately 2½ years old, and Samantha 3½ years old.
The following diary entries written by their mother give an account of the nature and extent of their socially instigated number mediation at home.

12-10-93 CODED VA
Breakfast: Samantha, "I want both orange and milk"
Afternoon: Samantha playing with clock puzzle, counting as she puts the parts in.

13-10-93 CODED IIP; VA, VIP; IIIP; IA
Paul counting stairs as he walks down.

Paul putting TV on number 4, saying "Press four Mummy".

Samantha feeding her dolls, saying how many needed feeding.

Paul and Samantha singing along to a counting tape, - getting parts correct.

14-10-93 CODED IIIP, IIIP
AM: Shopping: Paul saw one bus coming, (and we went on one train with aunty Lorna yesterday). Paul: "Can we buy two bananas, I like it"

14-10-93 CODED IIIA
PM: Mum-Paul bought six doughnuts.
Samantha: "Can I have piece? No, no; a round one, like football"
Paul: "I got them"

15-10-93 CODED VIA, VA; IIA; VP; VA
Samantha: "Paul, cartoon's on four, press four; yes that's it"

Paul counting records in toy player

Samantha playing with number puzzle.

Mum: (to Samantha) "Tell me the time on the video?"
She replied: "Six-O-O-five-four", (which meant) 6:54

16-10-93 CODED VA, VP; VA

Paul and Samantha reading off numbers on the house, recognizing same number on grandparents house.

Playing matching number game with cards, including + and = signs.

18-10-93 CODED IIIP, IIIP
AM: Paul and Samantha playing a game.
Samantha saying, "You are naughty, in the bathroom two minutes".
Paul: "No, one minute and then I'll be good"

18-10-93 CODED VA; IA; VA, IIA, IIIA
PM: Number floor puzzle.

Counting wall frieze up to 10.

Getting them to recognize number, by asking about picture (as to how many).

19-10-93 CODED IIA, IIIA; IIA, IIIA; IIIP; IIIP; IIIP; IIA, IIIA

Paul counting apples as I picked them up. Paul: "One, two, three"

Paul counting railings as we waled along, up to six.

Samantha: "I have a book and Paul has one too"

Samantha: "The shop is next to our house; I want two eggs for lunch"

Paul: (counting stairs) "One, two, three, four"

Mum reading stories, counting different things as we go along

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20-10-93 CODED VS; IIIP; IA
AM: Paul playing with the telephone, pressing different numbers and saying them out loud,
"Three, five, four, seven"

Paul: "One vitamin for me and one for Samantha"

Paul and Samantha watching Sesame Street, counting with the count, one to twenty.

20-10-93 CODED IP; IIIP

PM: Paul jumping up and down counting,
"One, two, three, four, 'A', 'B', 'C', six, seven, eight"

Samantha asking for "Three" hula-hoops, given it and asked for more. Had a visitor with a baby, Samantha wanted to know how much baby was coming.

21-10-93 CODED VP, VA

Samantha and Paul's cousin came for a visit, so we had three different types of number puzzles out. Samantha was pleased she could say the numbers on the clock one.

01-11-93 CODED VIP, VP; IIIP; IP, IIP

Paul turning TV to channel 3 and 4 to find a cartoon.

Paul counting out his shoes.

Samantha singing, "One, two, buckle my shoes", all the way through, then started counting on her fingers, to ten, without stopping.

02-11-93 CODED VA, IIA, IIIA; IIA, IIIA; IIA, IIIA

Samantha choosing a counting book from nursery school library, wanting it read at once.

Explaining to Paul how many bowls was on the table, by counting them, "One, two, three";
then saying, "Now we count the cups, One, two, three, four; One for Mummy and one for you, and two for Samantha"

03-11-93 CODED IIIP; IA; IIS; VIP

Paul: "I love you too, and I love Samantha one, and I love you three"

Collecting Samantha from nursery school, Paul was counting "One" to "Thirteen", - with me repeating what he said, ie. "One, two, three, four, ... seven, seven, seven, eight, nine"

Samantha was counting photo's of dad in her room.
Paul asking for £2 to buy 'ice-pole'

04-11-93 CODED IP; IIP; VA

Samantha counting during a jumping game in the nursery school playground.
Paul counting steps also in playground.
Paul and Samantha playing number snap.

05-11-93 CODED IP, IIP
Paul counting a picture of horses in a room, counting, "One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve" without stopping (first time he did this).

08-11-93 CODED IIIP, IIIP; IIA, IIIA
Samantha counting toast, saying, "I will have two, Paul can have one, and you two like me"

Paul painting with cousin, counting paint brushes, "One" to "Five".

09-11-93 CODED VA
Counting and recognizing numbers on fridge door, also spaghetti shapes.

10-11-93 CODED IIS; VP
Paul counting stairs by himself, without help.

Finding up to '8' on TV channels.

15-11-93 CODED IIIP; VS, IIS, IIIS

Samantha: "I have two babies now; One is B and one is B both babies"
Paul is reading a counting book, he can do this on his own, by himself, without help, recognizing pictures and numbers up to ten.

16-11-93 CODED VA; VA
Paul and Samantha played snap numbers;

and worked on the puzzle clock.

17-11-93 CODED IIP; IIIA, IIIP
Paul counted stairs.
Paul pointed out two of things, eyes, ears, lips, hands and feet. He is very comfortable with 'two' of things, wanted two books to take visiting.

18-11-93 CODED IIA, IIP, IVA, IVP; IIA, IIIA; IA
We played dominoes, Paul and Samantha very keen to match numbers up;
and we counted baby's toes and fingers, "One" to "Ten";
and later in the afternoon, sang with numbers tape.

19-11-93 CODED VIP

Paul wanted £2 to buy 'ice-pole' and to give £1 to Samantha, also for 'ice-pole'.

22-11-93 CODED IIIA; IIA, IIIA

Out shopping: Paul wanted to know how much doughnuts we were buying.

Counting out the stairs, "One" to "Ten".

23-11-93 CODED VIP, VP; IP, VP, VIP

Paul was changing TV channels, checking out numbers and pressing the correct numbers, '1' to '8'.

Samantha and Paul were playing a numbers game in the nursery school playground, later others joined in (Activity captured on Video, KNS tape 3).

24-11-93 CODED VA; VP; IIA, IIIA, VA

Paul was playing number snap with Samantha and Mum.

Counting out numbers in room on frieze.

Read counting book from nursery school, liked the pictures of different fruits, '1' to '10'.

29-11-93 CODED IIP, IIIP; VP, VIP

Paul counting items in shopping basket, mostly ones that interested him, ie. "Three apples"; "Four oranges"; "Two doughnuts" and "One packet Wheetabix".

Paul was pressing buttons on the TV correctly, depending on which channels he wanted.

30-11-93 CODED IA, IIA, IIIA, VA

Reading a counting book. Samantha finds it difficult to understand that you start from "one" ...., she seems to think that you can start at "four" or "seven" etc.

07-12-93 CODED VA

We were writing numbers, copying around different shapes, recognizing, and painting out the different shapes.

08-12-93 CODED IA; VP, VIP; IIP

Paul was counting "One" to "Twenty" on Sesame Street.
Paul confidently pressing correct buttons on the TV and phone.
Paul counting "One" to "Eight" books in the library.

10-12-93 CODED VP, VA
Paul counting out numbers on the playground, recognizing easily the correct ones

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12-12-93 CODED VIA, VP, VS
Counting off dates on the Advent calender, pleased with themselves recognizing numbers '1' to '20'.

25-01-93 CODED IIP, IVA, IVP, VP
Paul and Samantha playing dominoes and snap, match numbers easily, but still confuse their order. [possibly meaning their order of turn taking]

02-02-94 CODED VIP
Paul and Samantha racing to the front door, saying,
"I am first, you are second, third, fourth, fifth", - getting the order mixed up, but knowing it's counting"

No. of incidents = 74 **Total Coding = 121** **Time period = 64 days**

APPENDIX B3

CASE 3 THE CASE STUDY OF MARK SMITH

General Introduction to Mark

Mark comes from a white middle class family, he lives in central London and attends a nursery school in the morning. Mark was born on 08-11-89, and at the time of the study he was ~ 4 years old.
Unfortunately his mother did not follow the instructions given to parents completing diary accounts of their child's numerical interactions with their surrounding home micro-environment. His mother's diary accounts indicate very few specific instances of actual number mediation in the home, but instead often report her view of his 'number understanding', or his previous acquired number skill and past performances. In addition, there is a complete absence of diary dates in her accounts, and this makes direct comparison with the other studies in terms of quantity and quality quite impossible.

CODED IIA, VIA, VA

Mark is a very articulate child, his use of numbers relates to counting, time, age, money, dates, speed limits, door numbers, TV channels, prices etc.

CODED VA, VP

At the age of 3, he began to recognize written numbers, encouraged by my continually pointing out their uses.

CODED VA

At the age of 2, I cut out daytime naps and replaced them with a walk around the block, - we would choose the theme - cars or doors - then say this is a red door with the numbers '3' ["Three"] and '4' ["Four"], '34' ["Thirty-four"], the next is a blue door with the numbers '3' ["Three"] and '6' ["Six"], '36' ["Thirty-six"], or this is a blue van with the numbers '7, 8, 5' ["Seven, eight, five"] in the registration plates etc. - these combined learning and fun.

CODED VP

He often points out numbers we would generally overlook. In the car he will point out telephone numbers on the sides of vans, on shop fronts, on traffic signs.

CODED VP, VA

He could write the numbers '1', '7', '8', '0' before he could write letters. He can now sometimes write '1', '2', '6', '7', '8', '0', although this ability comes and goes, - depending on his other temporary fascinations.

CODED VA

He finds it difficult to differentiate between '3' and '5' written.

<u>Mark's incidents of number awareness, from Sept 1993</u>

CODED VP

At Chiswick House he noticed the speed limit sign post, he said "Five"

CODED VIA

When asked how old Granddad was, he said, "About sixty-four"

CODED VIA

Understands he'll be 4-years old soon, but the concept of, "In four weeks time", is too hard to grasp.

CODED VIA, VIP

Several days after various discussions about:
(i) a building built a long time ago in 1883
(ii) not drinking the bath water
(iii) not wasting water as it is precious, especially in Africa
He said,
"In 1883 the people in Africa were so thirsty they had to drink their bath water"

CODED VIA, VA

We use the clock to gauge times to leave for school or expect visitors or watch a favourite TV programme, ie. "When the big-hand is on '1' and 0, number '10' [ten], we leave for school"

CODED IA, IIIA; IA, IIIA

He sings songs at school using numbers, daily, including:
"Five fat sausages sizzling in a pan, One went pop and another went bang, so there were three fat sausages etc. etc.";
they also sing - "Five little speckled frogs and five little ducks", - counting backwards.

CODED IIIA, VIIA

When having biscuits or crumpets etc., I say, "Take one for mummy, one for daddy, one for dexter, one for Mark; How many do you need?"

CODED IIIP, VIIP

When confronted with 'six' pancakes and 'four' consumers, he concluded, either:
Mark could have "Two"
Mummy could have "Two"
Daddy could have "Two"
Dexter could have "None";
or,
Mark could have "Two"
Daddy could have "Two"
Mummy and Daniel could have "One" [each]

CODED VIA

When asked how much things cost he will take a number very randomly, although often, "seven", "seventeen", or "twenty-seven", and add "Quid", rarely pence.

CODED VIP

Very aware of his and his peers age, - ie. saying,
"Ludovic (a friend) can sleep on his top bunk because he's already four, I'm only nearly four, so I have to sleep on the bottom bunk";
(pauses and considers),
"Are my teddies (who sleep on his top bunk) bigger (meaning older) than me?"

CODED VIP

At Chessington recently, he refused to go on a ride as it was for,
"Boys who are already four, or with their daddies"

CODED IIIA, IIA

The build-up to Christmas brought many opportunities to talk about numbers in connection with time, eg How many days until Christmas.
We had an Advent calender and counted forwards to Christmas Day, and backwards to the start of the calender.

CODED VIP

On Christmas day, when asked how many presents he'd received, he replied, "Just thousands"

CODED IIIA, VIIA

The removal of his old calender and putting up of his new one on New Year's Eve, led to discussions about how many days in a year, and the division of years into months, weeks, days, hours etc.

CODED VIA, VIA

We went backwards through the weeks of December pointing out past events, ie.
"Three weeks ago you had tea at Stella's, do you remember?";
"In three weeks time our new baby will probably be born!"
Also we went further back,
"Do you remember playing in the paddling pool at Granny's? That was six months ago", and,
"In six months time it will be warm and sunny again, like it was on that day"
So time and weather have some correlation.

CODED VIP, VIA

Age: Mark is convinced that old age equals death. He asked my Grandmother, who is nearly ninety, if she was, "Going to die soon!". Luckily she is of good humour and found it rather amusing! He finds anything to do with children dying very upsetting, mainly because he doesn't see them as old enough!
He has worked out that his friend Jack is exactly a year younger than him,
"When I will be six, little Jack will only be five"
The new children in his nursery class are only three-years old and therefore, "need looking after by the big four-year olds".

CODED VIP, VIP

At Chiswick House, Mark declared, "An old queen lived here, but she died fifteen years ago".
But Chiswick House was built, "Thousands of years ago";
"Dinosaurs lived 100 million years ago" (quite accurate) "But died because people threw coconuts at them"
He can't grasp that people didn't exist then, or that not all dinosaurs lived at the same time.

CODED IP, IA, VA

Mark can (Jan '94) accurately count to thirty (but leaves out thirteen!).
His recognition of written numbers comes and goes,
- at the moment we are concentrating on letters, which he has grasped quite readily.

No. of incidents from Sept '93 = 18 Total Coding = 41 Time period=3 months

APPENDIX B4

CASE 4 **THE CASE STUDY OF IVAN ROBERTS**

Ivan is a young boy who lives in an inner city borough of London. He was born on 06/11/89, and at the time of the study he was 4-years old. Ivan attended a nursery school in the afternoon, and he attended the Parent & Child playgroup, one that is reported in chapter 8 (and some of his numerical activities/speech are reported as part of that playgroup data). At the playgroup Ivan was observed to be well skilled in terms of number recitation, one-to-one correspondence counting, number figure reading/recognition and cardinal labelling. The following accounts written by Ivan's mother about his numerical interactions within his home micro-environment give further insight into the social role played by his mother in mediating these aspects of number to Ivan. The accounts cover a period of only one month, rather than the three months requested.

12-10-93 CODED IIIA, VIA, VIIA
In stores, on children's rides, we had to see which coins were acceptable to the machine. Which denomination and what multiples of certain coins, eg. two '10p', or one '20p'

12-10-93 CODED IIS, IIIS
Coming home, counting on fingers, totally spontaneous, - just counting fingers.

13-10-93 CODED VIA
We talked about children's ages, ie. One-, two-, three-years; How old his friends are, and how he will be four soon, - How old is Mummy etc.

13-10-93 CODED IIP, IIIP
Counting how many chips you can get into a pot of Tomato ketchup at once! (about 12/13).

15-10-93 CODED VIA, VA
In lifts, - recognizing floor numbers, - which buttons to press to get to the right floor.

15-10-93 CODED VA, IIA, IIIA
Supermarket: Reading numbers on checkouts, - deciding which checkout to go to, also counting the number of people in the queue to determine the best option,
ie. smallest = quickest; biggest = longest

17-10-93 CODED IIA, IIIA
Play: How many playmobil people can you get into the playmobil car, Why?
If it's too many people they won't fit.
space = size; size + space are relevant

17-10-93 CODED IIIA, VIA, VIIA; IIIA, VIA, VIIA
Talking about how, "Two 10p's make a 20p", and "Two 5p's make a 10p" (bit difficult!)

26-10-93 CODED VIA; VIA; VA
What time is school, playgroup, bedtime, breakfast, dinner, etc.
How long before school? - half-hour, forty-five minutes, etc. - studying clock face.

26-10-93 CODED IIIA, IIIA
Days of the week: How many-
How may days until birthday, Christmas, etc
An Advent calender seems a good idea.

29-10-93 CODED VIA, VA
Moving: Why have we moved to a new number?
What is new number?

29-10-93 CODED IIA, IIIA
Out in Street: Counting number of Red cars, blue, etc. parked.

03-11-93 CODED VIA; VP, VS; VA
Telephone: Remembering phone numbers for people we know.
Letting Ivan press the correct numbers from seeing the telephone number written down.
Ivan wonders why there's no number '10'!!

05-11-93 CODED IIIA, IIIP
Shopping: Deciding quantities of groceries we need, ie:
Lots of potatoes; "Four" apples, "One" packet of T-bags etc.
and why we don't need more than one packet of tea bags etc.

05-11-93 CODED IIIA, VP
Lifts: Deciding how many people will fit into a lift.
Letting Ivan press the right number, without telling him.

08-11-93 CODED VA, IIA, IIIA

Got new gloves with numbers printed on the fingers, which he loves!

08-11-93 CODED IIIA, VA

Looking at a calender - Ivan wonders why they only go up to 30 and 31 (quite difficult to explain).

10-11-93 CODED IIA, IIIA

At the dentist: The dentist let Ivan hold a mirror and they counted his teeth together; they counted twenty teeth.

10-11-93 CODED VIP, VP

Ivan loves standing on the scales and seeing how much he weighs,
- seeing he is '3' stone and small, and Mummy is a lot more and big!
- seeing size is related to weight.

Number of incidents = 19 **No. of codes = 46** **Time period = 30 days**

APPENDIX B5

CASE 5 **<u>THE CASE STUDY OF ARTHUR JONES</u>**

Arthur lives in a rural area of Shetland with his parents and five older brothers and sisters. Arthur was born on 30/10/90, and at the time of the study he became 3-years old. Arthur's mother kept a diary account of his numerical interactions, and although the accounts are spread over a three month period, the number of interactions were few, although once again it is likely that there were more than is reported.

25-10-93 CODED IA, IIIA
Sang songs in the afternoon, eg. " 1 2 3 4 5 Once I caught a fish alive"
& "Two little dicky birds sitting on a wall"

30-10-93 CODED IS, IP
Heard Arthur from the bedroom coming up stairs saying to himself, "Six, seven, eight";
Held his hand going down and he repeated on the way down, "Six, seven, eight"

07-11-93 CODED IIIP
He came through and asked for, "Half an orange with Linda" for supper.

09-11-93 CODED IA, IIA; IA, IIA
Counted together the stairs going up and down (numbers "One" to "Ten")

11-11-93 CODED IIA, IIIA
Counted objects in his good-night story.

12-11-93 CODED IIA, IIIA; IIIP
Played with the computer games (under-5) for a little while. You have to count the teddys etc. and do the colours (only for about 10 minutes).
When he went for his afternoon sleep he pointed to two teddies and said,"Two teddies please"

Nov 93 CODED IIA, IIIA; IIA IIIA
Most nights we have counted objects in his story at nights. He normally just listens, occasionally he will help point or say the numbers parrot fashion.
Most days when we remember, he counts the stairs when we go up and down.

Nov 93 CODED IA

He was sitting watching the TV programme 'Gladiators', and he repeated the numbers.

10-12-93 CODED IP, IIP

Donald asked him to get some cars and he went over and picked them up saying, "Six, seven, eight, nine, ten" and took them over (there were five cars, but instead of starting counting from 'one', he started from 'six')

Dec 93 CODED IA, IIA

At the moment he is becoming more aware of numbers by counting, but I have not shown him the numbers as they are written. He is only just learning to count one to ten parrot fashion, through his books and counting the stairs mainly.

06-01-94 CODED IVA, IIA, IIIA

Played a game with a dice and some cubes. He threw the dice then picked up the cubes and put them in the squares while I counted the number. He didn't repeat the numbers, just listened and picked up the cubes.

24-01-94 CODED IP

Played a game of Hide-and-Seek today with his Dad. His Dad told him to shut his eyes and count while he hid, so he shut his eyes and said, "Five, six, seven, eight"; "Five, six, seven, eight" till it was time to go and find him.

Well I don't suppose this will be much use, as I say Arthur is just beginning with numbers and I don't push him as he has plenty time before school. I will probably do more with him next winter when he will be that bit older and take more in.

no. of incidents = 12 **no. of codes = 25** **time period = 90 days**

APPENDIX B6

CASE 6 **<u>THE CASE STUDY OF CHARLOTTE CLARKE</u>**

Charlotte lives in a council house situated in a medium sized town in Scotland. She has an older brother (Allan), an older sister (Joyce), and younger sister (Mary). Charlotte was born on 26/01/91, and at the time of the study she was less than 3-years of age. Charlotte is a niece of the researcher. Charlotte's mother completed the following reports of her daughter's social numerical interactions.

16-10-93 CODED IP
Charlotte was sitting on the couch with her dolly, when she began to count to the dolly,
"One, three, four", she said then, "No, that's not right baby, it's One, two, three"

17-10-93 CODED IIP, IP
We were all at Charlotte's Grans. Her gran had on a shirt with many buttons. Joyce, her older sister began counting the nine buttons correctly. Charlotte then did the same, counted up to 'six', then "one, two, three" again.

18-10-93 CODED VIP
The three older children (Allan, Joyce and Charlotte) along with two friends, were playing, 'What's the Time Mister Fox'. For several hours later, Charlotte kept saying, "Six O'Clock; Three O'Clock" etc.

19-10-93 CODED IA, IP
Charlotte and Joyce were singing, 'One, two, three, four, five, Once I caught a Fish Alive'.
Once Joyce had stopped, Charlotte counted to five, but was mixed up with the rest of the words.

19-10-93 CODED IIIA, IIIA, IIIA
Out shopping, I told Charlotte to put two cartons of milk, two loaves of bread, and four oranges in the trolley. She had no problem with the milk and bread, but thought three was right, so I had to tell her to get another one.

25-10-93 CODED IIA
Charlotte was playing with Joyce in the nursery, they were putting beads on a string to make necklaces, and Charlotte copied Joyce, counting up to six.

28-10-93 CODED IIP, IIIP
Going to the High Street by bus. Charlotte counted three buses which went past all at once.

01-11-93 CODED IIA, IIIA
While at her Great-grans, Charlotte was given three biscuits to give one to each of her sisters.
When asked how many she had, she counted three.

08-11-93 CODED IIA, IIIA, VA
My nephew's birthday today. We counted two candles on the cake, and pointed out the "2's"
on all the birthday cards.

14-11-93 CODED IIP, IIA
While sitting quietly with her dad, Charlotte began to count her fingers, "One, two, three, four, seven". Sandy (her dad) corrected her, but she had by then lost interest.

17-11-93 CODED IIS, IIIS, IIS, IIIS
Playing with 'Big Yellow Teapot', Charlotte successfully counted four chairs and four people, while no-one was paying attention. When I asked her a short while later to repeat, she wouldn't.

22-11-93 CODED VIA
Allan had a friend in to play after school, who had to go home at Five O'Clock. He told me this repeatedly, so Charlotte kept asking, "Is it Five O'Clock?", "What time is it?"

23-11-93 CODED VIP
They (Charlotte and Joyce), started to play at 'Mummies'. Charlotte pretended to give her dolly "Four-ninety pounds" for her dinner money.

24-11-93 CODED IIIP; IIA, IIIA; IIA, IIIA, IIA, IIIA, IVA; IIP, IIIA, IIA, IA, IIP
Charlotte wanted "Two Wheetabix" for breakfast instead of one.

Sorting out washing at 10am. Charlotte helped to match socks, then successfully counted that everyone had three pairs in their pile.

Played 'Frustration' with Charlotte and Joyce at 2pm. Charlotte counted her four pieces and was able to move her piece as long as the dice was four or below, five and six bamboozled her.

At 5pm, while I was making the tea, Charlotte was playing 'This Little Piggy' with Mary and was counting her fingers, "One, two, three, four, six". She had to come and ask me to help as she knows you have 'Five' fingers. Once told, "One, two, three, four, five", she kept repeating until she went to bed.

26-11-93 CODED IIP, IIP, IIP
Charlotte's Great-gran was in to baby-sit, Charlotte counted her buttons, rings, and buckles on her boots, all correctly.

28-11-93 CODED IIIP; IIIP
At the corner shop, when asked what kind of sweets she wanted, she replied,
"A lolly with two colours"

Watching Bart Simpson, Charlotte asked if there were "Two on today".

29-11-93 CODED IIIP
Charlotte was playing with Mary, with 'The School Boot' (a toy school with play people shaped like a boot). Mary had two people (one the teacher), Charlotte wanted the teacher, so she said to Mary, "I'll give you two boys and you give me the man". Unfortunately Mary would not give in, so Charlotte just grabbed.

30-11-93 CODED IIIP
10.30am. Went to playgroup for a visit, Charlotte made many references to "lots", "more". Later she correctly told her dad, "There were two girls there".

01-12-93 CODED IIA, IIIP, VIA
Today I took Charlotte to see Santa. While in the queue she counted the elves. Said there were lots of people. She kept saying she wanted "Two dollies", but once inside said nothing but her name. Santa asked her age, she said, "Two".

02-12-93 CODED IIA, IIIA, IIA
I remembered only today about the Advent calenders. After they were opened, I explained that when the last was opened Santa would come. We counted the two doors already opened, Charlotte did this, and then counted the doors left; only Allan (age 6) counted up to 'twenty-two', Charlotte only made it to "Seven".

03-12-93 CODED IIA, IIIA; IIA, IIA, IIIA, IIIP
Counted three doors opened, and only up to six left.

At the shops I asked her how many packets of sweets we needed, one for everyone. She said the four names and held up one finger for every name, then she counted her fingers and said four. She then lifted four packets of sweets.

04-12-93 CODED VIP, VIP, VIP
Today they were all playing at shops. Charlotte was a customer first, and asked for, "Sixteen pounds of mince" and teabags. When it was her turn on the till, she pressed lots of buttons and said it was "Thirty-two pounds", she then gave "Fifty-eight pounds change" from Joyce's "Five pounds". So obviously she has no perception of large numbers.
P.S. I never buy sixteen pounds of mince!

05-12-93 CODED VIA, VIP, IIIA
It was my Gran's birthday today, and my Granddad tomorrow, so we made a birthday cake for them. They decorated it with smarties, but Charlotte wanted candles. I said, "One candle each?", but Joyce wanted to know how old they were. When I said "Sixty-four and Sixty-eight", Charlotte wanted "Eighty-six" candles on the cake. She seemed to realize this was a lot, but didn't understand that the cake wasn't big enough, or that I didn't have enough candles. In the end a compromise of "Twenty" candles was reached.

06-12-93 CODED IIIA, IIIA, IIIA, IIIA, IIIA, IIIA, IIIA, IIIA; IIS IIIS
The two younger girls (Mary and Charlotte) today were playing with bricks and building towers. I asked Charlotte to build one with "Two", then "Three", then "Four", then "Five", then "Six", then "Seven", then "Eight", then "Nine", then "Ten". She did it each time just by adding 'one' on the previous tower.

A little while later, while playing on her own, she was counting the bricks in her towers and she could only count properly up to seven.

07-12-93 CODED VIIA, IIA, IA, IIIA
Joyce and Charlotte were arguing over crayons. I decided to split the box between the two of them, "One to Charlotte, one to Joyce". When divided, I asked them to count, Joyce had "Eight", Charlotte had "Seventeen". I counted with Charlotte parrot fashion, so she had "Eight" as well.

08-12-93 CODED IIIA, IIIA, IIIA, IIIA
Charlotte set the table for lunch, "Five" spoons for soup, "Five" spoons for custard, "Five" soup plates, "Five" custard plates. She did it perfectly.

09-12-93 CODED VIIA

Allan brought his maths book home from school. He was showing it to his sisters. Charlotte asked what sums were, so I explained one brick with another brick, "How many now?". She said two, but that's as far as I took it.

10-12-93 CODED IIA, IIIA

Walking back from nursery, we counted the Christmas trees in the house windows. Charlotte counted four.

12-12-93 CODED IA, IIA, IIIA

Today when we counted all the doors left open on the Advent calender, Charlotte counted up to "Ten", although the other two children were counting at the same time.

14-12-93 CODED IIS, IIIS

Charlotte and I were Christmas shopping today. We were buying some more baubles for the tree, they were in packs of three. She kept picking them up and counting "One, two, three".

16-12-93 CODED VIA, VIA; VIP

This afternoon I had a friend in. I was discussing how many hours I had worked this week. Charlotte was sitting repeating, "Six till ten", "Three pounds tips" etc.
Later, before going to bed, she told her dad that I would be home at, "Six till ten".

17-12-93 CODED IIA, IIIA, IIP, IIIP

This afternoon we were putting the Christmas decorations up. We had to count how many pieces of red tinsel, garlands of angels, etc. Charlotte managed to count up to "Four" on her own with no prompting.

19-12-93 CODED IIIP, IIIP

Joyce and Charlotte were having a dollies tea party.
"Two sandwiches"; "Another cake"; "More sugar"; "Three sugars";
were some of the things Charlotte was saying.

20-12-93 CODED IIA, IIIA

At the nursery carol concert this morning, mince pies & fruit punch were provided. I asked Charlotte to get a mince pie for everyone (3 adults, Charlotte & Mary). Taking one at a time, saying everyone's name she got them. Then she counted them all.

20-12-93 CODED IA
One of the songs (at the nursery carol concert this morning) was, "Five snowmen ...... , Four snowmen ...., Three snowmen .... etc". All day long she sang, but did get the numbers confused occasionally.

21-12-93 CODED IIIP
Joyce had two ribbons, a long one for her dress, and a shorter one for her hair. I asked Charlotte to get the ribbons, while I was doing Joyce's hair.
Charlotte: "What one?"
Mum: "The little one"
Charlotte: "Has Joyce got two ribbons?"
Mum: "Yes"
She gave me the correct one.

22-12-93 CODED IIA, IIIA, IIA, IIIA
Charlotte was in the kitchen tonight when I was dishing up our tea. Dad & Mum had three sausages, two for the three big children, and one for Mary. Charlotte counted the amount of sausages on everyone's plate.

23-12-93 CODED IIA, VA
Told Charlotte this morning to count the buttons on the TV and press number '3' ["Three"], as cartoons were coming on. After several attempts she did it.

24-12-93 CODED IIA, IIIA; IIA, IIIA; IIIA
The children helped to wrap up presents. Everybody had three things in their present. Charlotte counted "Three" for each one. We also counted four stockings. Charlotte had to get "Two" carrots to put out for the reindeer.

25-12-93 CODED IIIP; IIA, IIIA, IIA, IIIA, IIA, IIIA
Today was very hectic. Among the things Charlotte said were:
"I've got more sweeties"; "I've got another jersey"; "My bike's got two wheels like Allan's"

In the afternoon, she helped set out the tables. She put out six sets of cutlery on one table and five sets on the other table. She counted them out the drawer and put them on the tables. She also counted crackers.

26-12-93 CODED IVP; IIA, IIIA
Today we went to a friend's house for lunch. When we arrived she said, "Look, two cars", in the drive.

She counted out the crackers again, this time "Eight", but I had to help after six.

27-12-93 CODED IIA, IIIA; IIIP; IIA; IIIA; IIIA
Today we stayed in and played with the children all day.
Charlotte got a Sesame Street game, - there is no counting required, just colour. When you spin the wheel you go to the next square with that colour. Each time you land on the same colour as your piece, you can hang up a balloon, - you start with five. Each time Charlotte hung up one of her balloons we asked her to count how many she had left. She did it properly each time, - she also won the game.

We also played Donutters. Everyone had to wear an elephant mask and pick up "Three" doughnuts on their trunk. Charlotte got two, but couldn't get the third, "I need one more" was all she could shout.

Then it was Snakes & Ladders. This she found very boring, but was able to count the number of spaces.

Mr. Bucket was next. Mr. Bucket runs around the room spouting balls out. Each player must collect the four balls of their colour and put them in Mr. bucket. Charlotte kept on getting hers in, then another, and was saying, "I've got one, I've got two, .." etc., except each time you put one in, it spurts it back out. So Charlotte couldn't understand why after getting "Four", there were still more.

Lastly, we played the Disney storyboard Game, which was puting cards in the frame, C1, B3, etc. She could count "Three" along etc, but the game was too old for her.

30-12-93 CODED IIIA
Today Sandy took Allan and Joyce out, and so Charlotte and I played with the SNES (games system). You start with five men who can jump on baddies.
"I jumped on another one"; "I've got four stars" etc. were some of the things she said.

31-12-93 CODED IIA, IIIA; IIIA
This morning we all went shopping. Charlotte helped to put things in the trolley, "six lemonades", "six carrots", "two bread" etc. - all correctly.

In the afternoon, we all helped to finish the cleaning. I sent her to bring me two dusters, another cloth, which she did.

01-01-94 CODED IIA, IIIA; IIA, IIIA; IIA, IIIA
This afternoon we all went to my Mum's, where Charlotte counted all the dirty glasses, - but lost count after seven.

We then went to my Gran's, where my uncle was getting her to count all the bottles on the table, he was helping her. Then she had to count all the children, and tell my Gran how many glasses of juice she had to pour.

02-01-94 CODED IIIP, VIP

This afternoon the two older girls were playing at shops. Charlotte asked for numbers of things, and when she was the shop lady she counted out the change using big numbers, eg. "Sixty pounds"; "Seventy-three pounds"; "Four pounds"; "Thirty-eight pounds"; "Thank-you".

03-01-94 CODED IIP, IIIP, IVA, IIA, IIIA

Today we went to Granny Clarke's, Allan took his dominoes. One was thought to be missing, so Allan counted them and saw that there were only twenty-seven. Granny Clarke then said they were all there, a recount showed still twenty-seven. While everyone else was looking for the missing domino, Charlotte held the dominoes and counted up to "seven" repeatedly with them. Before they had all been playing with Granny Clarke and she had given each of them "seven".

04-01-94 CODED IIA, IIIA

This afternoon I was ironing, and when I had finished, they all helped to pair socks, fold towels, and put everything in its correct pile. Charlotte counted the socks in each pile, and was upset that Allan had more (she had tights too).

06-01-94 CODED VIP

This morning before he went to school, I gave Allan his dinner money. He usually gets a 50p and a 20p, but this morning I had to give him 50p, 10p, 5p, and 2 x 2p and a 1p. He didn't think that was right, so I had to keep counting and adding with him till he realized he had 70p.

Later, when we returned from taking Joyce to nursery, Charlotte gave her dolly dinner money. She copied me counting it out, but used different numbers.

07-01-94 CODED IIIP

This afternoon Charlotte was at her cousin's third birthday party. She had a play kitchen, so they were playing with the food.

"Give me more chips"; "I've got two cakes"; "My cup is bigger than yours"; etc. were some of the things they were saying.

14-01-94 CODED IIIA

At the playgroup Charlotte was asked how old she was,

"I'm getting three candles on my cake next week" (It is actually two weeks to her birthday).

15-01-94 CODED IIA, IIIA

This morning we went to the two older girl's (Joyce and Charlotte) Highland Dancing class for the first time. They learned only two steps, but they had to count to "Four" with each step, - they both did it.

17-01-94 CODED IIIP

Today Charlotte was at playgroup. She did a 'gluing' with toilet rolls. She put "four" pieces of toilet roll on her paper and she told me this.

18-01-94 CODED VIA

Today we were talking about Charlotte's birthday, which is next week. She will be three.

"Joyce is 'four', but will be 'five' on her birthday, Allan is 'six' but 'seven' on his birthday, Mary 'one' but 'two' on her birthday"

Charlotte found all this confusing, but after a while she realized everyone was a different age.

19-01-94 CODED IA

Playgroup again this morning. Charlotte learnt a new song which she sang in full.

"Five fat sausages ......, Four fat sausages ......, Three fat sausages ..... etc"

22-01-94 CODED IIIA

Today we went for new shoes for Charlotte and Mary. Several times she had to say "Too big", "Too small", until we found two pairs that were just right.

23-01-94 CODED IIA, IIIA, IIIA, IIIA

This morning we were all helping to do the housework. Charlotte helped to wash the dishes. She cleared the breakfast table herself. when she had washed all the cups, I asked her how many she had, five were there. So we counted how many people were in the house, so she then realized she'd left Mary's cup on her high chair.

24-01-94 CODED IIIA, IIS, IIIS, IIA, IIIA

This afternoon we did some baking. We made Crispy cakes, and Charlotte was told to put two spoonfuls of mixture in each case, so she said, "One, two" about twenty times.

Later she took four eggs out of the box when we made a sponge.

25-01-94 CODED IIIP, VA, VA, VA; VIA, VIP

This morning at playgroup, all the children made a house to bring home. Charlotte proudly showed me the, "Two windows and the door".

Some of the children had their door numbers on their's, but Charlotte didn't, as she didn't know it. So when we came home, I showed her the numbers, and explained it was an '8', "Eight" then a '9', "Nine"; so her number was '89', "Eighty-nine".

Later she was explaining this to Allan. He was showing-off, saying he knew that, and he knew our telephone number was, "Two-O-Two-double-O-One", so Charlotte was playing with her toy telephone dialling any numbers, but saying, "Double O' One" all the time.

26-01-94 CODED VIA, VIA, VIA

Today was Charlotte's birthday. I read all her cards to her: "For a sweet girl who's three today";

"For a dear Three-year old" etc.

This launched a discussion about everyone's age, "Allan and Joyce were 'three' once, but now they are 'six' and 'four'. Mary isn't 'three', she is 'one', but she will be 'three' one day".

27-01-94 CODED VIA, VIA

In the afternoon Joyce was telling Charlotte she was going to school when she was 'five'.

I said that when Joyce was at school, Charlotte would get to go to nursery.

Following on from yesterday, Charlotte said that she, "Was a big girl now", so she should go tomorrow. But she couldn't understand that we had to wait till Joyce was 'five' and at school. So in the end, I said, "You have to be 'four' to go to nursery".

29-01-94 CODED IA, IP, IS

At dancing class again this morning. They were shown how to bow, you must count to "Eight" twice. Since we came home all she has done is sing to "Eight", practising her bow.

30-01-94 CODED IIA, IIIA, VA; IIA, IIIA, IIA, IIIA

Today the girls were playing snap with their dad. They were using an ordinary pack of playing cards, so they were counting the Hearts, Diamonds etc.

Later we were playing a game Joyce got when she was at a birthday party in Mcdonald's. Charlotte was able to count the 'hamburgers' on the dice, then count the correct number of squares by herself, - she won.

31-01-94 CODED IIA, IIP; VIA, VA

Today was Dad's birthday. We made him a birthday cake, but as he was so old we didn't have enough candles. So we put choc chips on, but we had to count to twenty-six, so I had to help. Charlotte only got to 'ten' by herself.

Later, Charlotte and her Dad were talking about time, as he got a new loud alarm clock.,

"This is Nine O'Clock, when playgroup starts"; "Seven O'Clock, bedtime" etc.

no. of incidents = 81 **no. of codes = 191** **time period = 108 days**

APPENDIX C

PARENTAL INTERVIEWS

UNIVERSITY OF NORTH LONDON

James Young

School of Teaching Studies

SEMI-STRUCTURED INTERVIEW SCHEDULE
AND PARENT MEDIATED INTERVENTION TEST

Name .... Date ....

1. Parental age group and sex of parent: M ☐ F☐

under 21 ☐ 21-30 ☐ 31-40 ☐ over 40 ☐

2. Child's age ....yrs ......months

3 Ask parent to carryout the ***Mediated Intervention Test***

4. At the present time, is your child able to correctly:

(a) SAY NUMBERS IN AN ASCENDING ORDER?

Yes ☐ → from ... up to number......
No ☐
Sometimes ☐ → examples? ....

(b) COUNT THINGS ?
Yes ☐ → up to number .... always correctly? → Yes☐ No☐
Sometimes ☐ → examples? .... ↓ ↓
No ☐ examples?
Not sure☐

(c) RECOGNIZE WRITEN OR PRINTED NUMBERS?
Yes ☐ No☐
↓
which numbers.....
↓
examples of when and where? ....

If **all** the answers to Q.4 are **No** then go directly to Q6.

5. At what age did your child start to :

	(a)SAY NUMBERS CORRECTLY?	(b)COUNT THINGS ?	(c)RECOGNIZE NUMBERS ?
Before 2nd birthday	☐	☐	☐
Between 2nd/3rd birthday	☐	☐	☐
After 3rd birthday	☐	☐	☐
After 4th birthday	☐	☐	☐

examples?

6. At what age do/did you expect your child to begin to correctly:

	(a)SAY NUMBERS ?	(b)COUNT *THINGS ?*	(c)RECOGNIZE *NUMBERS?*
Before 2nd birthday	☐	☐	☐
Between 2nd/3rd birthday	☐	☐	☐
After 3rd birthday	☐	☐	☐
After 4th birthday	☐	☐	☐
Whenever child is ready	☐	☐	☐
Whenever I find time to help him/her	☐	☐	☐
When he/she goes to school	☐	☐	☐

Other responses...........

7. Do you help your child to :

(a) SAY NUMBERS ?	(b) COUNT THINGS ?	(c)RECOGNIZE NUMBERS?
No☐ sometimes ☐	No☐ sometimes☐	No☐ sometimes☐
Yes ☐ always☐	Yes ☐ always☐	Yes☐ always☐
↓	↓	↓
since age	since age	since age.........
↓	↓	↓
examples?	examples?	examples?
(a)	(b)	(c) ......

If ***all*** *the answers to Q.7 are* **No** *then go directly to* ***Q.11***

8. How much time do you think you spend with your child on counting activity?:

(a) less than 2mins ☐ between 2&5mins ☐ between 5&10mins☐

more than 10mins ☐ more than 20 mins☐ .... ☐

(b) some days ☐ every day ☐ more than once per day☐ routinely ☐

once or twice per month ☐ just when the occasion arises ☐

....☐

9. Who usually starts the counting activity?:

child ☐ mother ☐ father ☐ another adult ☐ no single person☐

any examples? ....

10. Under what encounters have you known your child to have been engaged in counting activity:

songs/verses/rhymes ☐
up/down stairs ☐
play bricks/toys ☐
books ☐
dressing/undressing ☐
household objects ☐
food prep/serving ☐
finger counting ☐
board games☐
....................☐
....................☐

playground activity☐
money discussions☐
shopping items☐
switching T.V. channels☐
telephone calls☐
bus numbers☐
house numbers☐
body parts☐
playing cards☐
......................☐
......................☐

11. Do you think it is important for your preschool child to be able to:

(a) SAY NUMBERS IN THE CORRECT ORDER ?
No☐ Not Important ☐
Yes☐
↓
Up to.............

(b) COUNT THINGS ?
No☐ Not Important☐
Yes☐
↓
Up to............

(c) RECOGNIZE NUMBERS ?
No☐ Not Important☐
Yes☐
↓
Up to............

PARENT MEDIATED INTERVENTION TEST
AND PRE-DIARY TEST

Child's name .... Date ....

Could you please perform the following activities at a suitable time with your child:

Activity	Child's Response
1. Gain your child's attention, then ask your child to count.	1... ....
2. Say, "one, two, three, four" and then ask your child what is the next number.	2... ....
3. Let your child see three cups, and ask him/her, how many cups are there.	3... ....
4. Give your child three biscuits, and ask him/her, how many biscuits he/she has been given.	4... ....
5. Give your child a T.V. remote control, or a calculator, and ask your child to press the number three.	5... ....
6. Show your child a telephone dial/ key-pad, and ask him/her to touch the number three.	6... ....

PARENT MEDIATED INTERVENTION TEST
AND PRE-DIARY TEST

Child's name .... Date ....

Could you please perform the following activities at a suitable time with your child:

Activity	Child's Response
1. Gain your child's attention, then ask your child to count.	1... ....
2. Say, "one, two, three, four" and then ask your child what is the next number.	2... ....
3. Let your child see five cups, and ask him/her, how many cups are there.	3... ....
4. Give your child four biscuits, and ask him/her, how many biscuits he/she has been given.	4... ....
5. Give your child a T.V. remote control, or a calculator, and ask your child to press the number three.	5... ....
6. Show your child a telephone dial/ key-pad, and ask him/her to touch the number eight.	6... ....

2) Omar:

Omar was aged 4-years 3 months, and his mother was between 31-40 years. They were a bilingual family, both of his parents originated from Korea. Omar could recite the number sequence up to fifteen, although sometimes he would make a mistake by missing out a number, commonly six. Omar was only able to count items in one-to-one correspondence always correctly, up to four. Omar learned to recite the number sequence and count items in one-to-one correspondence close to the age of 3-years. Omar's mother said that he could recognize printed number figures up to '10', - because he had gone to a nursery school in Singapore for one year. It was after his third birthday that Omar began to recognize printed number figures. Omar's mother indicated that she had not assisted Omar to recite numbers, and only sometimes assisted him with counting items or recognizing figures, usually only at his request. Omar was interested in car number plates, and she occasionally interpreted the number figures for him. Omar's mother indicated that it was only on some days that she might assist him with counting activity, and then for only 2-5 minutes, mostly Omar engaged in number activity by himself, through:

counting books

money

house numbers

switching TV channels

and he used to finger count

Omar's mother appeared to rely on his nursery teacher to mediate aspects of number to him. Omar's mother thought that number recitation was important, but a meaningless activity without counting. She thought that counting for a pre-school child was important, but that a child should not be pushed very much, they should be left to their own interests.

3) Kevin:

Kevin was aged 4-years 0 months, and his mother aged between 21-30 years. Kevin's mother indicated that Kevin could recite the number sequence up to ten, and count items up to ten, although not always correctly, - sometimes Kevin would miss out a sequential number. Kevin's mother had assisted Kevin to recite numbers and count with numbers from the age of 1-year. Kevin mastered the skills of number reciting and counting between his second and third birthday. Kevin does not yet recognize number figures, and his mother indicated that she does not assist him with this aspect of number. She expects Kevin to learn to recognize number figures when he goes to school. Kevin's mother indicated that she routinely spends more than ten minutes everyday with Kevin mediating number activity, and that it is she who usually initiates the number activity, which takes the forms of:

songs/verses/rhymes	playground activity
up/down stairs	money discussions (counting coins)
counting books	body parts
food prep/serving	finger counting

Kevin's mother thought that it was important for a pre-school child to be able to recite and count numbers up to ten, but she did not think that it was important for them to be able to recognize printed numbers until school age.

4) Ivan Roberts:

Ivan is a boy aged three-years and eleven months. According to his mother, who is aged between 21- 30, Ivan is able to recite numbers in sequence from 1 to 120. He is also reported to be able to count items in one-to-one correspondence, with no cardinal limit, "Whatever is there", as long as they are in some sort of order. Ivan is able to read written or printed numbers, and he has practised this skill on door numbers and bus numbers. At present he is being introduced to three figure numbers. Ivan was able to recite numbers and count using numbers before he reached the age of two, he learned to read numbers around 2-years of age. Ivan's mother indicated that she began assisting Ivan to recite numbers at the age of 1-year, using nursery rhymes. She indicated that at 1-year she assisted Ivan to count toys and other items. From the age of 2-years, she instructed Ivan in the recognition of number figures through using and referring to door numbers, bus numbers and clock faces. Ivan can recognize all the coins by reading the number figure printed. Ivan is presently being introduced to time. Ivan's mother indicated that she spends time mediating number to Ivan everyday, and that it is usually Ivan that draws her into counting activity. Ivan's activities which give rise to the mediation of number are:

songs/verses/rhymes	prices during shopping
up/down stairs	money discussions
play bricks/toys	telephone numbers
counting books	bus numbers
finger counting	house numbers
cups/household items	body parts

Ivan's mother thinks that it is important for a pre-school child to be able to recite, count, and read number figures up to 50.

8) Yvonne:

Yvonne was a young girl aged 3-years 6 months, she attended a nursery school in the mornings and was looked after by a nanny five days per week. Yvonne was reported to be able to recite numbers up to ten, and to count items up to ten, although not always correctly. Sometimes Yvonne would miss out a sequential number, she would make less mistakes in pointing. Yvonne is reported to have already developed a dislike of using numbers, she shies away when confronted with an aspect of number. Although Yvonne talked at a very early age, and knew most colours by eighteen months, she did not learn to recite or count with numbers until close to her third birthday. Yvonne has recently begun to recognize the printed number figures for '1', '2', and '3', but she is reported to hate doing this, and often refuses to attempt or participate in number figure recognition exercises. Yvonne's nanny has helped Yvonne since the age of 3-years to recite numbers and count, sometimes counting jig-saw puzzle pieces and fruit. Yvonne is reported to be drilled in number at nursery school. At home, Yvonne routinely spends a total of twenty minutes everyday on activity involving number use, usually with her mother, father and her nanny. Number is mediated to Yvonne through:

songs/verses/rhymes	money discussions (counts foreign coins)
playing with bricks/toys	house numbers
counting books	telephone numbers
household objects	finger counting
food prep/serving	board games

Yvonne's nanny thought that it was important for a pre-school child to be able to recite, count and recognize number figures up to twenty.

9) Colin:

Colin was 3-years 5 months old, and his mother was aged 21-30 years. Colin was reported by his mother to be able to recite the number sequence up to twenty, but occasionally missing out a number. Colin was also reported to be able to count up to twenty objects, but not always correctly. Colin was able to recite numbers and count after his second birthday. Colin's mother started to assist him to recite numbers from the age of 1½-years, and to count with numbers from the age of 2½-years. An older sister had also assisted in this process, often stairs were counted. Colin was not able to recognize printed number figures, and his mother had not assisted him with this aspect of number. Colin's mother expected him to recognize number figures before he was 4-years old. Colin's mother routinely spends 2-5 minutes, everyday, sometimes more than once per day, on mediating number activity to Colin. Often it is she who initiates Colin's number activity, sometimes in connection with up/down stairs, but his sister also starts number activity as well. Colin's number activity is mediated through:

songs/verses/rhymes	playground activity
up/down stairs	shopping items
playing with bricks/toys	body parts
counting books	counts parked cars
household objects	finger counting
dressing/undressing	

board games (he plays with a dice but does not interpret the number)
money discussions (plays with coins but doesn't know their value)

Colin's mother thinks that it is important for a pre-school child to be able to recite numbers and count with numbers up to twenty, but that being able to recognize printed number figures is not too important before school.

Parent Mediated Intervention test results

1. When asked to count, Colin counted from "one" to "twenty".
2. After, "One, two, three, four" was recited, Colin said "Five" was next.
3. Colin counted three cups correctly in one-to-one correspondence.
4. Colin was able to cardinally label three biscuits
5. Colin could not press "three", a figure '3', on a remote control when asked.
6. Colin touched the figure '3' on a telephone dial when asked to touch "three"

10) Elizabeth:

Elizabeth was 3-years 5 months old, and she was of mixed parentage. Her mother was black, aged between 21-30 years. Elizabeth's mother indicated that Elizabeth could recite the number sequence up to fourteen, although she sometimes missed out 'nine' and 'eleven'. In terms of one-to-one correspondence counting, Elizabeth was able to count correctly up to eight objects. Elizabeth learned to recite numbers and count objects after the age of 2-years. Although Elizabeth could not yet recognize printed number figures, her mother expected her to acquire this skill soon, sometime before her fourth birthday. Elizabeth's mother assisted Elizabeth to recite numbers from the age of 2-years, and to count objects from the age of 2½ years. In the evenings her father usually assists her to recognize number figures, by writing the figures down. Elizabeth's mother indicated that she routinely spends more than twenty minutes everyday on counting activity with Elizabeth. Elizabeth's number activity is often sparked by Elizabeth herself, although her mother indicated that it was she who had initially interested Elizabeth in numbers, and now Elizabeth's father sometimes begins number activity in the evenings with her. Elizabeth's number activity has been mediated through:

songs/verses/rhymes	playground activity
up/down stairs	money discussions
playing with bricks/toys	shopping items
counting books	body parts

Elizabeth's mother thinks that pre-school children should be able to recite, count, and recognize number up to twenty.

12) Philip:

Philip was a boy aged 3-years 3 months, and his mother was aged 21-30 years. Philip could recite numbers sequentially up to twelve by himself, and up to twenty with some help from Mum and Dad. Philip is reported to be able to count items up to ten in one-to-one correspondence with his sequential number words, but not always correctly. Sometimes when counting a small quantity of items he will continue to recite numbers above the pairing threshold. Philip acquired his number recitational skill before his second birthday, and he learned how to count items using numbers after his second birthday. Philip is able to recognize all the number figures up to and including '9', and he acquired this recognition skill before he was three, mainly from switching TV channels. Philip often calls out the number name when he recognizes a displayed figure. Philip's mother assisted Philip to recite numbers from the age of eighteen months, he began talking around 13/14 months. Philip's mother also said that she helped him to count items and recognize number figures from the age of 2-years, mainly using a counting book. Philip's mother said that she routinely spends more than twenty minutes total everyday mediating number to Philip. Although Philip often initiates the number activity now, in the past it was usually Mum or Dad who started it. Philip's number activity is mediated through:

songs/verses/rhymes

up/down stairs

playing with bricks/toys

counting buttons while dressing/undressing

finger counting

playground activity (counts slide ladder steps, counts jumps on trampoline)

switches TV channels (correctly)

telephone numbers

bus numbers, house numbers

playing cards (recognizes figures)

ages (self and friends)

Philip's mother thinks that it is very important for a pre-school child to be able to recite the number sequence up to ten, and to be able to count items up to ten, and to be able to recognize all the single number digits.

13) Derek:

Derek was aged 3-years 3 months, and his mother was aged between 31-40 years old. Derek's mother said that Derek could recite the first five numbers in sequential order, but that he could not count using numbers. Derek was reported as not being able to recognize printed number figures either. Derek began to recite numbers around the age of 3-years while at nursery school. Derek's mother also suspected that he may count as well at nursery school, but she stated that he does not count at home. Derek's mother expects him to learn how to count and recognize number figures before he is 4-years old, mainly through practices at nursery school. Derek's mother indicated that she only sometimes assists Derek to recite numbers, from songs, and through playing a counting video. Derek's mother only sometimes assists Derek to count items, occasionally while tidying toys away. Derek's mother does not assist Derek with number figure recognition. Derek has counting books but these are not read at home, he is reported to do this at nursery school. In general, Derek's mother only assists Derek with aspects of number just when the occasion arises, between 2-5 minutes some days. Derek's mother indicated that Derek's father usually starts any number related activity, and Derek's number mediation may stem from:

songs/verses/rhymes

up/down stairs

counting books

finger counting

dressing/undressing(buttons)

playing with bricks/toys(returning toys to a box)

switching TV channels (presses number buttons at random)

household objects(but don't count spoons, knives, forks)

money discussions (plays with coins, mother differentiates coin values)

Although Derek's mother considers number recitation and counting to be important for a pre-school child, she considers this to be something that they just 'pick-up', and she acknowledges that she does not do too much to assist Derek in this respect. She also thinks that number figure recognition up to ten is important as well, but tends to leave this up to the nursery school.

15) Linda:

Linda was Helen's older sister, she was aged 3-years 0 months. Both girls were very close in age. Linda was reported to be able to recite numbers up to thirteen, and to count items up to thirteen, but occasionally making a mistake, - she would sometimes forget the sequential order. Linda had learned to recite numbers in order around the age of 2-years, and had learned to count items after her second birthday. Linda could not recognize printed number figures, but was expected to acquire that skill when Linda's mother finds time to help her, sometime before her fourth birthday. Although Linda's mother indicated that she had initially helped Linda from the age of 1-year to recite the number sequence, she had not assisted Linda to count items, saying Linda just began to count items on her own account. Linda's mother indicated that she intends to help Linda to recognize printed number figures. Linda's mother said that she spends more than twenty minutes everyday mediating number activity to Linda. Usually Linda initiates the number activity by getting a book. Linda's number activities stem from:

songs/verses/rhymes	playground activity
up/down stairs	money discussions
playing with bricks/toys	switching TV channels
counting books	body parts
counting buttons while dressing/undressing	finger counting

Linda's mother repeated that she would not be concerned if a pre-school child could not recite a number sequence, or count items or recognize number figures, since she did not think that these were important at a young age.

18) Janet:

Janet was a young girl aged 2-years 6 months. Janet's mother indicated that Janet could recite the number sequence up to ten, and that they often played a recitation game which takes the form of her saying 'two' and Janet replying 'three', and when she continues with 'four', Janet will reply 'five' etc. Janet can count up to ten items as well, usually always correctly, and she can differentiate between the cardinal quantities of 'one', 'two' and 'three'. Janet's mother deliberately assisted Janet with number recitation and counting from the age of 18 months, by reciting when appropriate, and quantifying anything that came to hand. Janet was able to recite numbers before her second birthday, and count items using numbers after the age of 2-years. Janet does not yet generally recognize printed number figures, although she may possibly know the figures '1', '2' and '3', Janet often switches TV channels, and she plays with a toy telephone and clock. Janet's mother said that she routinely spends between 5-10 minutes everyday, sometimes more than once per day, on activity involving aspects of number use. Usually Janet's mother initiates the activity, and Janet quickly joins in. The activities in which number is mediated to Janet are:

songs/verses/rhymes	playground activity (joins in with other children)
up/down stairs	money discussions (knows all the coins)
counting books	playing with bricks/toys
finger counting	dressing/undressing

shopping items (knows what to pick up and how many)
switching TV channels (can switch on a stated channel number)

Janet's mother thinks that it is important for a pre-school child to be able to recite numbers in sequence, and to be able to count items ("the more the better"), and for a pre-school child to be able to recognize all the single number digits.

26) Dick:

Dick is aged 2-years 3-months and his mother between 21-30. Dick's mother indicated that Dick could recite the first three numbers in sequence, although he cannot always count three items in a one-to-one correspondence relationship with his number words. Dick is able to recognize number figures, he knows '1', '2', '4', '5', and he has learned these from television channels, and a number pattern on his high chair. Dick has also seen numbers printed in books, magazines and newspapers. Dick started to recite numbers, count with numbers, and recognize numbers after his second birthday, and this was/is expected by his parents. Dick's mother indicated that she assisted Dick to recite numbers from the age of two, and she assisted him to count using numbers from the age of two, counting food items, crayons etc.. Dick's mother also said that she only sometimes helps him to recognize number figures. Dick's mother spends about 2-5 minutes mediating aspects of number to him, but only when the occasion arises, not everyday, and it is she who usually initiates the number activity. The activities in which number is mediated to Dick are:

counting books	switching TV channels
food preparation/serving	telephone numbers
finger counting	body parts

Dick's mother thinks that it is important for a pre-school child to be able to recite numbers, count with numbers and recognize number figures.

Parent Mediated Intervention test results

1. When asked to recite numbers Dick ignored his parent's request.
2. After, "one, two, three, four" was recited, Dick was unable to say the next number.
3. Dick was able to correctly count three cups.
4. When given three biscuits, Dick was able cardinally label their quantity as being "three"
5. Dick was unable to touch the figure '3', when requested to touch "three".
6. Dick was unable to recognize the figure '3' on a telephone dial.

The answers to Q5 & Q6 cast doubt on the figure recognition ability attributed to Dick in the parental interview.

27) Diana:

Diana was a little girl aged 2-years 3 months, and most days she was looked after by her Grandmother, while her mother worked. Her Grandmother provided the following information about Diana's numbers skills/interaction.

Diana was able to recite numbers up to ten or eleven. Diana could count items up to five or six by herself, and up to ten or eleven with some help. Her counting is not always accurate, sometimes Diana misses out a sequential number. Diana had learned to recite numbers and to count using numbers before she was 2-years old. Diana was also reported to be able to recognize the first few number figures, '1', '2', '3', '4', she had learned these from a counting book, and from watching a television ABC programme. Diana was reported to have learned to recognize these number figures before her second birthday. Diana's grandmother has assisted Diana to recite numbers since she was 1-year old, and by the time she was 1½-years she was able to repeat her grandmother's number recitations. Diana's grandmother had also began to mediate number counting and number figure recognition to Diana from the age of 1½-years, using a counting book. Diana usually initiates her own number activity, she loves playing with money, and she often hands money over while out shopping. Diana's grandmother said that she routinely spent more than twenty minutes everyday mediating number to Diana through:

songs/verses/rhymes	playground activity
up/down stairs	money discussions
playing with bricks/toys	playing with a toy telephone
counting books	body parts

Diana's grandmother thought that it was important for a preschool child to be able to recite numbers up to ten or eleven, to be able to count items up to ten or eleven, and to recognize number figures up to ten or eleven.

30) William:

William was a little black boy, aged 2-years 2 months, he was an only child and his mother was aged between 31-40 years. William's mother indicated that William could recite the number sequence up to twelve in order, and then he would often add some of the teen numbers such as 14, 15, 19, and 20, but usually jumbled up. William was reported to be able to count items up to ten, often counting stairs, steps on a climbing frame, and fingers on both hands. William's mother also said that William could recognize the number figures '1', '2', '3', '4' , and that he had learned these from using a TV remote control and from seeing them in books. William was reported to have acquired all his number skills before his second birthday, and his mother had aided him in this appropriation, - through counting fingers and reading counting books to him. William's mother said that she usually started number activity with William, and although the number activities often lasted less than 2 minutes, his mother said that they occurred more than once per day, everyday, routinely, through:

songs/verses/rhymes	playground activity
up/down stairs	money discussions (counting coins)
playing with bricks/toys	switching TV channels
counting books	body parts
household objects	finger counting
watching TV & video cassette numbers	

William's mother thought that it was important for a pre-school child to be able to recite numbers up to 100, to be able to count up to 50 items, and to recognize written number figures up to 100.

33) Walter:

Walter was Francis's younger brother. Walter was 2-years 0 months old. Walter was reported by his mother not to be able to recite a sequence of numbers, nor to be able to count, however he is able to recognize the number figures, '1', '2', & '8' (see examples below). Walter's mother is presently assisting him with number recitation and counting, she helps him to pronounce the number words and she counts stairs for him, she also counts his fingers. Walter's mother expects Walter to be able to recite numbers, count using numbers, and to recognize number figures before he is 3-years old. Walter's mother is the person who usually initiates number activity for Walter, and she routinely spends between 2-5 minutes everyday on number related activity. Number has been mediated to Walter through:

up/down stairs

finger counting

switching TV channels (video channel '8')

age discussions (he recognized a '2' on a birthday card)

playing with bricks/toys (recognized the '1' on Walter the Tank Engine toy)

Just as she had stated for Francis, Walter's mother thinks that it helps a pre-school child if they are able to recite numbers, count items, or recognize number figures, but that these skills are not too important for a young child to master.

34) Roy:

Roy was a little boy aged 1-year 10 months, and his mother was aged between 21-30 years. Roy is reported by his mother to be able to recite the first four numbers in sequential order, followed by a string of even numbers. Roy's mother also said that he could count small quantities of items, usually only getting the first few numbers correct. Roy's mother had assisted him with number recitation since he was less than 1-year old, and she has assisted him to count quantities since he was 1-year old. Roy is beginning to recognize printed number figures, he plays with a toy telephone and a real computer (his dad's). Roy's mother thinks that his number figure differentiation is more due to luck than skill, but she fully expects him to be able to recognize number figures between his second and third birthday, she assists him to draw the outline of number figures. Roy's mother routinely spends more than ten minutes everyday mediating aspects of number to Roy, often more than once per day. Roy's number activity is sometimes started by himself and sometimes by his mother. For Roy, number is mediated through the following activities:

songs/verses/rhymes	playground activity(counts the steps up the slide)	
up/down stairs	money discussions (he has real coins)	
playing with bricks/toys	shopping items	household objects
counting books	body parts	dressing/undressing(shoes/socks)

Roy's mother is not overtly concerned about a pre-school child appropriating aspects of number. Although she thinks that being able to recite numbers is important, she would not be concerned about a pre-school child who could not. Roy's mother does not think that it is important for a pre-school child to be able to recognize number figures.

<u>Parent Mediated Intervention test results</u>

1. Roy recited, "one, two, three, six, eight".
2. Roy was unable to say that "five" was after "one, two, three, four".
3. While his mother pointed to each of three cups, Roy said, "one, two, three".
4. Roy could not cardinally label three biscuits that he had been given, as "three".
5. Roy first touched the figure '5', then '3', when asked to touch "three"
6. When asked to touch "three" on a telephone dial, Roy touches '1', saying "three gone".

35) Sarah:

Sarah was aged 1-year 10 months and she was mostly looked after during the day time by a nanny. Sarah's nanny was aged between 31-40 years and she provided the following details concerning Sarah's number skills. Sarah is able to recite the first three numbers in order, followed by 'four, six, eight'. Sarah is able to recite numbers before her second birthday, and she has been assisted in this practice since the age of 11 months. Sarah's nanny was not sure if Sarah could count items in one-to-one correspondence with number words, at present she is only able to say 'two shoes'. However Sarah's nanny was aware that Sarah could recognize the number figures '1', '2', '3', since this had been demonstrated while reading a picture book. Sarah has been shown number figures in books since the age of 1½-years. Sarah has been assisted with counting, but . Sarah is expected to learn how to count quantities between the ages of 2- and 3-years, and to recognize more figures between the ages of 2- and 3-years. Sarah's nanny routinely spends less than 2 minutes everyday with Sarah on number related activity. Sarah's number activity is often started by Sarah herself or her mother. Sarah's nanny reports that Sarah is usually very interested in number activity, she recites numbers when playing jumping games. Sarah's number appropriations are mediated through:

songs/verses/rhymes
up/down stairs
playing with bricks/toys
counting books
dressing/undressing
playground activity (on the slide)
switching TV channels
house numbers (no. '6' & '8')
household objects (knives & forks)

Sarah's nanny thinks that it is important that pre-school children understand that numbers exist. Sarah's nanny also considers that it is important for pre-school children to be able to count quantities of items up to ten, and recognize number figures up to ten.

APPENDIX D

EXAMPLES OF MEDIATED NUMERICAL UTTERANCE IN PRESCHOOL PLAYGROUPS/NURSERIES

D1: A College Creche

D2: A Council Play & Stay Playgroup

D3: A mother & Child Preschool Playgroup

D4: A Private Drop-in Nursery

D5: A Primary School Nursery Class

APPENDIX D1

Total Examples of Mediated Numerical Utterance in a College Creche

23/2/93 (V) CODED IIIA, IIIA, IIS, IIP, IA, IIIA, IIIA, IIA

Prologue: It is Mid-afternoon and the children are all sitting around a group of joined tables, - it is time for an afternoon snack. Two of the creche staff are busily preparing drinks and the snack, and the two other staff members are sitting with the children.

Researcher: "You sit on your chair Ashley, sit on your own chair" (a staff member sits Ashley down)
Staff 1: "Oh Ashley, don't you want to sit on the other chair, you're a big boy now, you won't fall out, sit beside Daddy because we just have three baby chairs"
Staff 2: "Fifteen" (calling out the number of children after pointing to each child and counting inwardly to herself)
Staff 3: (speaking in the background, she is preparing the number of drinks required by the children, and she repeats the number called out by her colleague) "Fifteen"
(the children look at the staff member who spoke)
Staff 2: "Of you little horrors" (cuddling up close to the nearest child)
Children: (patiently sitting waiting, but a little)
Staff 2: (out of the video picture) "Are you counting?" (looking towards a little girl, she is dressed in a pink jumper and is called Kim)
Kim: (pointing with a finger to each of the children sitting around the table, her lips move subvocally, she appears to be counting to herself)
Staff 3: (obviously pleased with Kim's behaviour, staff 3 gives Kim a pat on the head)
Kim: (a few moments later, Kim appears to start counting once again, she points to herself and all the other children that she can see. Kim does this more than once, - possibly because she is not satisfied with her count or wishes to confirm it with subsequent counts)
Staff 2: (out of video picture, probably watching Kim, verbally assists Kim's counting by periodically mentioning a few numbers) "Fifteen, are you sure? Are there fifteen?"
Kim: (nods her head)
Staff 2: "Yes"
Staff 2: (out of video picture) "Fifteen, that's a lot isn't it; Fifteen" (starts to point to each child and counts aloud) "One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen"; (turning to speak to researcher) "You picked a good day"
Researcher: (replying to staff 2) "Is there more here than normal?"
Staff 2: "Yes, more than usual, yes ... more than usual"

Date:

26-02-93 (D) Codes IIIA

A group of children were seated at a table playing with dough and cutting out dough shapes by impressing a shape on top of the dough. A staff member was also seated at the table and she was showing the children what to do, and assisting the younger children. Ashley was also seated at the table and he was cutting out crescent 'moon' shapes. Researcher (Dad) assisted Ashley to cut out his 'moon' shapes, and researcher commented to Ashley that he now had "four moons". The staff member sitting at the table may have overheard this numerical description to Ashley, for she repeated the comment to another child seated beside her, saying to the child, "Look, Ashley's got **four** moons"

02-03-93 (D) Codes IP
A little girl sitting at a table set out with picture dominoes was shown one of the domino pictures by researcher, it had a picture of a fish on it, and she immediately burst into song, singing the rhyme "Once I caught a fish alive", starting with the number sequence recital "**One, two, three, four, five**, once I caught a fish alive; **six, seven, eight, nine, ten**, then I let it go again"

05-03-93 (D) Codes IIIA

Two children were playing on an indoor see-saw and Kirk wanted to join in their game, he called out to the two children, "Stop you two", and the children stopped.

09-03-93 (D) Codes VIA

As one of staff members concluded a talk to researcher, the staff member turned to a child to demonstrate her point about children being aware of their ages, and asked the child, "How old are you?" (a boy called Tom, a child in whom the staff member probably had confidence to provide a sensible answer to the question regarding his age). Tom immediately replied "Two and a half", and when pressed by the staff member, "How old will you be on your next birthday?", Tom replied "Three and a half"

12-03-93 (D) Codes IA

As a mother collected her child at lunch-time she immediately noticed that her child's runny nose required attention. As the mother raised tissue to her child's nose she called out to the child, "One, two, three, blow".

APPENDIX D2

EXAMPLES OF THE NUMERICAL UTTERANCE IN A COUNCIL UNDER-5 PLAY & STAY PLAYGROUP

Date/Time	Codes	Time length	No. of Children
12-10-93 (V)/14.21	IP, IS, IP, IA, IA, IP, IP, IA, IA, IP	9mins	6

Prologue: Children are playing in the sand-pit, one girl begins to stand on the surrounding wall and the girl recites a number string before jumping into the sand-pit, other children join in the jumping and imitate the number reciting practice.
Lauren: (standing on the surrounding sand-pit wall) "One, two, three"
(repeats her call) "One, two, three, go" (she jumps into the sand-pit)
Staff: "Hey"
Charlie: (copies Lauren's activity, he climbs onto the wall and shouts)
"One, two, three, four, five" (Charlie then jumps into the sand-pit)
The staff member supervising the sand-pit activity applauds by saying "Hey", and she attempts to encourage the other children to follow suit by saying, "You do it; No, you do it"
Another little boy, Raymond, jumps also, but does not precede his jump with any utterance.
The jumping activity ceases briefly. A few minutes later Ashley jumps, but he also does not call out anything before jumping. Raymond jumps again, but says nothing.
Another child, a boy, who is standing on the sand-pit wall begins the number recital again.
Boy: (stand on the sand-pit wall) "One, two, three" (he then jumps into the sand)
Yet another little boy is standing on the wall, he doesn't appear very sure what to do or say. Staff: (the staff member notices the little boy and she calls out on his behalf) "One, two, three, jump, jump" (the boy jumps, and the staff member voices her approval) "Hey"
Another three boys poise to join in the jumping activity.
Staff: (encourages the children by calling out the number string once again)
"One, two, three, go" (two of the three boys jump)
The staff member continues to encourage the children's jumping activity and she calls out once again to three children who have positioned themselves to jump from the sand-pit wall.
Staff: "One, two, three, ready, steady, go" (other children also call out "go, go" and the three boys jump)
More children stand on the wall, positioning themselves to jump.
Little Girl: "One, two, three, five, six, seven, nine, ten" (then she jumps alone)
The staff member corrects the number string recital by calling out to the girl who has jumped.
Staff: "You missed out four and eight"
Another child, a little boy, takes up the number chant.
Little Boy: "One, two, three, four" (the boy does not jump)
The staff member takes up an encouraging chant again.
Staff: "One, two, get ready Greg; One, two, three, ready, steady" (and some more children jump off the wall into the sand-pit)

Another boy jumps into the sand, but makes no number chant beforehand. The children continue the jumping game, and the staff member calls out "Ready", a child shouts "Go", and another boy jumps. The staff member continues to encourage the children "On your marks, get set", and other children call out "Go", a child jumps. All the children then take up the number chanting again:
Children: (calling out in unison) "One, two, three, four, five, six, seven, eight " (and a lone child's voice continues, probably Mary's - a 'bossy' 4 year-old child) "nine, ten, eleven,twelve, thirteen, sixteen, seventeen" (no jumping takes place, and the children continue to play with buckets and spades in the sand-pit)

Date/Time	**Codes**	**Time length**	**No. of children**
08-11-93 (V)/14.50	IP, IP	2mins	5

Prologue: Children are playing Hide-and-Seek outside the playroom centre, behind the bike-shed. The game has been organized by the oldest child, a girl called Mary, aged 4 years-old.
Mary: "Just a minute, you have to count"
Matthew: (stands on one side of the bike-shed, folds his arms and bends his head into the folded arms while leaning on the wall of the bike-shed, he begins to recite the number sequence) "One, two, three, four, five" (nothing audible beyond five)
The other children run around the other side of the bike-shed while Matthew counts, but they peek around the top end of the bike-shed and start chanting in unison
All the Children: "One, two, three, four, five, six, seven" (then they continue to hide behind the bike-shed)
Matthew: (appears to continue counting, although he cannot be heard, but when he stops counting he calls out) "Ten"
Matthew then turns around, he first sees a girl (Rebecca) who did not go and hide, (she probably did not know what was happening) and then Matthew runs around the bike-shed shouting, "I found ya, I found ya" and he sees all the children.
Mary runs back around the bike-shed, but the playgroup staff shout at the children not to go behind the bike-shed, and their Hide-and-Seek game ceases.

Date/Time	Codes	Time length	No. of Children
16-11-93 (V)/14.35	VS, VP, VP	2 mins	1

Prologue: A girl, Mary, is observed to be playing with a toy till. The till has levers which can be pressed, and there are number figures printed on the levers.
Mary: (playing alone with the till, she calls out as she plays) "Five, ten, fifteen, five, one"
Kirk goes over to see what she is doing, he watches her pressing the numbered levers, but Mary picks up the till and doesn't let him watch her. Kirk returns to his chair.
Mary: (continues to play with the toy till, and she calls out numbers again)
"Five, ten, fifteen, twenty, twenty-five"
Kirk returns to see what she is doing, but Mary stops playing with the till briefly, - it is broken and it doesn't function properly. A few moments later Mary returns to play with the till and she presses the levers again, calling out once more "Five, ten, fifteen".
Mary and Kirk then begin to chase each other around the room.

Date/Time	Codes	Time length	No. of Children
22-11-93 (V)/14.09	IIIA, IIIA, IIA, IIIA, IIIA, IIIA	2 mins	2

Prologue: Children are sitting at a table with a staff member, they are being shown how to make a snowman decoration with cotton wool, glue and black paper circles for buttons/eyes.
Staff: (returns to the table, she sits down, she is carrying black sheets of paper and scissors, she cuts out small circles for eyes)
A little girl called Amber tries to sit in Kirk's chair, the staff member stops her, saying
Staff: "That's not your chair, is it?; Its Kirk's" (Amber moves away)
Staff: "Two eyes" (lays down two eyes in their proper position on Kirk's snowman's head)
Staff: "You've got to steep them"
Kirk: (puts glue on the eyes, which still lie in the same position in which there were placed)
Staff: "Take your eyes off; Do under there" (demonstrates where Kirk should put glue)
Staff: "Joshua, here's your two" (places two eyes on Joshua's snowman's head, once again in their proper position) "Right, thank-you"
Joshua: "Do you put glue on them?
Staff: "Did you put glue on them?" (turns over Joshua's snowman's two eyes) "You put a drop of glue on there and some there (touches the surface of the two eyes) "Like Kirk, look"
A minute passes while the eyes are glued under a guided commentary from the staff member.
Amber's mother comes over to the table, Amber has left her snowman unfinished, her mother starts to spread glue over the paper, calling, "Here Amber; Here Amber". Amber comes over and sits down on her chair. Meanwhile Kirk has been examining his snowman's paper buttons, and he separates a button that has had two stuck together.
Staff: (laying buttons on Joshua's snowman's body, in suitable positions)
"Right; One button, two buttons, three buttons"
Staff: (turns to look at Kirk's snowman, and she call out in surprise) "You've got four"
"Let me see if Joshua's got four" (turns back to inspect the number of buttons that she has given Joshua) "One, Ah, three, got it"; (finding two buttons stuck together on the third button) "You've got four, that's it"
Amber runs off again, she is eating an apple, not interested in making a snowman, but her mother remains standing over the table, busy completing Amber's snowman with cotton wool.
Kirk: (he has placed the buttons on the snowman in a vertical position, without spaces in-between them, and a large space remains under the bottom button)
"I've not got enough buttons"
Staff: (turning to look at Kirk's snowman) "Right, that looks ready" (she touches Kirk's snowman's buttons to press them into the cotton wool to stick better) "Oh, you've got five, I think one of Joshua's snowman's buttons flew over" (one of Joshua's snowman's buttons must have stuck to her finger as she transferred her hand from Joshua's snowman to Kirk's, she then returns Kirk's fifth button to Joshua's snowman, commenting to Joshua) "Fall off did it?"

Date/Time	Codes	Time length	No. of Children
22-11-93 (V)/15.21	IIIA, IIP, IVS, IIP, IIP, IIS	3 mins	1

Prologue: Kirk moves over to where Mary and her mother are seated, and they all begin to play with toy cars and a garage. They are soon joined by another little boy called Jack. Mary's mother involves herself in the play, and a discussion as to the number of toy cars that will fit into the garage lift arises.
Mary's mother: "Can you get two in it?"
Mary: "Yea, you can"
Mary's mother: "Can you get two in it?"
Jack: "That one can go in"
Mary's mother: "Can't"
Mary: "It can"
Jack: "That one can't get in" (there are two differently sized toy cars)
Mary's mother: (winds up the lift) "Ready" (and the children claim their cars at the top)
Kirk watches all the activity.
Kirk: "Two lines" (looking at cars that Mary had arranged in two rows)
Mary: (points to the cars in her two rows, there are three in one row and four in the other) "One, two, three, four" (this is her row of three cars, she touches each car once, counting in one-to-one correspondence with her number words, but she miscounts at the start, touching a car not in the first row of three. Mary then moves on to count the cars in her second row) "One, two, three, four" (touching each car once as she matches each with a number word. Realising that she has miscounted her first row, - probably by subitization, she counts the first row again) "One, two, three"
Mary: (she then picks up another car and adds it to her first row, she then points to each of the cars in her two rows again, counting out loud) "One, two, three, four" (for the first row) "One, two, three, four" (for the second row)
Kirk: (picks up another car that has come down the garage slipway, and he adds it to Mary's second row, saying) "Here's another one"
Mary: (counts the number of toy cars in her second row again, this time from the opposite direction compared to her previous counts of this second row)
"One, two, three, four, five"
Kirk: (while Mary has been counting her second row after its extension, Kirk adds another car to Mary's first row, - it too now has five)
Mary: (points to each of the cars now in her first row, she counts silently to herself, and she is not happy with her final count word, she removes the last car that Kirk added, to leave only four in her first row)

Date/Time	**Codes**	**Time length**	**No. of Children**
23-11-93 (V)/13.27	IIS, IIIP, IIIA, IIA	5 mins	1

Prologue: A little girl, Emma, sits alone trying to count a number of toy trees that she has lined up next to each other. There are short gaps in-between each toy tree. Emma starts to touch each of the trees in her line, pointing once to each tree as she moves along the line, it appears as if she is counting the trees but nothing audible is heard, although she mumbles to herself. After Emma has completed her points to each tree in her line, she repeats the exercise, but this time she touches only a few of them and does not appear to count them. Emma then sits back and looks at her line of trees. No parent or staff member is nearby to help her. Emma takes a drink of her juice, and then directs her attention across the room. Emma continues to sit, periodically straightening up her line of trees and looking across the playroom. After a few minutes, researcher directs Ashley's attention to the line of trees.
Researcher: "Look at all these, what she's done"
Emma: (once again starts to point to some of the trees in her line, moving from one end to the other, as if she were counting the trees, but nothing audible is heard)
Emma: (noting the researcher's interest in her tree line-up, comments to the researcher) "I've got two"
Researcher: "How many?"
Emma: "Two trees" (there is in excess of twenty lined-up)
Researcher: "Count them; Count how many"
Emma: (pointing steadily along her line of trees) "One, two, three, four, five, six, seven, eight" (she stops counting, apparently unsure how to continue, but then she continues) "twenty, forty, forty, forty" (she stops counting and starts again)

"One, two, three, four, five, six, seven, eight, nine, ten" (the last three numbers are mumbled, but she completes her count with a clearly spoken) "Forty"

APPENDIX D2

TOTAL NUMERICAL UTTERANCES IN A COUNCIL UNDER-5 PLAY & STAY
(V) - video recorded (D) - Diary note

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
21-09-93 (D)	Nothing		
22-09-93 (D)	Nothing		
29-09-93 (D)	Nothing		
30-09-93 (D)	Nothing		
05-10-93 (D)	Nothing		
06-10-93 (D)	IIIA, IIA, VA (G) A father assists child with counting puzzle	10 mins	1
	IIIA, IIA, IIIP (C) Parent hands out smarties	3 mins	4
07-10-93 (D)	Nothing		
11-10-93 (D) /13.57	IP (G) A little girl (Sammy) jumped into sand-pit calling out "One, two, three". She later continued her recital up to ten, and some of the 'teens	1min	1
11-10-93 (V) /13.27	IA (AC) Staff member recites "One, two, three" as she brings out a birthday cake.	1min	20
/14.03	IP (G) A child is heard to call out "One, two, three" while playing an organized running game on the grass	1min	1
12-10-93 (D) /12.25	VIA (AC) Mother tells her child "Five more minutes, until half-past twelve	1min	1
/14.21	IP, IS, IA, IA, IA, IP, IP, IA, IA, IP (G) Number recital while jumping into the sand-pit	9mins	6

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
12-10-93 (V) /14.33	IA Staff member recites "One, two, three" while inverting a sand bucket for a child	(G)	1min	1
14-10-93 (D)	Nothing			
15-10-93 (D)	Nothing			
18-10-93 (V) /14.04	IA While a staff member plays a game of sand-ball throwing with a child she calls out "One, two, missed"	(G)	1min	1
/14.14	VIA, IIIA Staff member informs a child of his age and tells him the number of candles on his cake	(C)	1min	1
/14.22	IIIA Parent describes the number of children that she is talking to, "You two want some banana"	(C)	1min	2
20-10-93 (V) /12.48	IIA Staff member sitting at a table with children cutting out dough shapes calls out the number formed,"One, two, three, four, five"	(G)	1min	4
/14.38	VIA Researcher asked child how old he was, an incorrect answer, "Five" was given, but researcher informed the child that his correct age was "Two", and the child responded saying, "Two"	(C)	1min	1
22-10-93 (D)	VIP Some children asked each other their ages, Kirk informed a child that he was "Three"	(C)	1min	4
22-10-93 (V)	Nothing			
25-10-93 (V) /12.45	Not Counted, BIAS Staff member was deliberately tutoring Kirk in the number of pieces making up a plastic segmented snake. Nothing else.			

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
26-10-93 (V) /13.02	IIIP, IIP, IIIP, IIP, IIIP (G) Older children on a mid-term holiday from school are making sand-castles, the younger children watch. Older child:"I've made them, and all four of us here; one, two, three, four" Older child:"Do another two, one here and one there" Younger child:"One, two"(waving finger in the air) The younger child then breaks the sand-castles down Older child:"Oh no, that's two of them, three, four" A second older child:"That's two of them, no three, Amber"	8min	3
28-10-93 (V)	IIIP, IVP, IIIP, IVP, IIIP, VS, IVP, IIP, VP,IVP, IVP, IIP, IVP, IIIP, IIP, IVP, IIP, IIP,IVP, IIP, IIIP (G) Two girls play a board game with a dice. One child is Mary (aged 4 yrs) the other is an older girl.	4mins	2
29-10-93 (V) /13.00	IIIA (C) An older child asks a younger child if she has got "Two or three"		
/13.45	VIA (C) An older girl moves around asking the children if they "have seen fifty pence"	1min	6
1-11-93 (V) /15.06	IA (SB) An older girl reads a book to a younger children and calls out "one, two"	1min	3
2-11-93 (V)	Nothing		
4-11-93 (V)	Nothing		
5-11-93 (V) /13.34	VIA (SB) Staff member reads a storybook to children and asks, "Tell me the time", she answers herself saying "It's five O'Clock"	1min	4
/13.37	IIIA (AC) Staff member comments to a child who has brought a book for the staff member to read, "It's only got about three pages in it"	1min	1
/13.44	IIIA (AC) Staff member points out to a child that two books are the same "Two the same"	1min	

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
8-11-93 (V)	IA (AC)		
/13.14	Staff member calls out "One, two" while interacting with a child playing toy cars	1min	1
/14.50	IP, IP (G)		
	Children playing Hide-and-Seek, one boy recites up to ten	2mins	5
11-11-93 (V)	IA (AC)		
/13.23	Staff member calls out "One, two" as she inverts a bucket of sand for a child	1min	1
/13.45	IA (G)		
	Staff member calls out "One, two, three" as she encourages children to march over a grassy area outside	1min	5
/14.51	IIIA (AC)		
	Staff member comments "Two leaves" to a child who is using a park-keepers instrument to pick up leaves, the child is watched by others awaiting a turn	1min	5
12-11-93 (V)	VP (C)		
/13.31	Child notices a badge on Ashley, - a badge with the number figure '2' printed on it. Child comments, "He's two, yea?"	1min	1
12-11-93 (D)	IIIA (AC)		
	Staff member comments to children on the length of a passing train, "Look, the train has three coaches" (a train track runs along the side of the play-park area)	1min	4
15-11-93 (V)	IIIP (CP)		
/13.27	A child playing in the sand-pit comments to a staff member, "Get them two out"	1min	1
/13.30	IA (G)		
	As a parent plays with a child, the parent calls out "One, two, three"	1min	1
/13.43	IIA (G)		
	A staff member counts "One, two" as she begins to pick up four pieces of spaghetti that are being glued onto paper, as a demonstration to children	1min	5

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
15-11-93 (V) /13.52	IIIA, IIA, IIP A child counts buckets of sand for researcher "one, two, tree, four, five" after answering that he had "Two". Another boy copies the counting performance	(DC)	2mins	2
/14.33	IIA As children line-up for a race outside, an older girl (~ 5 years-old) counts all the children at the request of a staff member. A count of "eleven" is reached while the children watch and listen to the count	(G)	1min	11
16-11-93 (V) /14.35	VS, VP, VP While playing with a toy till, a girl calls out the numbers that she recognizes on the levers	(G)	2mins	1
18-11-93 (V)	Nothing			
19-11-93 (V)	Nothing			
22-11-93 (V) /13.22	IIIA, IIIA, IIA, IIIA, IIA, IIIA Staff member is sitting at a table showing children how to make snowmen decorations, using black paper circles for eyes and buttons. Staff member comments, "Two eyes"; "Joshua, here's your two eyes"; "Right, one button, two buttons, three buttons"; "You've got four!"; "Let me see if Joshua's got four"; "Oh, you've got five"	(CA)	2mins	2
/15.22	IIIA, IIP, IIP, IVS, IIP, IIS Parent comments to children about the number of toy cars that will fit in the lift of a toy garage, "Can you get two in it?"; Girl counts the number of toy cars in two separate rows, the number of toy cars in the rows changes as Kirk adds extra cars	(G)	3mins	3
22-11-93 (D)	IIA A mother was overheard counting her daughter's fingers as the mother placed gloves on the child's hands, fingers were counted as they were placed in the glove finger sleeves	(AC)	2mins	1

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
23-11-93 (V)	IIIA, IIIA, IIA	(G)		
/13.09	A group of children are playing with a toy farm and animals. A member of staff gives Kirk some animals, commenting as she does so, "Two zebras and two small ones". The staff member then asked Kirk, "How many he had", Kirk counted, "one, two, three, four" in the presence of the other children.		2mins	3
/13.27	IIS, IIIP, IIIA, IIA	(M)		
	A little girl sits alone, she has arranged toy trees in a row and she makes an attempt at counting them. Researcher prompts further counts.		5mins	1
/14.19	VIA	(AC)		
	Staff member comments to children playing on tricycles, "Five minutes, then it's Amber's and Charlie's" (turns)		1min	3
/14.37	IIIA	(AC)		
	Parent comments, "Come on you two"		1min	2
/14.39	VIA	(AC)		
	Staff member comments on the amount of money that Kirk has found, "It's just seven p"		1min	1
25-11-93 (V)	IA	(AC)		
/14.03	Staff member lifts a child down from a picnic table, saying "One, two, three"		1min	1
26-11-93 (V)	VIP, VIP, VIP, VIP	(C)		
/13.32	Children talk to each other about their ages		1min	4
/13.33	IIIP	(CP)		
	Boy playing with plastic fruits comments, "I've got six fruits"		1min	1
/14.51	IIIP	(CP)		
	Girl playing with plastic fruits comments to another girl, "I've got two fruits"		1min	2
/14.51	VIA	(AC)		
	The mother of one of the girls playing with plastic fruits calls out, "Two minutes you lot"		1min	2

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
29-11-93 (V) /13.29	IA Staff member calls out to a group of children, "One, two, three, hey"	(AC)	1min	3
30-11-93 (V) /13.27	IIIA Staff member talks to children playing in the sand-pit, " for all three of you"	(C)	1min	3
03-12-93 (V)	Nothing			
06-12-93 (V) /13.31	IIIP Child comments upon finding two sweets, "Look at these two"	(CP)	1min	1
/13.41	IS Child playing alone in the sand-pit, making a sand-castle, calls out "One, two, three"; "One, two"; "One, two, three, that fat one"	(CP)	1min	1
07-12-93 (V) /13.38	VIA Staff member asks Kirk how old he is, Kirk replies, "Three"	(C)	1min	1
/14.39	VIP Child talks to her mother, saying "I want to stay for five minutes"	(C)	1min	1
/14.59	IIIP, IIIP A group of boys play outside in a large puddle that has formed in the outdoor paddling pool, they start to place toy cars in the puddle. One boy shouts "I've got two, I've got two; and a few moments later "I've got three, I've got three Charlie"	(CP)	2mins	3
08-12-93 (V) /14.27	IA Child is asked by researcher to point to printed numbers and asked to say their names, but he points indistinctly to each figure and recites the first five sequential numbers, his words and the number figures that he points to do not match.	(SB)	1min	1
09-12-93 (V)	Nothing			

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
13-12-93 (V) /13.49	IIIA	(M)		
	Mother plays with her son, they are building with lego bricks, mother comments, "Go and get two little roofs"		1min	1
14-12-93 (V) /13.48	IA, IA, IA	(C)		
	A clown is visiting the children's Christmas party As the clown entertains the children outside on a unicycle, he asks them to, " Count to three", the children respond,shouting "One, two, three"; The clown continues to entertain the children with his antics and the children count again, this time up to seven; and then for a third time up to four.		2mins	10
15-12-93 (V) /14.15	IP	(G)		
	As children play a running game organized by a staff member, one child calls out "One, two, three, go"		1min	4
/14.46	IIIP	(SB)		
	As a little boy looks through a book, he comments, "There's two monsters"			
17-12-93 (V) /13.50	IIP	(DC)		
	An older boy (~ 6 years-old) counts sweets in his possession, "One, two, three, four, five, six" while being watched by a younger child		1min	1

Totals:

Number of Days = 45 **Number of Incidents = 61** **Number of Codes = 126**

APPENDIX D3

EXAMPLES OF NUMERICAL UTTERANCE IN A PARENT & CHILD PRE-SCHOOL PLAYGROUP

Date/Time
12-10-93 (V) CODED IIA, IIIA
/10.37

Prologue: A 4-year old boy called Ivan is counting the baby-cups that are situated on the kitchen area table-top. The children attending the playgroup will later on be given a drink and a biscuit. Ivan's mother has just informed the researcher that Ivan can count very well, so his mother has asked him to demonstrate his counting skill by counting the baby-cups on the kitchen table-top. The baby-cups are not aligned in any way, but randomly scattered.

Ivan: (pointing to each cup once, coordinating his points with a number word utterance) "...... fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two"

Ivan's mother: "Twenty-four; Is there twenty-four? Wonderful"

Ivan: (nods his head)

Ivan's mother: "It might be a bit more than what is actually there, I think it's confusing this, the layout, I think the layout more than anything"

28-10-93 (V) CODED IIA
/10.16

Prologue: A mother talks to her 4-year old daughter, Francis, and the child is seated at a table with glue, paper and crayons. The mother sits down beside her daughter and begins to draw a picture for Francis, the picture is a hand pattern. Francis's mother places her own hand down on the paper and begins to draw around its outline. As the mother draws the outline of each the fingers she counts the number of fingers, matching each with a sequential number word.

Francis's mother: (drawing finger outlines) "One, two, three, four, five, there"

Francis's mother: (speaking to Francis) "Put your hand down, do yours, put your hand down, like that" (the mother takes hold of Francis's hand and places it flat on the paper); (the mother then draws around Francis's hand, calling out the quantity of fingers drawn as before) "One, two, three, four, five, there "

17-11-93 (V) CODED IIIA, IIIA, IIA
/14.31

Prologue: The children are being given a drink of juice and a biscuit from a tin. Most of the children continue to sit on the floor, a parent crouches down beside them, she brings a baby, then leaves it sitting with the other children. The playgroup leader begins to talk to the children. She asks the children how many biscuits they have had, this is obviously for the benefit of the camera.

Playgroup leader: "Petras has had three biscuits, she's had three already, how many have you had?" (speaking to a child who does not answer her)

: "How many have you had Mark?"

Mark: "Two"

Playgroup leader: "Two!": (speaking to a boy sitting at the end of the line) "How many have you had?"

Boy: "Ten" (he gives an answer that the playgroup leader finds surprising, and then the boy holds up his hand with fingers extended to demonstrate his quantity)

Playgroup leader: "No" (she disagrees with the boy's expression of the quantity of biscuits that the boy has had)

Boy: (nods his head to reaffirm his answer)

Playgroup leader: (leans forward to listen to the boy's explanation of "ten", but after listening to the boy's explanation she counter answers his quantity, saying) "Two"

Boy: (insists on the answer of 'ten', and he once again extends the fingers on his hand to assert his quantity "ten" over the playgroup leader's "Two")

Boy: (he counts his fingers, but the counts are not audible)

Playgroup leader: (she is not convinced by the boy's counting, she points to three of his fingers, saying) "One, two, three"

Boy: (he points to the biscuit that he is holding, as if to say 'and this one')

Playgroup leader: (she picks up the biscuit tin and leaves the group of children)

18-11-93 (V) CODED VA
/10.33

Prologue: A mother sits on the floor cuddling her child, a boy, who is playing with a toy telephone. The mother then begins to help the boy press the numbered push-buttons on the toy telephone, - there are four printed digits '1', '2', '3', '4'.

Mother: (holding boy's hand, and pressing one of his fingers onto each push-button digit) "One, two, three, four"

26-01-94 (V) CODED IIA, IIIA
/13.27

Prologue: The playgroup leader has brought out some paper party-hats for the children to play with, the hats have been scattered on top of a table.

Playgroup leader: (speaking to a boy called Mark) "How many is there?"

Researcher: "Have you got a hat? How many hats are there?"

Playgroup leader: "How many Mark?" You count them; I'll put them out, you count them";"There's quite a lot there; Right, how many?"

Mark: (touches the hats on the table, and matches each hat in one-to-one correspondence with a sequential number word) "One, two, three, four, five, six, seven"

Playgroup leader: "Seven; eight, very good"

Researcher: (commenting to Mark on his counting performance) "Good"

APPENDIX D3

TOTAL NUMERICAL UTTERANCES IN PARENT & CHILD PRE-SCHOOL PLAYGROUP

(V) - video recorded (D) - Diary note

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
23-09-93 (D)	IA As a mother assisted a child over a doorstep she recited, "Down you go, two, three"	1min	1
28-09-93 (D)	Nothing		
30-09-93 (D)	VIA A father was overheard to tell a child that he was "Going to get his hair cut at 1 O'Clock"	1min	1
	IIA A mother playing with children on a wooden frame, (representing a car seat, and which has peg holes and pegs to insert in the holes) counts peg holes to the children, "One, two, three"	1min	2
12-10-93 (V) /10.37	IIA, IIIA Mother asks her child to count baby-cups variously arranged on a table-top to demonstrate his skill to researcher	2min	1
13-10-93 (V)	Nothing		
14-10-93 (D)	Nothing		
19-10-93 (V)	Nothing		
21-10-93 (V)	Nothing		
26-10-93 (V)	Nothing		
27-10-93 (D)	IP A four year old child, the same boy who counted the baby-cups, recited up to ten before sending a paper aeroplane flying into the air.	1min	1
27-10-93 (V)	Nothing		

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
28-10-93 (V) /10.16	IIA As a mother assists her child with a drawing of the child's hand, the hand being used as a template, the mother calls out, "One, two, three, four, five" as she draws the outline of each finger.	2mins	1
/11.22	IP, IP A 4-year old boy, (the same one who counted baby-cups and gave a number recital while playing with a paper aeroplane) is playing with another boy on an indoor slide and he calls out, "One, two, three, four, five, six, seven" and then begins again, this time he recites up to twelve.	1min	2
02-11-93 (V) /10.21	VA, IIIA A father talks to researcher, and then deliberately turns his attention to his young daughter (not yet 2 yrs) showing her number figures and vocalising the associated number words to the daughter	1min	1
03-11-93 (V) /13.15	VIA Ashley walks over to a parent and tells her that he has got money, the parent asks how much, and Ashley replies "Two", the parent qualifies his answer, responding "Have you got two pence?"	1min	1
/14.00	VIP A 4-year old boy, Mark, overhears researcher telling Kirk that "It is two O'Clock", the boy runs and tells the playgroup leader that, "It is two O'Clock; time for biscuits"	1min	1
04-11-93 (V)	Nothing		
09-11-93 (V)	Nothing		
11-11-93 (V)	Nothing		
16-11-93 (V) /10.52	IIA Researcher assists a little girl to load-up a toy truck with model figures. Researcher call out a count number as each model figure is put into the truck, a count of "Five" is reached by researcher, and as the little girl puts in the next model figure she calls out, "Six".	1min	1

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
17-11-93 (D)	IIIP A 4-year old girl, Francis,busy painting, comments to her mother that she has got "Two pots of paint"	1min	1
17-11-93 (V) /14.31	IIIA, IIIA, IIA The Playgroup leader deliberately asks some of the children hoe many biscuits they have had. One boy replies "Two", another "Ten" while holding up two hands with all fingers extended. The playgroup leader tries to reason with the boy that he was mistaken.	2mins	4
18-11-93 (V) /10.33	VA A mother holds her child's hand and makes one of his fingers press the numbered buttons on a toy telephone key-pad. The mother voices each numbered figure as each button is pressed "One, two, tree, four" (there are only four numbered buttons on the toy telephone)	2mins	1
23-11-93 (V)	Nothing		
24-11-93 (V)	Nothing		
30-11-93 (V)	Nothing		
01-12-93 (V) /14.10	IIIA A little girl dressed up as a fairy, offers the playgroup leader, "Just one" wish	1min	1
07-12-93 (V)	Nothing		
21-12-93 (D)	IIIP A little boy aged 2-years old, gives researcher two toy cars saying "Two cars" to researcher.	1min	1
22-12-93 (D)	VA, VA, VA Researcher probes a 4-year old boy, playing with a toy till and play money, about the number figures printed on the till levers. The boy recognizes correctly the figures '5', '10', and '25', saying "Five", "Ten", and "Twenty-five" while researcher points to the number figures.	1min	1
06-01-94 (V) /10.03	IIIA Parent comments to a child that she has given the child "One of each" colour of crayons	1min	1

Date/Time	Codes/Numerical Incident/Activity form	Time length	No. of children
11-01-93 (V)	Nothing		
13-01-94 (V)	Nothing, (despite many children attempting to play with the toy till)		
25-01-94 (V) /11.12	IIIA As the playleader gives out biscuits, she comments on the number that some children have had, "Are you going to have another one? You're going to have two"	1min	1
26-01-94 (V) /13.27	IIA, IIIA The playgroup leader asks a child to count the number of party-hats that she has brought out for the children to play with. The child, a boy aged 4-years old, counts up to seven in a one-to-one correspondence with his points to hats. This incident was probably deliberately staged by the playgroup leader for the benefit of the researcher, and not the child.	1min	1
/14.04	IIIP, IIIA A little girl tells the playgroup leader that she has had "Two biscuits"	1min	1
27-01-93 (V)	Nothing (despite lots of play with a toy till)		

Totals:

Number of Days = 32 **Number of Incidents = 21** **Number of Codes = 30**

APPENDIX D4

Examples of Numerical Utterance in a Private Under-5 Drop-in Nursery

24-01-94 (V)/10.41 CODED IIA, IIIA, IP, IIA, IIIA

Prologue: Nursery supervisor shows some children teddy-bear pictures in a book, she counts the number of eyes shown in the picture to the children, and another child standing behind her chair begins to verbally recite on her own accord, the nursery supervisor then invites her to count the number of eyes shown in the picture.
Girl: (brings a book over to where the nursery supervisor is seated)
Nursery supervisor: "Thankyou sweetheart"
: (speaking to another child that she is sitting beside) "Oh, don't eat it"
: (she shows the book to the little girl, and then a little boy comes over, he
: watches as well, "Look at all these teddy bears; How many teddy bears?"
:(the little boy tries to turn the pages before the nursery supervisor has
:completed reading the page) "One; wait a minute; One; wait a minute, wait,
: wait"; "One; one, look, look, come over here" (draws the little girl closer, turns her back to the boy)
Boy: (he holds a piece of puzzle from the adjoining table, and when the nursery supervisor does not let him see the book, the boy throws the piece of puzzle on the floor)
Nursery supervisor: "Temper, temper";
(she then returns to count the number of teddy bears in the book picture for the girl) "One, two, three, four, five, six, seven, eight, nine" (she has pointed to each of the teddy bears on the page of the book, three other children have crowded round to watch) "How many teddy bears? Nine"
Another girl, Kaye, who is four years old, stands behind the nursery supervisor, she has been watching the counting of the teddy bears.
Kaye: (begins to recite a number string)"One, two, three, four, five, six, seven, eight, nine, ten"
The nursery supervisor continues to read the book to the children.
Nursery supervisor: "That green car has got eyes; How many eyes can you see? How many eyes? Look, there, there, there"
Kaye: "One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen" (the word 'sixteen' is emphasized, it is spoken more loudly)
Nursery supervisor: "Sixteen, Oh that's good; Sixteen pairs of eyes"

24-01-94 (V)/11.05 CODED IIP, VP, IIP, IIIA, IP, VP, VP

Prologue: A 4-year old girl, Kaye, reads the printed numbers on the back of a toy till, and she matches them with finger quantities.

Kaye: (standing behind the toy till) "One" (holds up one finger);
: "Two" (holding up two fingers)

: (she looks at the printed figures on the back of the till again) "Three, four";
: "three"; "One, two, three" (springing up one, then two, then three fingers)
Researcher: (watching Kaye) "Yea, that's three"
Kaye: "Four, five" (she springs up a fourth then a fifth finger on her hand, and then she continues to recite the number sequence without touching the printed figures, but she appears to be 'reading' the figures from a distance, she continues her recital beyond the last printed figure and she corrects herself)
: "Six, seven, eight, nine, ten, eleven"; "No"; "Five, six, seven, eight, nine, ten"
: (she then touches each of the printed figures again, calling out the number
: names as she touches each figure) "One, two, three, four, five, six, seven"
: (she then begins again, touching each printed figure and calling out the
: number name) "One, two, three, four, five, six, seven eight, nine, ten"
Researcher: "Hurrah"

26-01-94 (V)
/10.55 CODED IIA, IIIA, VA, IIA, VA, IIA, IIIA, VA, VP, VA, IIA, IIA, IIIA, VA, VA, IIA, IIIA, VA, IIA, IIA, IIIA, VA, VA, VA, VA, IIIA
Prologue: A brick puzzle that matches number figures with quantities of animals in pictures is being jointly constructed between a 4-year old girl called Sarah and a nursery assistant.

Nursery assistant: "How many chicks?"
Sarah: "One, two, three, four, five"
Nursery assistant: "Five, very good; and there's the number five" (she passes a wooden brick with the figure '5' printed on it to Sarah, who fits it next to the picture of five chicks) "That's it, very good"
: "How many cats? Can you count them?"
Sarah: (holding the brick and pointing to the pictures of cats) "One, two, three, four, five, six"
Nursery assistant: (counts with Sarah) "One, two, three, four, five, six";
:"Six numbers, where's number six? (looks for a '6' printed figure on a brick,
: - to match against the pictures of six cats)
Sarah: (picks up the brick with '6' printed on it)
Nursery assistant: "Right, well done, six cats"
: "Now what else, - but I don't think there's a number three, is there?"
Sarah: (quickly picks up another picture brick to count, a brick with pictures of crocodiles)
Nursery assistant: (looking at the brick that Sarah has just picked up)"How many crocodiles?"
Sarah: (pointing to each crocodile picture) "One, two, three"
Nursery assistant: "Three; Find number three" (she begins to search herself for a '3' brick) "Can you see number three anywhere?"
Sarah: (picks up an '8' brick) "Here"
Nursery assistant: "No, that's not a three; Can you see number three?"
The nursery assistant can see a number '3' brick, but she wants Sarah to find it.
Sarah: (shakes her head, she cannot see a '3' brick, or does not recognize the "three" figure)

Nursery assistant: "It's like an eight" (she points to the '8' brick that Sarah had picked up and then dropped); "Look, there it is" (the nursery assistant reaches out and picks up the '3' brick, and she gives it to Sarah) "Three crocodiles"
Sarah: (places the picture brick of three crocodiles and the '3' number figure brick into the long line of animal picture and number figure bricks that is steadily being built up on the table; Sarah then draws the nursery assistant's attention to the start of the brick line, saying that the line was begun with a '2' figure brick and that no 'two' animal picture brick has been placed next to it yet)
Nursery assistant: "Two what though Sarah?"
Kimtelle: (another girl watching the build up of the wooden brick construction, she picks up a figure '10' brick, saying) "Ten"
Nursery assistant: (momentarily distracted by Kimtelle) "That's right, number ten Kimtelle"; (returning her attention to the brick puzzle) "There's one" (she picks up a picture brick with one animal picture on it) "Where's two?"(looking for the picture brick with two animals to match with the figure '2' number brick) "Oh, there, Lindford's got it, two lions, that is two" (the nursery assistant then lays the brick with a picture of two lions next to the '2' figure brick); (nursery assistant then picks up another brick) "No, don't push, don't push Kimtelle";
: "How many rabbits?"; "Where's number one?
Sarah: (points to the 'one picture' brick that the nursery assistant holds in her hand and she takes the brick from the nursery assistant and inserts it into the middle of the long line, she then takes the '1' number figure brick and places it next to the 'one picture' brick)
Nursery assistant: "Right, that's it, very good"
: "What else have we got?" (the nursery assistant and Sarah search through the
: remaining bricks, looking for number figures and matching pictures)
: (nursery assistant counts out loudly, apparently to herself, on seeing a picture
: brick) "One, two, three, four, five, six, seven"; "We haven't got a seven"
: (referring to a figure seven '7' brick); (the nursery assistant lays down the
: 'seven picture' brick and picks up another picture brick, once again she count's
: out loudly, but appears to count for herself) "One, two, three, four, five, six,
: seven, eight, nine, Ah"; (nursery assistant shows the brick to Sarah)
: "How many fishes? There's a lot isn't there, a lot of fishes; How many?"
Sarah: (points to the pictures of fish on the brick that the nursery assistant holds)
: "One, two, three, four, five, six, seven, eight, nine, ten" (the 'ten' is emphasized)
Nursery assistant: "Ten fishes; Oh, well done; Can you see a number ten there?" (referring to a '10' figure brick)
Sarah: "I can't see it"
Nursery assistant: "Have a look at the numbers, see if you can see the number ten"
Sarah: (picks up a brick, holds it up to show the nursery assistant)
: "That one is it? That one, that one"
Nursery assistant: "No, that's number four"
Sarah: (drops the '4' brick)
Nursery assistant: "Can you see number ten?; Kimtelle knew number ten"
Sarah: (picks up the '10' figure brick)
Nursery assistant: "That's number ten; very good"

Sarah: (leans over to place the bricks at the end of the line most distant from her, but the nursery assistant takes the picture brick and places at the end of the line for Sarah)

Nursery assistant: "And number ten;

Sarah: (reaches over to place the '10' figure brick next to the 'ten picture' brick, but researcher places it for Sarah who is struggling to reach the correct position)

Nursery assistant: "It goes right at the top, well done, that's very good";

:"I don't think that we have got any more, I don't think that they match"

: (she picks up another picture brick, and begins to count the animal pictures)

: "One, two, three, four, five, six, seven, ah yes; How many?"

Sarah: (grabs the brick from the nursery assistant's hand and discards it, she then shows the nursery assistant the brick that she has picked up)

Nursery assistant: (looking at the picture brick in Sarah's hand) "We haven't got that"

:" We haven't got that number seven";

Sarah: (picks up the discarded picture brick that she had taken from the nursery assistant's hand"

Nursery assistant: "We've got that one, yes; How many birds?"

Sarah: (points to the bird pictures on the brick) "One, two, three, four, five, six, seven, eight"

Nursery assistant: "Eight; Well done, eight; Can you see a number eight?" (referring to an '8' figure brick)

Sarah: "Up there, up there" (gives the nursery assistant the picture brick of eight birds)

Nursery assistant: (places the eight birds brick at the end of the line furthest from Sarah)

Sarah:(picks up the first figure brick that comes to hand, she shows it to the nursery assistant)

Nursery assistant: "No; That's nine, (then correcting herself) Number six"

Sarah: (picks up the '8' brick)

Nursery assistant: "Let's see, yes, that's number eight"

Sarah: "Up there" (she hands over the '8' figure brick to be placed alongside the 'eight picture' brick)

Nursery assistant: "That's right" ;"I don't think that we've got any more"

Sarah: (picks up another picture brick) "We've got that one"

Nursery assistant: (looking at the picture brick held by Sarah) "One, two, three, four, five, six, seven, eight, nine, Hmm, I'm not sure"

Sarah: (still holding the nine picture brick) "Can we do that one?

Nursery assistant: "How many butterflies?"

Sarah: (points to the pictures of the butterflies on the brick, but does not match her points and her number words after 'four' has been reached, but waves her finger over the remaining butterfly pictures) "One, two, three, four, five, six, seven, eight"

Nursery assistant: "Nine, another one"

Sarah: (holds out a single finger) "Nine"

Nursery assistant: "Nine; And you can use this as a nine can't you? (she picks up a '6' brick and turns it upside down to look like '9') "Look this is number nine" (shows Sarah the upside down six looking like '9')

Sarah: "We'll use that one"

Nursery assistant: "Where can we put it? We haven't ant room, no room for it"

(A child picks up the '8' brick from the end of the line and gives it to the nursery assistant)

Nursery assistant: "No, leave it at the top, it says eight, eight birds";

: "That's in the wrong place Sarah, isn't it? (the nursery assistant removes the

: '4' figure brick from the line) "We haven't got four of anything"

: "We'll have to start another line, because it won't fit"

Sarah: (still holding onto the 'nine picture' brick and the upside down '6' figure brick)

As the nursery assistant and Sarah puzzle over what to do about the lack of space in which to fit the bricks, they notice that the '8' brick has gone missing.

Nursery assistant: "Where's the eight gone? Where's the number eight gone"

Sarah: (looks on the floor)

Researcher: "It's in someone's hand I think"

Nursery assistant: "Oh yes, Lindford's got it, Oh yes, can we have it back Lindford";

: "Lindford, bring it here" (lindford comes running towards the nursery

: assistant, and he gives her the figure '8' brick) "That's it"

: "Stick it down here" (telling Sarah to replace the brick that Lindford has brought)

Sarah: (tries to fit the figure '3' brick onto the end of the line)

Nursery assistant: "That's not eight; Where's eight gone? Hmm, it's not there; Where is it?; "On the floor, no?; "You didn't find it on the floor?"

Sarah: (shows the nursery assistant a brick, a figure '9' brick) "No, it was nine; Was it nine?"

Nursery assistant: (takes the '9' brick from Sarah) "Yes number nine, that's right Sarah,

: nine butterflies"

Sarah: (places the '9' brick on the end of the line that has now been formed in domino

: fashion)

Nursery assistant: "That's it; You put them all in as well; Hmm, well done, that's very good"

10-02-94 /11.37 (V) CODED IIA, IA, IIIA, IIIA, IIIA, IIIA, IIIA

Prologue: Action nursery rhymes are being sung involving cardinal number words, and the number words are matched with quantities of fingers.

Nursery assistant: "Are you ready? Ba Ba Black sheep" (she and the children sing the rhyme with finger actions, they hold up one finger when the words "one for the master" are sung, and they hold up a second finger when the words "one for the dame" are sung, and a third finger on singing "one for the little boy who lives down the lane".

The next rhyme sung is "Winding the bobbin up", and in this rhyme the actions and words are, "clap your hands, one, two, three, put your hands upon your knees".

Next, the group sing Ipsey Wipsey Spider, but there are no number utterances, as is the case in the following rhyme, "Heads, and shoulders, knees and toes".

The next rhyme is very numerical in nature, it is called "Five currant buns in a baker's shop"

The nursery assistant holds up a hand with five fingers spread out, singing with the children, who imitate the actions,

Nursery assistant & Children (singing): "**Five** currant buns in a baker's shop, big and round with a cherry on top, along came Caroline (a girl in the group) with a penny one day, bought a currant bun and took it away"
Nursery assistant: "Come Caroline" (Caroline comes out to the front and takes a pretend currant bun from the nursery assistant, Caroline then returns to her chair)
Nursery assistant & Children: (continue to sing, this time showing four fingers on their hands) "**Four** current buns in a baker's shop, big and round with a cherry on top, along came Elliot (a boy in the group) with the penny one day (Elliot comes out to get a pretend currant bun, he is smiling) bought a currant bun and took it away" (Elliot returns to his chair, still smiling, and the rhyme singing continues, this time with three fingers showing on hands) "**Three** current buns in a baker's shop, big and round with a cherry on top, along came Jenny with the penny one day, bought a currant bun and took it away (Jenny comes out to receive a pretend bun and then returns to her chair, the singing continues with two fingers being shown on hands) "**Two** current buns in a baker's shop etc.", and a girl called Loua receives the pretend bun from the nursery assistant "There we are, good girl" is the comment, and then the nursery assistant and the children show one finger on their hands, singing, "**One** currant bun in a baker's shop etc." and Kaye receives the last currant bun.
Two more action rhymes are sung without any numerical utterance in their content.

APPENDIX D4

TOTAL NUMERICAL UTTERANCE IN A PRIVATE UNDER-5 DROP-IN NURSERY

(V) - video recorded (D) - Diary note

Date/Time	Codes/Numerical Incident/Activity	form	Time length	No. of children
19-01-94 (V) /10.16	IIA, IIIA Child counts the number of eyes inside a lego construction that has 'eye' bricks built into it. The child is responding to researcher's question, "How many are there?"	(M)	1min	1
/10.18	IIIA Nursery supervisor calls out to two children that "Only one at a time can play on the trampoline, not two"	(AC)	1min	2
/11.10	IP A child calls out a string of numbers while seated amongst other children awaiting milk/biscuits and the action rhyme singing.	(S)	1min	1
/11.18	IIA Nursery assistant counts the number of children present who are to be given some milk.	(DC)	1min	1
20-01-94 (V) /10.17	VIA Nursery assistant comments on a child's age, it is his birthday today, "How old are you? Two, two"	(C)	1min	1
/10.23	IIA, IIIA, VA, VA Researcher asks child to count the number of bricks in a tower, and 'read' the printed number figures on another type of bricks	(M)	2mins	1
/10.27	VA Another child is questioned by researcher as to the number figures printed on the bricks	(M)	1min	1
/11.37	IA A number recital is jointly spoken by a child and the nursery supervisor prior to the singing of the Happy Birthday song.	(DC)	1min	1

Date/Time	Codes/Numerical Incident/Activity	form	Time length	No. of children
20-01-94 /11.37	IIIA Nursery supervisor encourages the birthday child to blow out "One more candle"	(AC)	1min	1
20-01-94 (D)	IIA, IIIA, IIA, IIIA, IIA, IIIA Nursery supervisor leads all the children in counting up to ten with fingers prior to singing the nursery rhyme 'Once I caught a fish alive' with actions and up to three while singing 'Ba Ba Black Sheep'	(S)	5mins	15
21-01-94 (V) /10.08	VA, VA Researcher questions a child as to the number names given to figures printed on the levers of a toy till	(CP)	1min	1
/10.10	IIIA Nursery supervisor comments on a child's answer to a researcher posed question about the number of clips placed on her fingers, "Did you say ten?"	(AC)	1min	1
/10.35	IIIA Nursery supervisor comments to a child on the number of toys inside a toy shopping trolley, "There's two here"	(AC)	1min	1
/10.38	IIIA Nursery supervisor comments to a child on the number of heads on a constructional toy formation, "Two heads"	(M)	1min	1
/10.51	VA, VA Researcher questions a boy as to the number names of printed figures on plastic coins for a toy till.	(CP)	2mins	1
/11.00	IIIA Nursery supervisor comments to a child on the number of plastic coins for the till that are lying on the floor	(AC)	1min	2
24-01-94 (V) /10.36	IP A girl stands swinging her body from side-to-side and she recites the number sequence from one to fourteen, with the numbers twenty-eight and forty-two tagged on at the end of the sequence.	(CP)	1min	1

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
24-01-94 (V)				
/10.41	IIA, IIIA, IP, IIA, IIIA Nursery supervisor shows some children teddy-bear pictures in a book, she counts the number of eyes shown in the picture to the children, and another child standing behind her chair begins to verbally recite on her own accord, the nursery supervisor then invites her to count the number of eyes shown in the picture.	(SB)	3mins	3
/10.54	IIIA Nursery assistant comments on the number of humps possessed by a camel shown in a picture in a book, "Two humps he has;How many?;Two"	(SB)	1min	2
/10.56	IIIA Researcher asks a child how many cars she has put into a handbag, the girl correctly replied "Four"	(CP)	1min	1
/10.58	VA Researcher asks a child to 'read' number figures printed on a till, and tutors the child in the correct answers	(DC))	2mins	1
/11.00	VP Child correctly reads the first ten digits printed in a row on the back of a toy till	(DC)	1min	1
/11.02	VIA Nursery assistant labels a hand-slap "Fives" and asks a 2-year old child to give her "Five"	(C)	1min	1
/11.05	IIP, VP, IIP, IIIA, VP, IP, VP A 4-year old girl reads the printed numbers on the back of a toy till, and matches them with finger quantities	(DC)	2mins	1
/11.29	IP, IIIA A child starts reciting a nursery rhyme involving number utterance, and she is quickly joined by another child, whom she corrects, "No, two"	(S)	1min	2
/11.35	IIA, IIIA Nursery supervisor starts the children singing action rhymes, and they begin with Ba Ba Black sheep, matching fingers to 'bags' in one-to-one correspondence until "three" are reached	(S)		

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
26-01-94 (V)				
/10.49	IA Nursery supervisor recites the first three sequential numbers as she plays on a rocking-horse with a child	(CP)	1min	1
/10.52	IIIA Nursery assistant counts the number of lego-brick houses that a child has made.	(M)	1min	1
/10.54	VA, IIA, VA Nursery assistant questions a child about number figure '2' that is printed on a wooden brick	(J)	1min	1
/10.55	IIA, IIIA, VA, IIA, VA, IIA, IIIA, VA, VP, VA, IIA, IIA, IIIA, VA, VA, IIA, IIIA, VA, IIA, IIA, IIIA, VA, VA, VA, VA, IIIA A brick puzzle that matches number figures with quantities of animals in pictures is being jointly constructed	(J)	7mins	3
/11.09	IIIA Nursery assistant comments on the number of toy cars that she has given a girl, "There you are Kaye, two more cars"	(AC)	1min	1
/11.29	IIP, IIIP A girl sitting after finishing her milk and biscuits begins to flick up fingers on her hand, and counts from one to ten as she does this.	(S)	1min	1
/11.35 2mins 15	IIA, IIIA, IIA, IIIA, IIA, IIIA Nursery supervisor involves the children in nursery rhymes sung with actions. Ba Ba Black sheep is sung first, and fingers are matched to 'three bags' in one-to-one correspondence. Later a count of "one" to "ten" is performed by matching number words to fingers to prior to singing the rhyme "Once I caught a fish alive"	(S)		
/11.40	IA, IA, IA As each of three children take turns to sing a rhyme to the rest of the children, the nursery supervisor starts each child singing with the introduction, "One, two, three"	(AC)	2mins	3

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
31-01-94 (D)	IIA As the nursery supervisor was reading a book to a child, the four buttons in a picture were counted, the nursery supervisor began the count with "one, two" and the child picked up the hint and finished the count with "Three, four"	(SB)	1mins	1
	IIIA Nursery assistant used the cardinal number word "Two?" as a descriptive quantity, and the children she was talking to responded by answering "Two"	(C)	1min	2
	IIIA, IIA, IIA Nursery supervisor held up three dolls to show a girl, saying "Three", she then held each doll forward one by one to emphasize their numerosity, counting "One, two, three" to the girl. The girl imitated the count words, saying "One, two, three"	(DC)	2mins	1
	IIIA As the nursery assistant read a story to a child, cardinal number words were used in the descriptions	(SB)	2mins	1
09-02-94 (V) /10.06	IIIA Nursery supervisor calls out to two children who are playing on the trampoline, "One at a time"	(AC)	1min	2
/11.29	IIIP, IIIA A child takes two biscuits instead of one, another child reports, "She's taken two"	(C)	1min	2
10-02-94 (V) /11.17	IIA, IIIA Nursery assistant counts the number of children present before arranging cups of milk, she does not involve any of the children in the count, nor does she make it obvious that she is counting, the count takes place behind the children's backs, some children may be aware that they are being counted, the nursery assistant then calls out "Fifteen" to the other nursery assistant	(DC)	1min	-

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
10-02-94 (V)				
/11.31	IIIA A nursery assistant overhears two children talking about a girl's name, one child asked "Who's that?" the other child responded "Sarah", the nursery assistant confirms the name as being the same as that of another girl, "Sarah, two Sarah's"	(C)	1min	2
/11.37	IIA, IA, IIIA, IIIA, IIIA, IIIA, IIIA Action nursery rhymes are being sung involving cardinal number words, and counting with fingers	(S)	5mins	15
11-02-94 (V)	Nothing			
15-02-94 (V) /11.13	IIA Nursery supervisor counts the number of 'eyes' on a lego-brick construction that has 'eye' bricks built into it, "One, two, three, four"	(M)		
/11.40	IA As a child begins to sing a nursery rhyme alone, the nursery supervisor calls out, "One, two, three, go"	(AC)	1min	1
16-02-94 (V)				
/10.53	It is noted that a child is wearing a T-shirt with the slogan ' 5 4 3 2 1 THUDERBIRDS' printed on it, but no-one appears to comment throughout the session			
/11.20	IIIA, IIA All the children are counted by a tap on their heads, the count is made by an older girl on a mid-term break from school, she is aged ~ 8 yrs, she calls out her cardinal number total. Some of the younger children begin to imitate the count by pointing to all the children seated, an older boy, also aged ~8 yrs, counts up to seventeen. None of the younger children manage a successful count.	(DC)	3mins	3
/11.37	IIA, IIIA, IA During the action nursery rhyme singing, the nursery supervisor matches one finger to each of the "bags" in the BA BA Black sheep rhyme. In another action rhyme the numbers 'one' 'two', 'three', 'four', 'five' are used sequentially in the action rhyme 'Peter Works with Hammers'.	(S)	3mins	17

Date/Time	Codes/Numerical Incident/Activity	form	Time length	No. of children
18-02-94 (V)				
/10.25	VIA Nursery supervisor comments to a child that a piece of number puzzle, a '3' piece, is missing, "Oh, the three is missing"	(J)	1min	1
/10.52	IIIA Nursery supervisor comments to a child about the missing pieces from a puzzle, "Those two pieces are missing"	(J)	1min	1
/10.57	VA Nursery supervisor assists a child to complete the number jigsaw puzzle, "Number four, alright"	(J)	1min	2
/10.58	VA, VA, VA, VA, VA, IIIA Nursery supervisor points to the number figures on the number puzzle and she questions two girls about the number words associated with each figure. During the number figure questioning, the nursery supervisor calls out to children playing on the trampoline, "No, one at a time"	(J)	2mins	2
/11.02	VA, VA, IIA, VA, IA, IIA Nursery supervisor assists a child to complete the number jigsaw puzzle	(J)	5mins	1
/11.30	IIS A little girl suddenly points to children, as if counting, nothing audible is heard, if she counted, it would not be more than seven	(DC)	1min	1
21-02-94 (V) /10.03	IA Nursery supervisor recites part of the number sequence "four, five, six, seven, eight" while playing with children at a table set out with play-dough. A little boy imitates her words, calling out "five, six, seven"	(CP)	1min	2
/10.37	IA As children slide down a chute attached to the climbing frame, a nursery assistant calls out "... eight, nine, ten, whee"	(CP)	1min	2
/10.39	IIA, IA, IIIA, IIA, IA, IIIA Nursery supervisor encourages the children to participate in counting fingers up to ten, as a prelude to singing the rhyme 'Once I caught a fish alive' with actions	(S)	2mins	15

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
23-02-94 (V) /10.02	Researcher pointed out to a nursery assistant that a construction toy that the children played with, involving body parts, had hands with only 'three' fingers and a thumb, apparently neither she, nor the nursery supervisor had ever noticed this before, so had the children?			
/10.22	IA Nursery assistant calls out "One, two, three" as children slide down the indoor play chute	(CP)	1min	3
/10.27	IIIA, IIA, IIIA Nursery assistant helps a child to do a puzzle, and in the process questions the child about the number of teddy-bears shown in the picture on a piece of the puzzle that is being fitted.	(SB)	1min	1
/11.03	IA Researcher asks a boy how many wheels are on his model car that he is driving around the playroom, the boy does not point or count, but mumbles a number string, "One, two, three, wheels"	(CP)	1min	1
/11.33	IIIA Nursery supervisor openly questions why a child is in possession of more than one biscuit, "Why has he got two or three biscuits?"	(AC)	1min	1
25-02-94 (V) /11.34	IIIA Nursery supervisor echoes a girl's comment on a child who has taken two apple slices, "She's got two, that's what she's trying to tell us"	(AC)	1min	1
/11.38	IA The children sing an action nursery rhyme involving their sequential use of the number words 'one', 'two', 'three', 'four' 'five'	(S)	1min	15
/11.41	IIA, IIIA, IIA, IIIA, IIIA Nursery supervisor steadily springs up each of her fingers on both hands as she leads the children in a count to 'ten' prior to singing the rhyme 'Once I caught a fish alive' with actions. The children imitate the one-to-one correspondence count as best they are able.	(S)	1min	15

Date/Time	Codes/Numerical Incident/Activity	form	Time length	No. of children
28-02-94 (V) /10.25	IIIP, IIIA Nursery assistant and a little girl are making a sticky-brick model construction of a house, and the little girl is furnishing the house with "Two televisions"	(M)	2mins	1
/10.31	VIA Nursery supervisor asks a child to give her "Fives" - a hand slap	(C)	1min	1
/11.19	IA, IIA, IIIA Nursery assistant counts the number of children behind their backs, but counts out loudly and calls out her cardinal total	(DC)	1min	19
/11.39	IA A nursery rhyme that is being sung by all of the children contains the number string "One, two, three"	(S)	1min	1
02-03-94 (V) /10.33	IIA, IA,IIP, IIA, IIIA, IIA, IIA, IIA, IIA, IA, IIA Nursery assistant reads a counting book to a child, she involves the child in counting the numbers of items associated with each number figure. Another child stands watching and listening.	(SB)	4mins	2
/11.36	IA, IA Nursery supervisor introduces each of two children that volunteer to sing a nursery rhyme by themselves with the recital. "One, two, three"	(AC)	1min	2
04-03-94 (V) /10.55	VA Researcher asks a 4 year old girl the name of the number figure '25' printed on a toy till that she is playing with, the girl replies "Number two, number five, number two"	(CP)	1min	1
/11.00	VA Researcher questions a child about the printed number figures on a toy till and plastic coins	(CP)	2mins	1
/11.08	VA Researcher questions yet another child about the number figure '10' on the toy till	(CP)	1min	1

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
04-03-94 (V) /11.37	IIA, IIA, IIIA, IIA, IIIA, IIIA, IA Nursery supervisor leads the children in a count to 'ten' with fingers being sprung up on both hands as each number is called out. The children imitate the nursery supervisors actions as best they are able, the counting is a prelude to the singing of the rhyme 'Once I caught a fish alive" Another action nursery rhyme involving the number recitation "One, two, three" is sung.	(S)	3mins	15
07-03-94 (V) /10.38	IA, IIA, IA Researcher questions a child as to the number of trains shown on a jigsaw puzzle picture	(J)	1min	1
/10.48	VIA Nursery assistant questions a child about his age, but the child does not answer, and the nursery assistant suggests an age, saying "Two"	(C)	1min	1
/10.50	IA Nursery supervisor recites some numbers while sitting at a table playing with children, "Six, seven"	(CP)	1min	3
/10.56	IA Researcher asks a girl, "How many candles" are on a model construction that she has made, - a birthday cake with candles, "One, two, three, four" is the answer as she randomly waves a finger over the pretend cake.	(M)	1min	1
/11.36	IA The action nursery rhyme singing of 'Peter works with hammers' involves the children reciting the numbers 'One' to 'Five'	(S)	1min	15
09-03-94 (V) /10.12	IIIA Nursery supervisor calls out to children playing on the trampoline, "One at a time"	(AC)	1min	3
/10.25	IIIA, IIA, IIIA, IIA, IIA, IIA Nursery assistant reads a book to a group of children, it involves singing a rhyme about 5 little boys in a bed with one periodically rolling over and falling out. The nursery assistant encourages the children to count the number of children and their feet.	(SB)	2mins	6

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
09-03-94 (V) /11.25	IIA, IIA, IIA, IIIA Nursery supervisor encourages the children to count their fingers up to 'ten' as she introduces the singing of the action rhyme 'Once I caught a fish alive'	(S)	2mins	15
11-03-94 (V) /10.19	VA, VA, VP, VA, VA, VIA, IA, IIA, IIA, IIA, IA, IIA, IA, VA, VA, IIA, IA Nursery assistant 'reads' out the number names to a child while pointing to number figures printed on pieces of a number puzzle.	(J)	3mins	1
11-03-94 (V) /10.24	VA, VA, VA, VA, VA, VA, VA, VA, IIA, IA Nursery assistant assists another child to complete the number puzzle	(J)	14mins	1
/10.43	VA, IIA, VA, VA, VA, VA, IIA, IIA, IIA, VA, VA IIA, VA, VA Another child is assisted in her completion of the number jigsaw puzzle by the nursery assistant.	(J)	8mins	1
/10.52	VA, VA, VA, VA, IA, VA, IA Yet another child is guided by the nursery assistant in recognizing the number names of the number figures printed on pieces of the number jigsaw puzzle	(J)	2mins	1
/11.03	VA, VA, VA One of the children who has already completed the number jigsaw puzzle returns to the puzzle, and the nursery assistant reviews the names of the number figures with the child	(J)	1min	1
/11.32	IA, As a child begins to recite a nursery rhyme, the nursery supervisor calls out, "One, two, three, go"	(AC)	1min	1
/11.37	IA Children all sing the action rhyme 'Peter works with hammers' and they sequentially call out the numbers from 'one' to 'five' while singing the rhyme	(S)	1min	15

*N.B. On the following dates/times the incident was researcher prompted (BIAS)

1. 19-01-94/10.16	2. 20-01-94/10.23	3. 20-01-94/10.27	4. 21-01-94/10.08
5. 21-01-94/10.51	6. 24-01-94/10.56	7. 24-01-94/10.58	8. 23-02-94/11.03
9. 04-03-94/10.55	10. 04-03-94/11.00	11. 04-03-94/11.08	
12. 07-03-94/10.38	13. 07-03-94/10.56		

Totals:

number of Days 21 Total number of incidents 88 - 13 researcher prompted incidents = 75 incidents

Total number of codes 235

APPENDIX D5

Examples of Numerical Utterance in a Primary School Nursery Classroom

18-10-93 (V)/10.29 CODED IIIA, IIA, IIIA, IIA, IIIA, IIA, IIA, IIIA, IIIA, IIIA

Prologue: All the children are sitting on a floor mats, and they sit in a semi-circle around the teacher. It is just before their milk-break and the teacher plans on giving the children some sweets. The teacher questions children to see if they can show 2, or 4 or 5 fingers on their hands, and tells them that they can have only two sweets.
Teacher: "How many sweets shall we let them have, one or two"
Children: "Two"
Teacher: "Show me two, I don't want anyone taking any more"
Children: (they each hold up a hand with two fingers extended)
Teacher: "OK; Put your hands behind your back; Show me four please"
Children: (the children each hold up a hand showing four fingers)
Teacher: "You can't have four; How many can you have?"
Children: "Two"
Teacher: "Put your hands behind your back; Show me five"
Children: (they each show a hand with all fingers extended)
Teacher: "Are you allowed to take five sweets?"
Children: "NO"
Teacher: "Show me how many you're allowed to take"
Children: (some showing two fingers again) "Two"; "Four!"
Teacher: "Not four! (laughing); Who said four?; Two each, two each";
: "When you've had your sweets you can go and fetch your milk, OK"
: (hands the tin of sweets to a child to pass onto the others) "Take two and
: pass it on"
The sweets are passed around, and as this is done, the children watch and talk to each other.
Child: (speaking to another child) "What colours did you take?"
2nd. Child: "Pink and Orange"
Child: "Pink and Orange?"
Lots of chatter among the children
Researcher: (speaking to Kirk) "Take two"
Child: "He took one"
Kirk: (takes another sweet)

18-10-93 (V) /11.16 CODED IIP, IIIP, IIIP, IIIP, VP

Prologue: A boy, (Craig), sits at the computer playing the angle game, he assists a girl, showing her how to play the game, Craig holds the girl's hand and guides her in the key presses and the counting .
Craig: (sitting at the computer beside a girl) "Put in your name"
Girl: (types in her name)

Craig: "Press space-bar"
Girl: (presses the space-bar to begin the game, and an angle is shown on the monitor)
Craig: "This is an angle"
Girl: (presses a number figure key on the keyboard, - entering her estimation of the number of 10 degree sections that make up the total angle shown on the monitor)
Craig: "Too far out!" (he then counts the number of 10 degree sections now showing on the monitor screen) "One, two, three; three"
Girl: "One" (begins to press another key)
Craig: "It's two" (takes her hand and she presses the '2' key)
:"One; It's one too far out"
: "We have a queue today, press space-bar"
Girl: "Yea"
Craig: (types something) "It's my go, look" (types his name, sounding each of the letters) " 'c', 'r', 'a', 'i', 'g' "
Another boy walks over to the computer, he leans over the girl and presses a key on the keyboard.
Boy: "Now what is this angle?"
Girl: "Do you mind?"
Boy: (looks at Girl) "No"
Craig: "One, three" (types in his angle estimation)
:"Too far out, ninety"
Boy: "Let me do it" (he leans over and tries to type something)
Craig: (tries to pull the boy's arm away from the keyboard)
Boy: (pushes Craig away)
The two boys start to struggle with each other.
Craig: "Don't push me"
Boy: "Let me be in there"
Teacher: "Ah Craig, Craig and Dani, no, stop"
Both boys stop, the boy looks at the girl, then smiles, he leans over to begin to play.

18-10-93 (V) /11.17 CODED IIP, IIIP, VP, IVP, VP, IIP, VP

Prologue: The second boy (see above), Dani, starts to play the angle estimation game on the computer
Dani: (points at the monitor screen) "One, two, three, four; four" (he then smiles and presses the figure '4' on the keyboard"
Craig: "I'm bored with this" (and he walks away)
Dani: (presses the space-bar and starts another game, he looks at the angle displayed on the monitor screen and makes a guess) "Five" (he types in the figure)
The computer fills up the angle with 10 degree sections, and Dani counts while pointing to the monitor screen)
Dani: "One, two, three" (he types some more, counts on the screen again, and types in an answer)
Dani: (talks some more to the girl who continues to sit beside him watching)

18-10-93 (V) /11.23 CODED IVA, VA, IVA, VA

Prologue: Nursery assistant assists a child playing the angle estimation game on the computer.

Nursery assistant: "Now let me get my glasses on, hold on, coz I can't see anything"
: "Now this one, one and one more"
: " You haven't finished your name"
: "Right, how big is the angle?"

Child: "Little"

Nursery assistant: "Yes, but how big do you think it is?"
: "One, two, three, four?"
: "I say two, try two, number two"

Child: (presses the figure '2' on the keyboard)

Nursery assistant: "And press return"

The computer indicates that the answer was 'one' ten degree section.

Child: "One"

Nursery assistant: (laughs, pats child on the head and walks away)

Child continues to play with the computer.

Nursery assistant returns.

Nursery assistant: "How big is the angle? Two? One or two?
: "What do you think it is? One or two?"

Child: (answers, but answer inaudible)

Nursery assistant: "Well press number one then"

Child: (presses the figure '1' on the keyboard)

20-10-93 (V) /10.45 CODED IIA, IIIA, IIIA

Prologue: Nursery assistant comments on the number of volunteer helpers assisting with the milk distribution

Nursery assistant: "How many helpers have I got so far? One, two, three"
: "How many more do I need?"

Child: "One"

Nursery assistant: "One more, who's that? Michael, who's that?
:"You are the helper for today"
: "Come and serve the children, two in a basket, Michael, Elisa, Kylie, Amber;
: "Come and give the children their milk please. Two in a basket"

The four children get up, and the rest of the children begin to make some noise.

20-10-93 (V) /11.18 CODED VA, IIA, VA, VA, VA, IIIA

Prologue: Nursery assistant assists two children, one after the other, with a computer game.

Nursery assistant: "Which one are you doing?"

Two girls both press keys on the keyboard.

Nursery assistant: "Only once darling; You haven't done a number; Do the number two"

Mellisa: (presses the figure '2' on the keyboard, but not firm enough nothing happens)

Nursery assistant: "Do number two again;That's it"

Computer plays a tune, - indicating that the choice was correct.
Nursery assistant: "You see; You go one, two, three, four"
: "Hold on a minute" (she leaves Mellisa at the computer, but returns shortly)
Mellisa: (plays)
Nursery assistant: (returning to speak to Mellisa)
: "No you haven't"
Mellisa: "Oh yes I have"
Nursery assistant: "No you haven't, No you haven't; Now which slot it went on?";
: "Which number?; No, No darling; Right, do number two darling"
: "You won't win like that; You won't win, no way, no way"
: "I'll show you something; You see; Well this is yellow, you see this is
: yellow"
: "Right, let's change this; Now what colour's this?"
: "Blue, Right; When this is blue it means not properly; That's why you can't
: win properly";
: "Right, You see number three"
: "I can not go number three with this one, But I will go"
: "Right now we go with the yellow one, number three"
: "Come on, go number three; Right, number seven; Right, number three now"
: "They've got to be four yellows or four blue crosses"
: "Yes, that's a win; I'll tell you why; Hold on, start again"
: " Y for yes, N for no; Press Y; Do you know what Y is?"
Mellisa: (presses Y on the keyboard)
Nursery nurse: "Go on then, you know what to do"

20-10-93 (V) /11.34 CODED IIIA, IIA, IIIA
Prologue: The teacher has been reading a story about a farm and farm animals, they have been singing the rhyme 'Old Macdonald had a Farm'.
Teacher: "And on the next page there's going to be two holes, and that word say's
: Bow-Wow"; "On this we've got a dog and ... sheep; Sheep; Old Macdonald
: (repeats the verse with sheep, and the sound of sheep, Meah, Meah)
: "How many holes have I got on this page?"
: (she counts with the children) "One, two, three"
: "And here it says 'Quack, Quack, Bow-Wow and Meah, Meah' "
Children: (repeat the animal sounds, and then they join the teacher in a verse of Old Macdonald's farm with ducks and Quacks)
Teacher: "Which one's missing? There are three holes here";
: "Do we have a sheep?"
: "Do we have a lamb? Yes"
: "Do we have a duck? Yes"
: "Do we have a dog?"
Children: "Yes"
Teacher: "No; There's no dog here; I haven't got a dog; I can't find him; I've looked"
: (begins a chorus of Old Macdonald's farm again)

20-10-93 (V) /11.39 CODED IIA, IIIA, IIIA, VIIA, IIIA

Prologue: The teacher continues to talk to the children about her story about farm animals (see previous example), this time they count all the animals that have been in the story.

Teacher: "We have, one, two, three, four, five; Put your hands behind your back"; :" Show me five"

Children: (they extend all the fingers on one of their hands and hold it out)

Teacher: "Right; If you hold two hands out you have ten; Put your hands behind your : back" ; "Show me ten"

Children: (they all hold out ten extended fingers on their hands)

Teacher: "Five and five is ten; Ten tiny fingers, ten tiny toes, two little eyes and one : little nose, and what's this hidden underneath your hair, two little ears with : which to hear" ; "Right, if you could be any farm animal, which one would you like to be Jermaine?"

22-10-93 (V)

/9.11 CODED IIA, VIP, VIA, VIP, IIA, IIIA, IIIA

Prologue: Children are drawing candles on paper, to make decorations for the Festival of Light (Diwali). The teacher (Jill) asks a girl how many candles she has drawn. Her answer of "Four" sparks off an age equivalence conversation.

Teacher: "You can make as many candles as you like, and then draw round it, and : then you can move it" (she places a paper candle underneath Serena's paper)

Child: "Jill"

Teacher: "One?; How many have you got there?"

Child: "One, two, three, four"

Another child: "I'm four"

Child: "Jill"

Teacher: "Yes, you're four"

Yet another child: "I'm four"

(various shouts of "I'm four" come from around the table)

Child: (counting candles drawn on her paper) "One, two, three, four"

Another child: "Jill, I've got none; I've got no pen"

Teacher: "Draw two more"

The children all begin to draw around the paper candles just as the teacher has shown them.

A few moments later.

Teacher: "Oh; What have you done? You've got five haven't you? What have you got?

22-10-93 (V) /9.36 CODED VIP, IIP, IIIP

Prologue: A group of three girls are sitting at a table drawing.

1st Girl: "I'm four; I'm four then"

2nd Girl: "One, two, five" (looking at the eight fingers held out by another girl)

3rd Girl: (holds up five fingers on one hand and a thumb on the other hand)

2nd Girl: (counts the fingers on the other child's hands) "One, two, three, four, five, six; six"

22-10-93 (V) /11.01 CODED IIA, VA, IIIA, IIA, VA, IIIA. VA, IIIA, IIA, VIIA, IIA, IIIA,

IIA, VA, IIIA, VA, IIIA, VA, IIA, VIIA, IIA, VA

Prologue: Nursery assistant tutors another child in the operation of the computer game.

Nursery assistant: "What are you doing? Now look darling if you don't know how to
: play"; "Will you please ask; No! Look; What does this say? Where's the
: space-bar darling?"

Child: (presses the space-bar, computer bleeps)

Nursery assistant: "Right"
:"Now" (she begins to count objects displayed on the monitor screen)
: "One, two, three, four, .. seven, eight, nine"
: "Find me a nine up there" (gestures towards the keyboard)
: "Now you count, look" (she touches each of the number figure keys, and
: vocalizes the number names) "One, two, three, four, five, six, seven, eight,
: nine"; "There's nine; There's number nine" (pressing the '9' key)
:"Space-bar; Space-bar" (telling the child to press the space-bar to start a new
game)

Child: (presses the space-bar)

Nursery assistant: "Right"; "Ooh, how many you got there? Five"
:"You need Five up there darling" (meaning that the figure '5' must be found
: and pressed on the keyboard) "Find them from the beginning"

Child: (counts along the row of numbered keys on the keyboard)

Nursery assistant: "Right, press number five"

The game is completed, the computer bleeps, indicating a correct answer.

A new game is begun, the computer monitor shows a new number of objects to be counted.

Nursery assistant: "How many you got there? Four?"
: "Right, find number four" (implying that the figure '4' must be located on the
: keyboard and pressed)

Child: (finds the figure '4' on the keyboard and presses it)

Nursery assistant: "Good, see how clever you are";
: "Right, space-bar" (a new game is to be started by pressing the space-bar)
: "How many you got there?"
: "Do you know this is the number five" (points to the five objects displayed
: in the first of two sets of objects on the computer monitor);
: "That's five fingers" (shows the child five fingers extended on her hand);
: "And this is the number four" (points to the four objects displayed on the
: monitor in the second set);
: "Four fingers, count my fingers, please" (child counts her four fingers)

A man comes in and the lesson is interrupted briefly.

Nursery assistant:"Count my fingers; One, two, three, four, five, six, seven, eight,
nine"; "See, five plus four is nine"
: "You count this one now" (referring to the combined set of objects that is
: also displayed on the computer monitor)
: "It'll be a nine there" (counting the objects displayed in the combined set)
: "One, two, three, four, five, six, seven, eight, nine"
: "I told you it would be nine; Right let's count nine there" (referring to the
: row of number figure keys on the keyboard)

Child: (counting very quietly, steadily progressing along the row of number keys on
: the keyboard, touching each one as the number name is called out)
: "One, two, three, four, five, six, seven, eight, nine"
Nursery assistant: "Right, there's a number nine" (referring to the '9' key)
Child: (presses the '9' key)
Nursery assistant: "Now what does this say?" (the game is ended)
: "Right, space-bar" (a new game is begun; a set of '1' and a set of '3' are displayed)
: "One, two; Right, press number one"
Child: (presses the '1' key, then counts the number of objects displayed in the second set)
Nursery assistant: "How many do you get?
Child : "Three"
Nursery assistant: "Three; Right, press number three then"
: "One, two, three" (counting the along the row of number keys on the keyboard)
: "You see; One plus three makes four, you will have four down there, you
: watch" (referring to the combined set of 'one' and 'three' that is displayed on
: the monitor)
:"One plus three makes four; One, two, three, four" (counts the objects in the
: combined set) "Now press number four there" (referring to the '4' key)
Child: (presses the figure '4' key on the keyboard)
Nursery assistant: "Yes, clever"
The computer acknowledges a correct sum with a bleep.

03-11-93 (V) /9.26 CODED IIP, IIP, IIP, IIIP, IIP, IIP, IIIP, IIP, IIIP, IIP, IIP
Prologue: A group of girls are sitting at a table drawing candles for a Diwali festival decoration, suddenly, one girl, without prompting, begins to count the candle flames on her friend's decoration, - her friend meanwhile has left her seat.
1st. Girl: (picks up a decoration belonging to the person sitting in a seat next to hers, and she begins to count the number of candle flames in the decoration)
: "One, two, three, four, five, six, seven"
: (she then replaces the decoration in the position from which she had picked
: it)
Several other girls are busy drawing candle flame decorations at the table. The girl whose decoration was counted, returns to her chair, and she begins to count her number of candle flames. She has several attempts at counting.
2nd Girl: (counting the same decoration, her own decoration) "One, two, three, four;
: No"; "One, two; No; One, two, three, four, five, eight, nine"
!st. Girl: (listening to her friend's count, which she knows is wrong, recounts the candle flames for the benefit of her friend who has failed to count sequentially) "One, two; No; One, two, three, four, five, six, seven; seven"
This second girl, whose decoration was counted, and who has failed to count her own decoration in a proper sequential order, lays aside her own decoration. She then takes a fresh Diwali cut-out decoration from the centre of the table, and she attempts to count the candle flames which are on this new uncoloured decoration.

2nd. Girl: (counting the candle flames on this new decoration, this time she counts sequentially and accurately, coordinating her points in a one-to-one correspondence with her number words) "One, two, three, four, five, six, seven"

The 2nd Girl then replaces this decoration in the centre of the table, and the same girl then picks up yet another Diwali cut-out decoration, and she begins to count this one.

2nd. Girl: (counting a second fresh candle cut-out) "One, two, three, four, five, six, seven": (she emphasizes the "seven" by saying it directly into the face of the 1st girl who counted)

1st. Girl: (passes a different type of Diwali decoration over to the 2nd girl to count)

2nd. Girl: (counting the candle flames on the new decoration that she has been given) :"One, two, three, four, five, six, seven, eight" (she then looks at the 1st. girl to note her reaction to this count of eight)

!st/ Girl: (looking at the 2nd. Girl and confirming the 2nd. Girl's count of eight) : "Eight"

This second type of candle decoration is put away to the side of the table, and then another similar styled decoration is passed over to the 2nd girl by the 1st. Girl.

1st. Girl: "Count this"

2nd. Girl: (counting this other second styled decoration, similar to the one that she has just counted) "One, two, three, four, five, six, seven, eight"

The 1st Girl then counts her own decoration, one that she is colouring with a crayon, one of the second styled decorations.

1st. Girl: (counting her own decoration) "One, two, three, four, five, six, seven, eight"

The two girls then stop counting.

APPENDIX D5

TOTAL NUMERICAL UTTERANCE IN A PRIMARY SCHOOL NURSERY CLASS
(V) - video recorded (D) - Diary note

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
23-09-94 (V) /10.10	IIIA Teacher comments to two children "When you two have finished playing with that, you pack it all up"	(AC)	1min	2
/11.00	IIA, IA, IIIA, IA, IIA Teacher discusses the prospects of counting sweets or biscuits to be shared out.	(C)	5mins	20
/11.05	IIIA Teacher tells children to take only "one" sweet	(AC)	1min	20
/11.28	VIA Teacher calls out the title of a book that she is going to read to the children, "It's fun to be three"	(SB)	1min	10
18-10-93 (V) /10.00	IIIA, IIA, IIIP, IIP, IIIA, IIP, IIIP Researcher comments that a plasticine cake has one candle, and then invites a child to count the number of candles on another plasticine cake. Another child comments that she is making a cake with "Three" candles. A girl counts candles on Kirk's plasticine cake, "One, two three, four, five; he's got five" A girl puts three candles back onto her plasticine cake and she counts them, "One, two, three, we've got three"	(CP)	3min	2
/10.26	IIIA, IIIA, IIA, IIA, IIIA Researcher guides a child in the use of a computer programme involving angle estimation.	(CMP)	2mins	1
/10.29	IIIA, IIA, IIIA, IIA, IIIA, IIA, IIA, IIIA, IIIA, IIIA Teacher questions children to see if they can show 2, or 4 or 5 fingers on their hands, and tells them that they can have only two sweets, "Not four (laughing), who said four? Two each, two each"	(C)	5mins	20
/10.45	VIP, IVP, VIA, IIS; IVP, IIS, IIP, VP Child plays an angle estimation game on the computer	(CMP)	2mins	1

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
18-10-93 (V)				
/10.48	VP, IIIA, IIP, VIA, VP Child begins to play the angle game on the computer Researcher assists	(CMP)	1min	1
/11.03	IIIP, IIP, IIIP, IIIA, IIIA, IIIA, VA, IIIP, IIIA, IIP, IIIP IIIA, IIIP, IIP, IIIP, IIIA, VP Researcher assists two girls sitting at the computer, one girl counts eight objects displayed on the monitor, the girls play a computer number game.	(CMP)	5mins	2
/11.16	IIP, IIIP, IIIP, IIIP, VP A boy, (Craig), sits at the computer playing the angle game, he assists a girl, showing her how to play the game, Craig holds the girl's hand and guides her in the key presses and the counting .	(CMP)	1min	1
/11.17	IIP, IIIP, VP, IVP, VP, IIP, VP A second boy starts to play the angle estimation game on the computer	(CMP)	1min	1
/11.23	IVA, VA, IVA, VA Teacher assists a child with the computer angle estimation game.	(CMP)	2mins	1
/11.25	IIIA, IIA Teacher assists another child with the computer game.	(CMP)	1min	1
/11.27	IIIA, IIIP Researcher asks children how many toy cars the have, "We got four"; A girl: "I got two cars"	(DC)	1min	3
20-10-93 (V)				
/9.30	IIIP Child comments to others that she has, "Got three"	(C)	1min	4
/9.50	IIIA A health visitor to the nursery classroom comments that she will allow "Two more" children to brush a set of giant teeth	(AC)	1min	20
/10.45	IIA, IIIA, IIIA Nursery assistant comments on the number of children helping to distribute the milk..	(C)	1min	1
/10.50	VP, VA Researcher and another boy, Craig, try to assist Kirk to play the computer game	(CMP)	1min	2

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
20-10-93 (V)				
/10.54	IIP Craig counts the number of numbers on the keyboard	(CMP)	1min	1
/11.07	IIA Nursery assistant counts out cutlery to one of her volunteer helpers	(DC)	1min	1
/11.13	IIIP, IIIA, VIA, IVA Two children play at the computer, initially the researcher assists, then the nursery assistant helps the children	(CMP)	2min	2
/11.18	VA, IIA, VA, VA, VA, IIIA Nursery assistant assists two children, one after the other, with a computer game.	(CMP)	5mins	2
/11.34	IIIA, IIA, IIIA Teacher reads a story to a group of children	(SB)	2mins	15
/11.39	IIA, IIIA, IIIA, VIIA, IIIA Teacher involves the children in counting related to the story	(SB)	2mins	15
22-10-93 (V)				
/9.11	IIA, VIP, VIA, VIP, IIA, IIIA, IIIA Children are drawing candles on paper, to make decorations for the festival of Light (Diwali). The teacher asks a girl howmany candles she has drawn. Her answer of "Four" sparks off an age equivalence conversation.	(D)	4mins	4
/9.18	IIIA, IIIA, IIP, IIIP Researcher playing with children, - a guessing game with numbers of geometric shapes	(CP)	4mins	3
/9.29	VIP, IIIP Child talking with the teacher about the number of candles that have been drawn, "How many is that?" Child: "Four"; Teacher: "That is four"	(D)	1min	1
/9.36	VIP, IIP, IIIP A group of girls sitting at a table drawing candles, one girl indicates her age, the others count fingers shown on each others hands, - probably representing the number of candles that they have drawn.	(D)	1min	3

Date/Time	Codes/Numerical	Incident/Activity form	Time length	No. of children
22-10-93 (V)				
/9.45	IIA, IIA, VA, IIA, IIIA, IIA, IIIA, IIIA, IIA, IIIA, IIA, IIA, VA, IIIA, VA, IIIA, IIA, VA, IIA, IIIA, IIA, VA, IIA, VA, IIA, IIA, VA, IIA, VIIA, IIA, VA, VA, IIA, VA, IIA, VIA, IIA, IIIA, IIA, IIA, IIA, VA, IIA, IIA, VA, IIA, VA, IIA, IIA, VA, IIA, VA, IIA,VA, IIA, IIA, VA	(CMP)	18mins	1
	Child is being tutored at the computer by the nursery assistant, counting objects displayed on the monitor and pressing the correct number figure key on the keyboard.			
/10.15	IIS	(CP)	1min	1
	Girl is seated at a table alone, she begins to count to herself the number of wooden blocks that she is playing with.			
/11.01	IIA, VA, IIIA, IIA, VA, IIIA. VA, IIIA, IIA, VIIA, IIA, IIIA, IIA, VA, IIIA, VA, IIIA, VA, IIA, VIIA, IIA, VA	(CMP)	5mins	1
	Nursery assistant tutors another child in the operation of the computer game			
/11.30	IIIA	(AC)	1min	3
	Teacher comments to three children to follow her into the other room, "You three come with me"			
/11.38	IIIA, IIIA, IIIA, IIIA, IIIA, IIIA, VIA, VIA, VIA, VIA	(C)	3mins	15
	Teacher questions children about the number of puppets that they are playing with as part of their interaction with a story that she has been reading to them, - the teacher asks some of the children to ask their puppets to say their puppets age.			
01-11-93 (V)				
/9.47	IIA, VA, IIP, IIP, IIP, VP	(CMP)	5mins	2
	Children are sitting at the computer, initially the teacher assists then leaves			
/9.53	VA, IIA, VA, IIA, IIA	(CMP)	3mins	1
	Teacher begins to assist another child at the computer after the previous two children leave			
/11.14	IIA, IIA	(SB)	1min	1
	Researcher asks a girl 'reading' a book, "How many plumbs" are shown in a picture on the page that she is looking at, then, "How many oranges", the girl answers correctly			

Date/Time	Codes/Numerical Incident/Activity	form	Time length	No. of children
01-11-93 (V)				
/11.36	IIIA While the teacher talks to the children about the dangers of fireworks, she comments, "After four more sleeps"	(C)	1min	1
/11.40	IIIA While the teacher is talking to the children about a car in a story that she is reading to the children, the teacher comments during the story, "All cars have four wheels, and a spare one, a fifth one"	(SB)	1min	15
03-11-93 (V)				
/9.03	IIA Teacher assists a child to count pictures of candles that the child has been drawing for the Diwali festival	(D)	1min	1
/9.05	VA, IVA, VA, IIA, IIIA, IIA, IVP, IIP Teacher assist one of two children sitting at the computer, to play an angle guessing game, then the children briefly play alone while the teacher attends to some other children at a table	(CMP)	3mins	1
/9.08	IIA Teacher has meanwhile gone over to a table where children are painting, and the teacher counts the children aloud, saying "How many people are here? One, two, three, four"	(C)	1min	4
/9.09	IVP, VP, IIP, IVP, IIP, IIIP, IVA, IIA, IVS, IVS, IIS The two children sitting at the computer continue to play together, then the teacher returns briefly, then one child leaves, and one child continues to play the computer game alone	(CMP)	5mins	2
/9.18	IIIA, VA Teacher quantifies the number of flowers in a child's drawing, and writes the number figure '4' on the drawing	(D)	1min	1
/9.22	IVA, VA, IIA, VIA, IVP, VP Teacher begins to assist another child playing the computer angle estimation game, then the teacher leaves him there, but the child is unable to play by himself	(CMP)	2mins	1
/9.26	IIP, IIP, IIP, IIIP, IIP, IIP, IIIP, IIP, IIIP, IIP, IIP A group of girls sitting at a table drawing candles for a Diwali festival decoration, count each others candles	(DC)	5mins	3

Date/Time	Codes/Numerical Incident/Activity form		Time length	No. of children
03-11-93 (V)	IIS, VP, VA	(G)	2mins	1
/9.34	Child begins to play with a mosaic number toy, where quantities of pegs can be impaled on number figure blocks			
/9.55	VA, IVS	(CMP)	2mins	1
	Teacher assists a girl playing the angle estimation game at the computer, then the teacher leaves the girl playing by herself			
/9.56	VA, IIA, IIIA, VA, VP	(G)	1min	2
	Another teacher assists a child to count pegs on the mosaic number figure blocks			
/10.00	IIA, IIIA	(DC)	1min	1
	Teacher asks a girl playing at the crayon table to count her number of candles			
/10.19	IVA, IIA, IIIA, VA, IIA, IVA, IIA, IIIA, VA, IIA,IVA, IIIA, VA, VIA, IVA, VA, IIA, IIIA	(CMP)	2min	1
	Teacher assists another girl playing the angle estimation game at the computer, but when the teacher leaves the girl stops playing			
/10.30	IIIA, IIIA, IIIA, IIIA, IIIA, IIIA	(C)	3mins	20
	Teacher talks to all the children about colours, and she often asks children to stand up to demonstrate various coloured clothing that they are wearing, "Sit down you three", and "Nathon has got three different colours of blue"			
/10.36	IIIP, IA, IIIA, IP	(C)	2mins	20
	Teacher talks to all the children about the number of sweets that the children will be given			
/10.55	IIS, VS, IIS, VS, IIS, VS, IIS, IIS, VS, IS	(CMP)	3mins	1
	A boy, Craig, who seems to enjoy playing with the computer sits alone talking to himself as he plays a computer game			
/11.08	IIA, IIIA, IIIA, IIIA, IIIA	(C)	6mins	2
	Nursery assistant is being assisted by two children to set out the tables for lunch. The number of chairs that still needs to be set out is discussed.			

*N.B. On the following dates/times the incident was researcher prompted (BIAS)

1. 18-10-93/10.00	2. 18-10-93/10.26	3. 18-10-93/10.48	4. 18-10-93/11.03
5. 18-10-93/11.27	6. 20-10-93/10.50	7. 22-10-93/09.18	8. 01-11-93/11.14

Total number of Days 6 Total number of incidents 55 - 8 researcher prompted incidents

= _47 incidents_

Total number of codes 280

APPENDIX E

NURSERY TEACHERS INTERVIEWS

APPENDIX E

NURSERY TEACHERS VIEWS

Teacher 1:

Teacher 1 did not expect caregivers to explicitly prepare their children for nursery school mathematics. She did not believe that preparation could take place during the course of daily interaction at home, "I don't think it would come up". However, teacher 1 appeared to acknowledge that caregivers do contribute to the 'teaching' of number to young children, and she believed that young children can learn number skills as easily from a caregiver as from a teacher. Teacher 1 thought that caregivers and teachers each had something different to offer young children in terms of the development of number skill.

Teacher 1 indicated that much of the mediated numerical practices in her nursery class take place through play, saying "A lot of play is mathematical in content", and she quotes as examples: water and sand play & large block play. Nursery teacher 1 also encouraged talk in her classroom, she said that she always invited young children to discuss their experiences. For teacher 1, "play is meaningful", and young children respond to play, so for teacher 1 play is the most important activity in her nursery classroom through which young children learn about number.

Teacher 1 indicated that she viewed children's acquisition of the language associated with number as a means of assessing young children's number development, rather than a means by which young children learn number.

In the experience of teacher 1, when young children enter nursery classes they already display a **very wide range** of developed number skills.

According to teacher 1, some young children can recite up to twenty and beyond, they are usually competent and accurate at one-to-one correspondence counting, they can determine a cardinal quantity of five, they are often aware of differences in cardinal quantities, and they can recognize numerical symbolism up to ten.

For teacher 1, young children appropriate number through play situations involving water, sand, bricks when the teacher is, "sensitive to what the child is finding out", and when, "the teacher intervenes at the right moment".

Teacher 2:

Teacher 2 did not expect young children to be formally prepared for school mathematics by caregivers. She believed that learning should be child centred in the nursery, and this would exclude the imposition of a didactic approach towards mathematical learning for young children. Teacher 2 believed that young children could learn number skills equally easily from a parent as from a teacher. She also though that both caregivers and teachers had something different to offer young children in terms of learning experience, saying that the teacher had more pedagogical skill, but that the caregiver knew the child better.

In her nursery classroom, teacher 2 said that each child was "getting something different" in terms of number appropriation from the activities. Teacher 2 considered that forms of talk in the nursery were the principal driving force behind all activities, and she believed that this was the case for number work as well. Teacher 2 thought that young children learn about number through talk and interaction, and she intuitively thought that there may be a link between linguistic interaction and a child's numerical development.

Teacher 2 thought that the development of young children's number skills could be viewed from two levels, a vertical level (formal) and a horizontal level (everyday). She acknowledged that young children entering primary school nurseries normally exhibited a range of number skills on both these levels. For teacher 2, the broad capabilities of a 5-year old entering nursery, in terms of already developed number skills, are: ability to recite up to ten; count in one-to-one correspondence in the range of 5-10 items; able to determine a cardinal quantity between five and ten, and being aware of differences in cardinal quantities; able to recognize number figures up to ten.

Teacher 2 believed in a child-centred approach to number development, involving language use and interaction on the part of the child.

Teacher 3:

Although Teacher 3 does not expect caregivers to prepare their children for school mathematics she acknowledged that most do, "they come to school counting and using the language of mathematics". Teacher 3 thought that caregivers were the chief educators of pre-school children, and that they should teach their young children aspects of number is usually accepted as a caregiver responsibility; but as a teacher she would also accept it as her responsibility, "the onus is not on parents". Teacher 3 thought that young children could learn number skills just as easily from a caregiver as from a teacher. She thought that caregivers had more to offer, "because parents are with their children more". Teacher 3 viewed the development of numeracy as a skill that was guided by experience. In her nursery classroom she indicated that her children's numerical practices were, "probably slightly different", - they sang nursery rhymes and counted cups etc., she encouraged talk between the children, and between teacher and children. The practices which she has found effective is singing nursery rhymes and pretend cooking (they count during the activity), she also indicated that she often draws out aspects of number from the children's activity.

Teacher 3 has noted that young children do not all possess equivalent number skills, that they normally display a wide range of skill. She indicated that young children entering nursery school are often able to recite up to 100; able to count in one-to-one correspondence up to 20 items; they experientially 'know' the cardinal quantity of 'five'; they can compare cardinal quantities with one another and note differences; and they can recognize printed number figures up to '10'.

For teacher 3, young children's number skills are often best developed through activity in which the purpose is made explicit, where the reason 'why' is clear to the child, and "if the teacher points this out"

Teacher 4:

Teacher 4 did expect caregivers to prepare their young children for school mathematics, saying that caregivers often work within a nursery set-up at home, working on numeracy, sorting, and pre-maths skills. She would expect caregivers to 'teach' number recognition, and the one-to-one correspondence counting of small cardinal quantities, - up to five possibly. Teacher 4 thought that young children could learn number skills as easily from a parent as from a teacher, as long as the learning is made 'fun'. In the view of teacher 4, caregivers and teachers offer young children something different in terms of their development of number skill, - the nursery classroom offers more structured activity than home and the child will listen to the teacher more, whereas the caregiver at home is able to interact easier on a one-to-one basis.

In the nursery classroom of Teacher 4, the mediation of a child's numeracy skills is structured through group activities: puzzles, creative work, water, sand etc., and the interaction often involves one adult to ten children, - interactive talk and discussion are encouraged. Teacher 4 has found that visual practical activity, and activity that children do by themselves (including computer work) are effective in promoting young children's interest in aspects of number. Teacher 4 has noted that young children's interest in number is ineffectively promoted by non practical activity, including recitations of the number sequence, and counting practices, - although she intuitively acknowledges that their may be a possible link between language development and acquired number skills. Teacher 4 has noted that young children entering nursery school at aged 5-years old display a wide range of already developed number skills. She believes that these differences are due to differences in home backgrounds, speech differences and social differences.

The broad capabilities of a 5-year old in the view of teacher 4, are that they are usually able to: recite up to twenty; count in one-to-one correspondence up to ten, possibly twenty; they can determine a cardinal quantity of five and recognize differences in cardinal quantities. In the opinion of teacher 4, young children's numerical skills are best developed through an adult being involved in a child's interests, through using different resources to practice "counting in lots of different ways".

Teacher 5:

Teacher 5 expected caregivers to indirectly prepare their young children for school mathematics through home activity, but not realize that they are doing this, since, "they think that's a teacher's job". As a teacher, she accepts that it is her responsibility to 'teach' young children number skills, but she also expects caregivers to "back-up the teacher's effort". Teacher 5 believed that young children are able to appropriate aspects of number just as easily from a parent as from a teacher, qualified by the consideration that the teacher may have more pedagogical skill and the caregiver more time.

In the nursery classroom of teacher 5, aspects of number were usually perceived to be mediated through practical activities, item counting practices, and the recognition of number figures. Numerical talk is encouraged in the nursery classroom, it often takes place in the form of counting children and singing nursery rhymes. Nursery teacher 5 considers the verbal usage of number to be very effective in mediating aspects of number to young children, but in her experience there is no link between a child's language development and acquired number skills. Teacher 5 believes that a young child cannot appropriate aspects of number when they are 'not ready', - if the child is too immature.

In the experience of teacher 5, young children entering nursery school usually display a wide range of already developed number skills. In terms of ability to recite the number sequence, the range may be between 'ten' and 'twenty-nine', with 'twenty' being a good average. In terms of one-to-one correspondence counting, usually young children can count up to ten items, possibly beyond; they are able to determine specific cardinal quantities up to ten and recognize differences in cardinal quantities. Also in her experience, young children are usually able recognize number figures up to '10'.

According to teacher 5, the mediation of young children's numerical skills best takes place through, "lots of practical experience and lots of talk"

Teacher 6:

Teacher 6 does not expect caregivers to prepare their young children for school mathematics. She does not recognize that the possibility of a preparation stage exists, "children cannot be prepared for school in any sort of way". As a teacher, she is quite willing to accept the total responsibility for 'teaching' young children aspects of number, - with home support for teachers. However, teacher 6, accepts that young children can 'learn' number skills from caregivers just as easily as from teachers, saying that both caregivers and teachers each have something different to offer, but must support each other to achieve the same goal.

In her nursery classroom, aspects of number are mediated to children through: songs; stories with numbers; sorting activities; matching; puzzles; bead threading; possibly recording. Talk is actively encouraged during activity work in the nursery classroom. Teacher 6 also acknowledges that some of these activities may go on in the home. In her experience, practical activities, "hands on activities", using materials are most effective in mediating aspects of number to young children, and she sees the abstract manipulation of number difficult an ineffective. Teacher 6 has intuitively recognized that there may be a possible link between young children's language development and their acquired number skills.

In her experience, young children display a wide range of developed number skills when they enter nursery school at 5-years of age. According to teacher 6, the broad capabilities of a 5-year old are: ability to recite the number sequence up to twenty; count in one-to-one correspondence between 10 and 20 items; they are not usually able to determine cardinal quantities, although they can recognize differences in cardinality if there is a wide numerical gap; they are usually able to recognize all the number figure digits.

In the opinion of teacher 6, a variety of activity and language assists young children to develop skills with aspects of number.

APPPENDIX E

Interview Schedule for Nursery/Reception Class Teachers

Interview Schedule for Nursery/Reception Class Teachers

Date ....

Valerie Walkerdine (1990) in her book "The Mastery of Reason", raises questions about the relationship between home life and school experiences and their separate impact on young children's mathematical cognitive development. She writes:

> *"Several points are worth noting here. The first is the assumption that development occurs within a 'facilitating environment'; this often means that mothers are expected to prepare their children for school mathematics by providing them with the 'right kind' of experiences: in order for words to provide a practice which matches that of the school"* (p88).

Q.1 Do you expect mothers (or fathers) to prepare their children for school mathematics?

Q.2 (a) If not;

(1) "Why not?"

(b) If affirmative;

(1) "In what way, should children be prepared?"

(2) Does the school inform the parents of potential school children about this parental obligation?"

Walkerdine continues to write (p88):

"The basic question, ..., which remains unasked, is why mothers should be expected to teach their children when a system of state schooling exists for the purpose, and why, when children fail, teachers should themselves be blamed for a system which, through its insertion into a system of social inequality, has failure built into it. However, the discourse of child development does not recognize failure."

Q.3 Should mothers (or fathers) be expected to 'teach' their young children number skills, or do you accept it as a teacher's responsibility?

Q.4 Do you believe children can learn number skills as easily from a parent as from a teacher?

Q.5 Does parent or teacher have more advantage than the other, or do they each have something different to offer?

Walkerdine further writes:

"There have also been those studies which have claimed that mothers are better than teachers, thereby castigating teachers (Wells 1982; Tizard & Hughes). Again this seems most unfortunate, since clearly pedagogic practices are different from home ones" (p88).

Q. 6 What numerical practices go on in your nursery/reception class?

Q.7 Does your children's numerical classroom practices involve a great deal of talk or activity (either between children or in association with the teacher), or is talk and activity discouraged during numerical work?

Q.8 From your experience, what practices are most effective at encouraging and promoting children's interest in number work ?

Q.9 Are there any practices that you have used that are ineffective?

Q.10 Has your experience led you to recognise any intuitive link between language development and acquired number skills?

Q.11 In your experience, do young children, say aged five, all possess equivalent number skills, or is there a wide range of skill?

Q.12 In your experience, what are the broad capabilities of a five year old in terms of:

(a) reciting the number word sequence in the acceptable order;

(b) counting items that they can touch or see in front of them;

(c) being able to determine a cardinal quantity;

(d) being aware of comparative differences in cardinal quantities;

(e) recognizing written (printed) numerical symbolism;

Q.13 In your opinion, what do you consider to be the principle ingredient responsible for developing young children's numerical skills?