Modelling insight as a creative domain: Process or phenomenology?

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Modelling Insight as a Creative Domain: Process or Phenomenology?

Abstract In this paper, we examine a recent shift in research on insight problem solving research away from how people solve problems characterised by an underlying structure designed to mislead and towards how problems and problem solution types elicit feelings of insight. We suggest that this focus on the phenomenology accompanying problem-solving has led to a neglect of the question of *how* people solve an insight-type problem, instead replacing that question with an investigation of the metacognitive effects of experiencing insight. We argue that this shift leaves unaddressed the issue of how new knowledge and understanding are generated and instead relies on circularity – the feeling of insight shows a problem was solved by insight. We argue that the assumptions of current models unwittingly commit researchers to as-yet untested theoretical assumptions about the nature of problem solutions. We propose that this shift of the research field has led to a disproportionate focus on outcome over process and a worrying aggregation of idiosyncratic tendencies. We conclude with a call to generate multiple research pathways, one examining the phenomenology of the feeling of insight, the other returning to tackle unanswered questions about the process of generating novel understanding when faced with a problem which seems unsurmountable.

The feeling of insight – the "ecstasy of discovery" (Thagard & Stewart, 2011, p. 10) – is strongly associated with the generation of a novel thought. At least in Western cultures, the sudden illumination of a metaphorical lightbulb is assumed to accompany moments of creative genius (Glăveanu, 2011), often after a period of intense incubation. Our hero[1] has uncovered the solution and is filled with clarity, certainty and purpose. For cognitive scientists, this feeling is operationalized as the feeling of "aha", which is commonly described thus:

> A feeling of insight is a kind of 'Aha!' characterized by suddenness and obviousness. You may not be sure how you came up with the answer but are relatively confident that it is correct without having to mentally check it. It is as though the answer came into mind all at once—when you first thought of the word, you simply knew it was the answer. This feeling does not have to be overwhelming, but should resemble what was just described. (Jung-Beeman et al., 2004, p. 0507)

A folk association between creativity and this flashbulb moment of confident certainty has carried over into psychological research into the cognitive processes underlying creativity, despite evidence from other domains that it is more often a *lack* of certainty that accompanies creative practice (Beghetto, 2021; Ross, 2022a). Most important for the argument we shall lay out here, the *feeling* of insight has become epistemically entangled with the cognitive *processes* that underlie how human agents go about solving a difficult problem. This has been reinforced by experimental paradigms that require many trials of short duration and a clear unambiguous correct solution (Jung-Beeman et al., 2004; Spiridonov et al., 2021). This paper will put forward the argument that the focus on the feeling of insight has shifted the insight problem-solving away from its original aim: To model how people generate solutions to opaque and difficult problems. We will propose that this shift in the direction of the research field has led to a disproportionate focus on outcome over process, which fails to adjudicate between different models and leads to a worrying aggregation of idiosyncratic tendencies.

This link between the feeling of insight and cognitive processes relies on two core assumptions: That the insight experience is the key outcome of interest and that it is a stable measure of an underlying process. This paper will argue that these assumptions have led to a misplaced faith in the feeling of "aha" as a marker of cognitive process. We will then discuss how an overreliance on phenomenological approaches to insight fails to adjudicate between current and competing models of insightful problem solving and so leads away from this research area. We follow Place (1956) in assigning such views to the category of a phenomenological fallacy, described below. We conclude with a call to generate multiple research pathways – one examining the phenomenology of the feeling of insight and the other returning to tackle unanswered questions about the cognitive process of generating new discoveries.

Problems that yield insight phenomena

Processes that generate insights are just one of various mechanisms proposed to underlie creative cognition. One such mechanism is based on access of semantic memory to generate new concepts through spreading activation elicited by stimuli in the external environment (e.g., Knoblich et al., 1999; Ohlsson, 2011). Alternatives to memory-based mechanisms include search processes that seek to apply 'operators' (i.e.,

[1] For it is always a hero rather than a heroine

methods, techniques, and tools) to the current mental representation of a problem to transform it to another state (e.g., MacGregor et al., 2001; Ormerod, 2023). Still more alternative accounts seek to exploit the external task environment as a source of solution cue to creative idea generation (e.g., Ross & Arfini, 2023). These broad categories of process theory capture potential contributions to creative cognition from prior knowledge, goal-directedness and the task environment. In essence, they try to capture the impact of memory, purpose and place on creative idea generation. These models draw on existing theories to explain creativity using the same mechanisms used to explain other cognitive processes.

One of the key application areas of process theories proposed to underlie the generation of novel thoughts is the generation of 'insight', broadly defined as a sudden clarity about a situation with little or no conscious awareness of how that understanding was attained. This was formalized by Graham Wallas's (1926) stage theory of creative thinking that posited four (or five) stages in the 'art of thought'. In this highly influential model, Wallas suggested that thinking consists of preparation, incubation, illumination, and verification, alongside a fifth stage of 'intimation' (Sadler-Smith, 2015) which bridges incubation and illumination in shifting from pre-conscious activation of ideas to their conscious awareness. For Wallas, insight is an unconscious "flash" that resists the individual's will, but which can be cultivated through a focus on preparation and incubation. Wallas draws from case studies such as that of Poincaré who solved a complex mathematical problem in a rush on the steps of a bus (Wallas, 1926). In the same year, Wolfgang Köhler (1925) published observational work with apes that seemed to demonstrate the same quick movement from ignorance to sudden understanding. This effortless achievement of clarity has thus remained of interest to cognitive psychologists since the 1920s because it seems to represent the gaining of knowledge without effort.

The feeling of insight (or "aha") is a naturally occurring phenomenon (Friedlander & Fine, 2018) that has been investigated using qualitative reports in real world settings (Hill & Kemp, 2018). However, there are practical implications of investigating *in vivo* moments of insight as they happen rather than through post-hoc self-reports: Hill and Kemp's analysis of recalled moments of insight indicates that participants experience insight at moments when they were away from the problem and in places such as driving or in bed. This makes the naturally occurring phenomenon of insight less than amenable to experimental investigation. So, the idiosyncratic nature of the feeling means that it tends to be investigated in the cognitive psychologist's laboratory using "insight problems". This class of problem provides a clear and structured task environment that has been designed to be not easily solvable through analytical steps, and to induce a feeling of impasse. Yet, once impasse is resolved, the problems typically become trivial, and the answers arrive "all in flash". Investigations into insight, then, have become strongly associated with solving a problem of this class.

Insight problems, then, are typically structured in such a way as to seem initially intractable before a sudden realization occurs, perhaps about a misunderstanding of the problem statement, after which the answer becomes obvious. A characteristic of insight problems is that, while they are typically easy to state and should in principle lie within the competence of the solver without recourse to problem-specific expertise or other sources of knowledge and skill, they are hard to solve. What makes them hard is disputed by different theories, with accounts falling into two main camps: theories that posit constraints imposed by prior knowledge as the source of difficulty (e.g., Knoblich et al., 1999) and theories that posit misdirection through application of strategies for seeking ideas for attempts (e.g. Ormerod & MacGregor, 2017). What interests researchers are the cognitive moves made when participants do not know what to do, and how they move from a state of ignorance to one of understanding (Ross & Arfini, 2023). This state of understanding is theorized to result in the feeling of insight marked by the moment of "aha". Experiencing a moment of "aha" is therefore considered a marker of having engaged in the kind of opaque process of interest. From an epistemological perspective, insight accompanies a feeling of knowing without the normal guarantees of the validity of that knowing that come through the effort of working something out (Martínez-Ordaz, 2023). With non-insight driven solutions, the process of reaching the solution conveys the confidence. For example, with something such as mental arithmetic, while the problem solver may not know the solution, they will know the operators and rules that correspond to the most efficient process. While the answers to simple arithmetic problems may be pulled from long term memory, as the problems become more complex the answer must be checked, not by sudden recognition that is correct, but by following through each step. These steps will have been predetermined culturally and through personal experience. However, with insight problem-solving, the opacity of the process means it cannot be relied upon to grant confidence in the outcome. This, epistemic opacity rather than the *feeling* of insight than follows it, is what makes it of interest to researchers.

A theory of insight which suggests that, because these processes happen subconsciously they are unlike normal cognitive processes, relies on the phenomenology associated with epistemic opacity to argue that these processes are "unreasonable" (Perkins, 2001); in other words, they resist traditional methods of reason and are reliant on more "special processes". Underlying this claim is a view that there is a form of human reason specific to creativity which involves hitherto unidentified cognitive processes. Positing a unique set of processes requires strong evidence rather than an ongoing circular assertation. To test a claim of creativity-specific processes, it is more important to profile the moves that are made during a creative act than the *feeling* of insight (or its absence) that accompanies such moves. Using outcome as a direct measure of process, is, we argue, a mistake. The main object of this research programme should be to examine the cognitive processes which underlie how people reorient themselves to solve a problem that initially seemed intractable and the processes they bring to bear on that intractable problem. That process and reaction to process have been entangled historically is not a reason to carry on collapsing the two without a critical examination of the impact of that collapse. More saliently, this collapse makes it harder to distinguish between competing explanations for human performance on this class of problems. For models of problem-solving process to be useful, they must allow us to adjudicate between competing hypotheses.

Current Models of Insight Problem Solving

It would be disingenuous to suggest that insight problem solving has not always had a side interest in the feeling of insight: the problems were constructed precisely to elicit that feeling. However, we argue that the focus of the research programme into insight problem-solving was and should continue to be understanding the cognitive processes that allow a human agent to convert seemingly intractable problems into ones which are solvable. Were these processes to be clearly identified in the laboratory, the hope is that they would be scalable to scaffold solving more complex problems. Lightbulbs would be popping all over. The feeling of insight was subordinate to the process by which insight problems were solved. This becomes clear when we examine three competing models for insight problem solving. Broadly, the domain currently recognizes models which pose different loci for the sources of new ideas: memory, purpose or place.

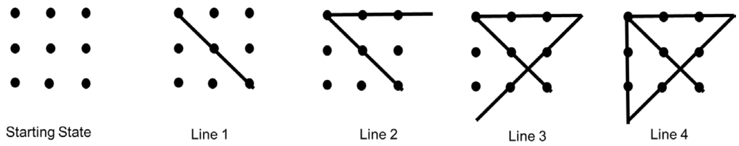
The first kind of model is exemplified by the Representational Change Theory (RCT) of Knoblich et al (1999), in which problem statements cue prior knowledge from memory. This knowledge imposes inappropriate constraints on the ideas individuals generate in their solving attempts. This is exemplified by Knoblich et al with respect to a class of Matchstick Algebra problems, in which the task is to move a single matchstick to correct an arithmetic sum presented as a series of Roman numerals made from matchsticks. For example, the sum II = II + II can be corrected by moving the vertical stick of the 'plus' sign to make a second 'equals' sign. This problem is hard to solve, they argue, because the solution requires abandonment of the common (but inappropriate in this instance) mathematical knowledge that arithmetic sums have a structure X = fY and are rarely tautologies. Negative effects of prior knowledge are overcome by constraint relaxation, a process described as "one of the mind's responses to persistent failure" (Knoblich et al, 1999, p. 1535). Thus, according to RCT, an "Aha" moment rises through the relaxation of constraining prior knowledge, which allows different knowledge to be discovered. Ohlsson (2011) proposes a revision of RCT -- Redistribution theory -- which sets out to specify conditions under which negative feedback (e.g., the experience of failure) changes activation levels across a knowledge network, thereby implementing the notion of constraint relaxation.

The notion that failed attempts contribute actively to eventual solutions is an attractive component of this theory, since it captures the idea that the work done in solution attempts is not in vain but rather a critical component of the solution path. However, the idea that knowledge is turned off and on during solution raises a conundrum: to solve a problem like the Matchstick Algebra example above requires the application of knowledge of mathematics, yet the very same knowledge is required to evaluate solution correctness. How can problem-relevant knowledge be both suppressed and active during solution? This is another strong claim that needs closer examination. A second problem this memory-based theory raises is captured within the 'Frame' problem, noted by artificial intelligence researchers such as Hayes (1981). The frame problem questions how the mind can determine from a potentially infinite set of information those pieces that are relevant to the task at hand. In the case of insight problem-solving, the frame problem concerns where in a potentially infinite space of possibilities the solver should seek as-yet undiscovered solution ideas. If one turns off some mathematical knowledge, what is the guarantee that the mind will be guided to more relevant knowledge? This would be easy in a finite store of information, where reduction of the accessible knowledge by inhibiting 'wrong' knowledge would isolate the right knowledge eventually. But it is a moot point whether most individuals asked to solve the puzzle above have ever seen a tautologous equation, begging the question of how constraint relaxation in memory can reveal knowledge that isn't there.

The second kind of model originates in the pioneering 'General Problem Solver' (GPS) theory developed by Newell & Simon (1972). Their interest was in explaining, through a computational simulation, how individuals solve analytical problems such as the Towers of Hanoi task or cryptarithmetic. The GPS theory posits that individuals solve problems by searching for paths from an initial state to a desired goal state, applying operators (i.e., actions and ideas) to generate moves between states. Moves are selected under a generic heuristic of means-ends analysis, in which an operator is selected that maximally reduces the distance between initial and goal states. If this operator cannot be applied immediately, a sub-goal is set up to achieve the conditions under which the operator can be applied. Although Newell and Simon did not apply GPS specifically to insight problem-solving, the same principles can be applied. For example, Kaplan and Simon (1990) describe solving insight problems as a search for moves involving a 'Noticing Invariants' heuristics, that is, detecting components of the problem representation that remain stable across multiple solution attempts.

The idea of insight problem-solving as a process of search is central to the PRODIGI (PROgress and Detection of Ideas in Generating Insights) theory of Ormerod, MacGregor, Banks, and Rusconi (2024). This theory proposes that insight problem-solving proceeds through the application of two heuristics: progress monitoring and idea discovery. Progress monitoring is, like means-ends analysis, a heuristic that selects moves based on the perceived progress they make towards the hypothesized goal, though it adopts a simple 'hill-climbing' approach, in which operators are applied immediately without sub-goaling. Moves are selected if they meet a criterion of satisfactory progress, specified generically as the ratio of work remaining to resources available. For example, in solving the nine-dot problem (see Figure 1), the criterion for satisfactory progress is the number of dots remaining to be cancelled divided by the number of lines available to cancel them. Although less efficient and powerful then a means-ends analysis heuristic, progress monitoring seems to model the relative lack of planning ahead that participants show in insight problem-solving that is entailed in means-ends analysis. The reason that the nine-dot problem is hard to solve according to PRODIGI (with only 5% of individuals solving the problem within a 10-minute period: MacGregor et al, 2001), is that there are so many criterion-satisfying moves available connecting dots within the square array that, until these are exhausted, the solver does not consider the possibility of extending lines beyond the dot array.

Figure One



The Nine Dots Problem and its Solution. The Task is to Cancel all the Dots by Drawing Four Straight Lines, Without Removing Pen from Paper During Solution. The Problem Requires the Problem Solver to Draw Lines Beyond an Imaginary Square boundary.

The second heuristic, idea discovery, operates after impasse is encountered, where no moves that make sufficient progress against the current criterion can be found, which is how impasse is operationalized in PRODOGI. Idea discovery takes place by the model inspecting the properties of previous moves, and comparing how these properties vary between moves of different value (i.e., how much progress is made by each move). It learns the effects of varying a property (i.e., how much progress can be made if the property is changed on move attempts) and uses this new knowledge to find new moves. In the case of the nine-dot problem, the model inspects properties of line length, angle between lines, and line trajectories, properties that can be assessed through visual inspection[2]. It discovers that moves vary according to each of these properties, and thus it applies different lengths, angles, and trajectories in an attempt to find new ways of tackling the problem. In the case of the nine-dot problem, the only property that needs to be varied is line length (though the model will try the other properties as well). Thus, the solver may discover line 2 shown in Figure 1 only once impasse has been reached and the property of line length variation is discovered. Of course, given the possibilities made available by changing line length, let alone those arising from changing angle and trajectory of drawn lines, the model may never discover the lines that lay on the solution path.

Ormerod et al (2024) have shown how PRODIGI provides a close approximation to human performance on the nine-dot problem. They have also shown how the model can predict performance on the Cards problem (Cunningham & MacGregor, 2008) illustrated in Figure 3. The Cards problem is an analogue of the task faced by Mendeleev in developing the periodic table of chemical elements (Akin & Akin, 1998). Mendeleev's insight was to leave gaps between known elements for as-yet-to-be-discovered elements so that the element properties could be captured systematically. Thus, although PRODIGI is tested with toy puzzles like the Nine-dot and Cards problems, its principles may extend to more realistic creativity tasks.

Two other features of PRODIGI are of note. First, it is the only computational implementation of a model of insight problem-solving we are aware of in which solution information is not available from the outset. PRODIGI must discover concepts that are relevant to solving the problems. This contrasts with other attempts at computational models of insight (e.g., Ollinger et al; Hele and Son), where solution knowledge is provided from

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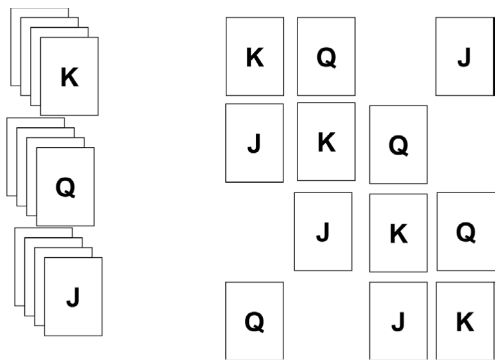
[2] The computational implementation of PRODIGI does not have a visual processing module. Instead, it has a library of properties to inspect that would be available to a system that did have one.

the outset and the task of the model is to determine when to apply it. PRODIGI must discover both what knowledge to apply *and* when to apply it. Second, Ormerod (2024) argues that the model provides a partial solution to the Frame problem. Other models solve the Frame problem by including solution-relevant information within the immediate task environment, so that its discovery is inevitable and bound only by solving time available. In our view, this approach cannot generalise to most domains of creativity. Instead, PRODIGI uses the properties of its previous attempts to seek solution ideas. The relevance of this source of ideas is established by coming from the problem-solving process itself. Although limited in its current implementation to knowledge-lean problems (i.e., problems whose statement contains all the information needed to solve, without expertise or additional knowledge being required), Ormerod et al (2024) argue that similar principles may apply in all creative problem-solving domains.

Figure 2.



The Cards Problem and its solution (Cunningham & MacGregor, 2008). The Task is to Arrange the Royal Cards from a Pack of Playing Cards Such That There is Exactly One of Each Denomination in Each Row and Each Column. One Solution is Shown on the Right-Hand Side of the Figure.

A third kind of model places an emphasis, not on the internally generated memories or decisions of the problem-solver, but on the guidance and concepts offered by the task environment in which a problem or creative activity is set. The idea that insight may come from environmental triggers and non-linear actions on the world is also gaining increasing acceptance (Ross & Arfini, 2023; Vallée-Tourangeau, 2014; Vallée-Tourangeau & March, 2019). Proponents of this view tend to draw from both RCT and PRODIGI as proposed mechanisms, but with the core distinction that actions that take place in the world can reveal the answer to problems – in other words, they propose the phenomenon of *out*sight where the mechanisms are external to the human agent. The cognitive actions that are required to make a complex task trivial are said to be those which occur in the world. In the classic paper describing outsight, Vallée-Tourangeau and March (2019) argue that embedding a problem solver in a materially rich environment (what they call “first order") makes insight problems trivial. A problem solution is not evinced through either effortful cogitation or a moment of sudden internal change but can be seen through the process of human-environment interaction.

For example, outsight offers a mechanism through which representational change can occur that avoids some of the problems outlined above. If we return to the matchstick arithmetic task described by Knoblich et al., where the constraint that needed to be relaxed was the inviolability of the operator, outsight explains how this chunk can be decomposed without forgetting mathematical knowledge. Vallée-Tourangeau et al. (2024) demonstrate that when the task is presented as first order representation, that is a decomposable and movable set of matchsticks, rather than a second order representation that relies on purely mental operations, the decomposition of the operator becomes trivial and can arise through playful movements such as fiddling with the matchsticks. The answer literally appears in front of the problem-solver. Similar work from Scarabusci et al. (2024) emphasizes the nonlinear process of idea discovery when embedded in a materially rich environment and how unintended actions can cue solution discovery. They illustrate how the constraints of two dimensions which characterises the 8-coin problem (Figure 2) is overcome when the participant piles coins, thoughtlessly, in a gesture similar to one that Steffensen et al (2016) call aesthetic. That is the goal of action appears to not be epistemic clarity but one related to “tidying the space”. This move cues solution discovery. Although this theory of insight emphasizes how actions can generate representational change, the mechanisms that it draws on are more closely related to PRODIGI. A first order environment significantly reduces the cognitive cost of maximization moves, scaffolding a try and then fail approach. The main difference between the two models is the role of the human agent. Much like RCT, theories of outsight de-centre the agent and rely on underspecified mechanisms of either mental (RCT) or externalized (outsight) breakthrough.

It is trivially true that models are only useful if they are abstracted representations of the phenomena at hand (Box, 1976; Smaldino, 2017). We follow Smaldino (2020) in acknowledging, first, that there is no non-socially constructed “truth” to map onto, second, that no map is useful if we do not leave something out, and third, that the non-trivial task is to ensure that what remains will allow us to find our way towards answering the question we are asking. Theories and models constrain the state space of what we are looking at, otherwise they are not useful. They are cognitive artifacts that are used to support scientific understanding and advances, but they do not map every possible parameter (Miłkowski, 2022). So, we see that each of the three competing models focuses on different aspects of the problem-solving experience. Weisberg (2015), indeed, suggests that the best approach is an integrated one (see also Gilhooly et al., 2015). Despite this difference focus, it is noticeable that of the three competing models only PRODIGI can produce a computationally tractable account. Both RCT and outsight require the agent to passively encounter the required representational change.

Note that none of these models address the feeling of insight, although intriguingly they allow different predictions. RCT explains the experience of insight as a representational change that allows solution, thus tying feelings of insight to the point of solution, that is, the achievement of a conceptual insight into the nature of the solution itself. In contrast, PRODIGI solves problems without requiring insight into the conceptual nature of the solution. For example, the nine-dot problem (Figure 1) is not solved by an insight that lines must extend beyond the dots: It is solved (eventually) because the solver has found a set of properties that extend the range of things they can try. Thus, the feeling of insight is tied, not solely to the point of solution, but incrementally throughout the solving process. Proponents of outsight remain neutral with regards to the feeling of insight. Vallée-Tourangeau et al., (2020) illustrate their outsight-driven claim that insight is discovered through action with a participant demonstrating accepted phenomenological markers of insight, that is surprise, happiness, certainty and suddenness after impasse (Danek et al., 2014), but they also remind us that outsight can happen through slow generative steps, opening the paper with the story of non-insight. In this case, they return to Kohler’s original observations of apes solving problems. They remind us that while the ape named Sultan demonstrated the classic signs of insight, another case study Koko instead showed none of the same conceptual leap instead progressing through fits and starts. The authors speculate that the history of insight problem solving might be very different were Koko to have formed the basis of the research programme. Of course, the accidental nature of play with the environment compared to effortful manipulation could easily engender two different reactions. If, however, the feeling of insight only arises after non goal directed problem solving shows the participants the unexpected answer, then it behooves RCT to develop models that can account for similar “accidental” internal overlaps.

Insight as feeling

The topography of the field of insight problem solving has shifted significantly in the last 15 years. Here, we make the argument that this change has shifted the focus of research from an investigation into how we solve hard problems into how we feel when we manage to solve them. Both are important, but one is now being neglected in favour of the other. This is a problem because, despite this current neglect, the models used to explain insight still aim to explain the process of solving an insight problem rather that the events which lead up to a feeling of insight. Therefore, it is not clear that we can adjudicate between the competing models based on the experience of insight. More important, perhaps, by shifting the focus from the problem structure to how it feels to solve the problem, we have created an artificial and unhelpful divide between analytical and insight problems based on *feelings* rather than processes. Our argument is that a reliance on the feeling of “aha” will not allow us to adjudicate between the three explanations for solving insight problems and constrains our ability to answer core questions about creative cognition.

The class of insight problems is not a natural kind. Instead, the types of problems have been constructed to allow theories to be investigated which aim to understand what human agents do when faced with a certain problem situation or task environment. The feeling of insight does not seem to be clearly tied to the cognitive actions required to solve these types of problems; reports from participants suggest this feeling arises across many different problem types. Webb et al. (2018) assessed the self-reported levels of insight across a variety of classic insight and non insight problems, anagrams and compound remote associates. They found that self-reported insight was highest for anagrams followed by compound remote associates, then classic non insight problems and then classic insight problems. This suggests that the affective component of insight may not have such a strong link solely to problems called “insight” problems. In fact, the research from Webb and colleagues across two studies coupled with other work from Fleck and Weisberg (2013) suggest that the binary split between analytical and insight problems may be misplaced. Rather than assuming insight from the problem, it appears that there are many different phenomenological responses elicited by the correct solution, no matter the path to reach them.

The direct association between an insight problem and the feeling of "aha" reflects the shift in research on insight problem-solving as neuroscientific methods became more popular. As Bowden et al., (2005) argue traditional insight problems have several characteristics which make them resistant to the kind of multi-trial administration required for neuroimaging or behavioural priming. Traditional insight problems have a long latency to solution – typically participants are given between 5 and 10 minutes to solve the problem – a low success rate and they are constructed so that multiple trials are often difficult to administer. Neuroscientific and online studies need low latency stimuli and high trial numbers to compensate for the obvious noise (Ross, 2022a; Spiridonov et al., 2021). Different problems were required which could be standardised and aggregated across many participants. This has led to a shift away from modelling insight in terms of strategies and tactics for solving a particular class of problem towards a focus on the post-task feeling as an indicator of how the problem was solved: "Phenomenological approaches are best used to determine which problems actually produced insight for each individual solver" (Bowden et al., 2005, p. 323). This phenomenological approach assumes that the feeling of insight is assumed to reflect a cognitive process which operates differently from analytical processes. There is evidence from behavioural and neuroimaging studies that suggest that this is the case. Different brain regions are associated with different phenomenological experiences (Jung-Beeman et al., 2004) and participants reliably report different experiences (Metcalfe & Wiebe, 1987)

The feeling of insight is a fascinating psychological phenomenon, but we are not convinced that it supports the primary aim of mapping how people solve initially hard problems and discover new information. Instead, the focus on the feeling of insight has led to a change in the focus of the research field. Insight is no longer seen as occurring when a participant solves a problem that does not contain enough relevant information in the problem statement to solve quickly – an "insight problem" - but rather one in which they display the typical phenomenology outlined earlier – they have had an "insight experience". However, the existence of problems that can be solved either with or without the feeling of insight, coupled with the existence of insight when problems are not structured in an *unreasonable* manner, falsifies the default assumption of use of overlap between the two when it comes to idea discovery. In other words, if we use solving the problem as a proxy for experiencing insight then we can never know if the participant actually has an insight experience, because it is possible to solve the problem without an insight experience. Although there is some evidence that (on aggregate) the feeling of insight tends to cluster around similar non monotonic and subconscious processes, it cannot be relied upon to indicate those processes. If, on the other hand, we use the phenomenology of insight and we also know it can be elicited by problems that don't require information discovery, we can never be sure that insight reflects information discovery because it might just reflect success. In other words, the focus of the research programme should separate to properly reflect these two different interests.

Adjudicating between the competing claims of the different models requires a set of stimuli that can elicit the phenomenon of interest. As we have outlined above, these stimuli fall into a class of problems called insight problems which are also used to investigate the feeling of insight. We believe that the current focus on the feelings of insight that are elicited by these stimuli is a distraction from the competing models that currently exist. The idea that the cognitive processes of insight on the one hand and insight as a phenomenological experience on the other are necessarily related is complicated by the complexities of research relying on phenomenology. Researchers such as Bowden et al (2005) critique the traditional approach to insight because the complexity of different problem types acts as a confound, blocking the clear decomposition of solution components. However, phenomenological reports can suffer from similar problems. For example, Webb et al., (2021) show how the magnitude of the strength of insight differs as function of the participants score on a positive schizotypy scale, suggesting that the insight experience is a combination of the effect and individual differences. The feeling of false insight (Danek & Wiley, 2017; Grimmer et al., 2022) which occurs when a participant experiences insight and believes they are correct suggests that a correct and an incorrect problem solution can generate the feeling of insight limiting how useful it is to assess process. This is like the findings from Ross and Arfini (2024), which demonstrated that a similar number of people experienced insight of similar strengths whether they experienced impasse or not. Of course, phenomenological reports are also reliant on the implicit understanding (Shen et al., 2018) of the participants and it is not clear that this implicit understanding is the same across cultures. More generally, a reliance on accounts of the experience of insight, captured in the expression of an 'aha' moment when a solution seems to pop suddenly into conscious awareness as if from nowhere, to explain how insight might actually arise encounters what Place (1956) described as the 'phenomenological fallacy', which he describes as "the mistake of supposing that when the subject describes his experience, when he describes how things look, sound, smell, taste or feel to him, he is describing the literal properties of objects and events on a peculiar sort of internal cinema or television screen, usually referred to in the modern psychological literature as the 'phenomenal field' " (p. 49). Indeed, at a recent conference of British cognitive psychologists attended by the authors, the conversation grew heated around whether insight should be measured on a binary all or nothing scale or along a continuum (see also Danek, 2023; Laukkonen & Tangen, 2018).

This complexity is further enhanced by a research programme that struggles to map the relationship between insight process and insight phenomenology in a way which avoids self-referential circularity. In other words, the process and method of testing the process are collapsed. Problems are solved insightfully when they generate a feeling of insight which is theorised to come from an insightful problem-solving process. While there is no way to track process rather than a post-task analysis, such a circularity is likely to continue. This is the very notion of experimenter's regress that Collins warned about in the 1970s (Collins, 1975, 1985; the same argument has been made by Ash et al. 2009 about theories of representational change with regards to insight). We therefore suggest that the two research areas are not as overlapping as the names might suggest, and that research into insight problem solving should stand alone from research into the feeling of insight. Perhaps the three models of insight problem-solving discussed above are right to ignore (or at least remain neutral to) the place and role of feelings of insight in achieving it.

What happens when you substitute outcome for process: The cautionary tale of the accuracy effect.

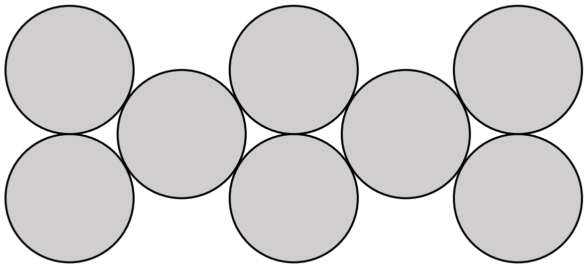
According to insight proponents, insight is the "best" way to solve a problem (Danek & Salvi, 2020; Salvi et al., 2022). This view comes from robust data showing that having a feeling of insight is associated with getting the correct answer. However, we believe this is a fallacy with its foundations in this focus on final feeling at solution rather than an analysis of the process of problem solution. To be clear about this, let us imagine that a participant in an experiment is tasked with solving an insight problem. There is no empirical evidence to suggest that it is possible to begin with the strategy to solve a problem through a feeling of insight. We are not sure what that would look like, although we admit that it is possible. Our suggestion is that the average participant reads the problem and moves through a step-by-step way to the first failed solution. This is an analytical approach and would be experienced as such. There are then (theoretically) five possible outcomes: first, the participant carries on with the analytical approach and fails to get an answer at all (failure of omission); second, the participant carries on with the analytical approach and generates the incorrect answer (failure of commission); third, she carries on with the analytical approach and gets a correct answer (solution through analysis); fourth, she carries on with the analytical approach but the correct answer comes through an insight (correct insight); and finally, she carries on with the analytical approach and she gets the wrong answer but with a feeling of insight (failure of commission/false insight).

Note that failure of omission is only possible through analytical problem solving. A participant cannot have an insight and fail to produce an answer. That is impossible given the definition of insight outlined above. Of the three ways of producing a wrong answer, two thirds of those must be analytical. This means even if the answer rate were evenly distributed, we would expect more wrong answers in the analytical case. However, they are not evenly distributed because the problems are constructed in such a way that it is hard to have an insight about a wrong answer. Solutions are obviously either correct or incorrect. Failures of commission are harder to have when the problem solution provides its own feedback, so failures are likely to be weighted towards failures of omission (only possible with analytical approaches). In addition, in data collected for Ross & Arfini (2024), it was clear that if participants were under time pressure they offered a guess rather than failing to answer at all. Again, this "guessing" strategy is more likely to lead to failure of commission and, by definition, this can only occur when a participant is pursuing an analytical strategy.

It is true that the extent to which a solution to an insight problem can be seen prior to its enactment in the world depends on the problem structure and presentation. Ormerod et al (2024) distinguish between global and local problem evaluation of solution states. For example, the nine-dot problem (Figure 1; Maier, 1930) allows for global evaluation of progress since the current state of the problem can be evaluated at a glance through a process of subitisation, which is the evaluation of quantities of objects in a single glance (Peterson & Simon, 2000). In contrast, the eight-coin problem (Ormerod et al., 2002), illustrated in Figure 3, requires local evaluation of progress, since the extent to which each coin is correctly positioned relative to others requires individual inspection. Nonetheless, the basic idea that insight solutions are amenable to some kind of 'pop-out' correctness remains (Novick & Sherman, 2003). In other words, the process may be opaque, but when the answer is correct it is accompanied by a strong feeling of correctness. This is because the construction of the problem is such that you can "see" that you are right, and in this moment, you have gained new knowledge – your epistemic landscape has shifted.

In problems where this external feedback is less clear, then the feeling of "aha" as a marker of accuracy diminishes. Ormerod et al (2006) present an analysis of non-naïve participants re-attempting the Nine-dot problem. Despite possessing the 'insight' that lines must project beyond the dot array, most participants took multiple trials to solve, many failing to solve at all. This is true of the data presented in the paper that sets out evidence for the accuracy effect (Danek and Salvi). In this paper the feeling of aha diminishes as the problems become more opaque and the idea of a normatively correct answer becomes more complex. Ross and Vallée-Tourangeau (2022) showed that for more complex problems where there was less of a clear normatively correct answer, the feeling of insight was linked directly to confidence in the problem whether the solution was correct or incorrect. There are two competing explanations for their results: first, that feeling that you are correct leads to insight; and second that the feeling of insight contaminates both forwards and backwards thoughts about the solution. In other words, the feeling of insight is not a reliable marker of solution accuracy or process. The accuracy effect only holds in toy tasks with clear normative outcomes and yet by assuming process from outcome rather than mapping process first, the notion of an accuracy effect persists.

Figure 3.



The eight-coin problem (Ormerod et al, 2002; Ormerod, 2024). The task is to move two coins only such that each and every coin touches exactly three others. The solution requires the arrangement of coins in three dimensions.

Conclusion

This paper lays out a call for a return to investigating the steps that people take to solve the class of problems traditionally understood as insight problems to complement research on what the processes are that generate insight. We believe that the focus on the feelings on solution has shifted the research field excessively to the *outcomes* of problem solving. However, we suggest that there is no straightforward mapping between a conscious experience of 'aha' and the solution of a complex problem. To make such an uncritical mapping is to commit the phenomenological fallacy. A return to the mapping of process of problem-solution rather than insight generation allows us to investigate how people solve complex problems. This will support us in unpacking how the cognitive moves made by the problem solver change her epistemic landscape and allow a more open-minded approach to understanding the processes that underlie insight problem-solving. For example, there is a widespread assumption that insightful solutions emerge immediately and effortlessly from a restructuring of the mental representation of a problem, an account consistent with a sudden onset of an 'aha' experience. Yet if one removes the privileged status of this state as a predictor of process, then one can see reams of evidence for progress being made towards solution of insight problems prior to any phenomenological experience of a change in understanding. In addition, focusing on "aha" continues the problematic modelling of this feeling as a marker of creative thought. Such an image is heavily influenced by implicit ideas of the creative process as one centered wholly in the mind of the thinker and occurring all at once after a period of incubation. This idea draws on individualist and romantic paradigms of creative thought that have been subsequently debunked (Montuori & Purser, 1995; Ross & Vallée-Tourangeau, 2018; Weisberg, 1986) and ignores the evidence that creative thought is often a process of not knowing and uncertainty (Beghetto, 2021; Glăveanu et al., 2013; Ross, 2022a) and any moments of insight mark the start not the end of the process.

We propose the following fundamental requirements for modelling of this form of problem solving. First, there is a crucial need to reorient insight research towards a process-oriented approach, focusing on the cognitive mechanisms underlying problem-solving rather than predominantly on the phenomenological aspects of insight experiences. Second, cognitive psychology posits the presence of unconscious processes which are beyond understanding (Ball & Ormerod, 2017) and so reliance on an individual's in-the-moment introspection may mean that important processes and explanatory factors that occur outside of the problem solver's conscious awareness go unnoticed.[3] The processes that underlie insight problem solving are by definition sub-personal and

[3] In a series of papers on serendipity (Ross, 2022b, 2023; Ross & Arfini, 2023; Ross & Vallée-Tourangeau, 2021), it is argued that framing of serendipity through the experience of the person, rather than through

so self-reports need to be triangulated with behavioural data. Fedor et al. (2015) demonstrated this when it came to the experience of impasse as did Ross and Arfini (2024). The former used complex move tracking and the latter used the simpler metric of latency, but these behavioural measures did indicate something about the phenomenology. Third, the distinction between the phenomenology of insight and its cognitive underpinnings must be clarified, advocating for research methodologies that can dissect the cognitive processes involved in solving complex problems without conflating them with the subjective experience of the "aha" moment. Finally, we suspect that comprehensive understanding of insight problem-solving requires integrating diverse models and theories, from representational change and memory-based theories to environmental cues, to capture the multifaceted nature of creative problem-solving processes. This is something that would be impossible to establish empirically with the current focus.

References

Akin, Ö., & Akin, C. (1998). On the process of creativity in puzzles, inventions, and designs. *Automation in Construction*, *7*(2-3), 123-138.

Ash, I. K., Cushen, P. J., & Wiley, J. (2009). Obstacles in investigating the role of restructuring in insightful problem solving. *The Journal of Problem Solving*, *2*(2). https://doi.org/10.7771/1932-6246.1056

Ball, L. J., & Ormerod, T. C. (2017). Cognitive psychology. In C. Willig & W. Stainton Rogers (Eds.), *The Sage handbook of qualitative research in psychology.*. (pp. 572–588). SAGE.

Beghetto, R. A. (2021). There is no creativity without uncertainty: Dubito Ergo Creo. *Journal of Creativity*, *31*, 100005. https://doi.org/10.1016/j.yjoc.2021.100005

Bowden, E. M., Jung-Beeman, M., Fleck, J., & Kounios, J. (2005). New approaches to demystifying insight. *Trends in Cognitive Sciences*, *9*(7), 322–328. https://doi.org/10.1016/j.tics.2005.05.012

Box, G. E. P. (1976). Science and statistics. *Journal of the American Statistical Association*, *71*(356), 791–799. https://doi.org/10.1080/01621459.1976.10480949

Collins, H. M. (1975). The Seven Sexes: A study in the sociology of a phenomenon, or the replication of experiments in physics. *Sociology*, *9*(2), 205–224. https://doi.org/10.1177/003803857500900202

Collins, H. M. (1985). *Changing order: Replication and induction in scientific practice.* Sage Publications.

Cunningham, J. B., & MacGregor, J. N. (2008). Training Insightful Problem Solving: Effects of Realistic and Puzzle-Like Contexts. *Creativity Research Journal*, *20*(3), 291–296. https://doi.org/10.1080/10400410802278735

Danek, A. H. (2023). The phenomenology of insight: The Aha! Experience. In L. J. Ball & F. Vallée-Tourangeau (Eds.), *Routledge handbook of creative cognition*. Routledge.

Danek, A. H., Fraps, T., von Maller, A., Grothe, B., & Ollinger, M. (2014). It's a kind of magic: What self-reports can reveal about the phenomenology of insight problem solving. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01408

Danek, A. H., & Salvi, C. (2020). Moment of truth: Why Aha! experiences are correct. *The Journal of Creative Behavior*, *54*(2), 484–486. https://doi.org/10.1002/jocb.380

Danek, A. H., & Wiley, J. (2017). What about false insights? Deconstructing the Aha! experience along Its multiple dimensions for correct and incorrect solutions separately. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.02077

Fedor, A., Szathmáry, E., & Öllinger, M. (2015). Problem solving stages in the five square problem. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01050

Friedlander, K. J., & Fine, P. A. (2018). "The penny drops": Investigating insight through the medium of cryptic crosswords. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00904

Gilhooly, K. J., Ball, L. J., & Macchi, L. (2015). Insight and creative thinking processes: Routine and special. *Thinking & Reasoning*, *21*(1), 1–4. https://doi.org/10.1080/13546783.2014.966758

Glăveanu, V. P. (2011). Is the lightbulb still on? Social representations of creativity in a western context. *The International Journal of Creativity and Problem Solving*, *21*(1), 53–72.

Glăveanu, V. P., Lubart, T., Bonnardel, N., Botella, M., Biaisi, P.-M. de, Desainte-Catherine, M., Georgsdottir, A., Guillou, K., Kurtag, G., Mouchiroud, C., Storme, M., Wojtczuk, A., & Zenasni, F. (2013).

observation, has shaped the current view of serendipity as an experience rather than an event and means that we miss moments which are not filtered through our experience.

Creativity as action: Findings from five creative domains. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00176

Grimmer, H., Laukkonen, R. E., Tangen, J., & von Hippel, W. (2022). Eliciting false insights with semantic priming. *Psychonomic Bulletin & Review*, *29*(3), 954–970. https://doi.org/10.3758/s13423-021-02049-x\

Hayes, P. J. (1981). The frame problem and related problems in artificial intelligence. In *Readings in Artificial Intelligence* (pp. 223-230). Morgan Kaufmann.

Hill, G., & Kemp, S. M. (2018). Uh-Oh! What have we missed? A qualitative investigation into everyday insight experience. *The Journal of Creative Behavior*, *52*, 201–211. https://doi.org/10.1002/jocb.142

Jung-Beeman, M., Bowden, E. M., Haberman, J., Frymiare, J. L., Arambel-Liu, S., Greenblatt, R., Reber, P. J., & Kounios, J. (2004). Neural activity when people solve verbal problems with insight. *PLoS Biology*, *2*(4), e97. https://doi.org/10/b3tpwf

Kaplan, C., & Simon, H. A. (1990). In search of insight. *Cognitive Psychology*, *22*, 374–419.

Knoblich, G., Ohlsson, S., Haider, H., & Rhenius, D. (1999). Constraint relaxation and chunk decomposition in insight problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*(6), 1534–1555. https://doi.org/10.1037/0278-7393.25.6.1534

Köhler, W. (1925). *The mentality of apes*. Liveright.

Laukkonen, R. E., & Tangen, J. M. (2018). How to detect insight moments in problem solving experiments. *Frontiers in Psychology*, *9*, 282. https://doi.org/10.3389/fpsyg.2018.00282

MacGregor, J. N., Ormerod, T. C., & Chronicle, E. P. (2001). Information processing and insight: A process model of performance on the nine-dot and related problems. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*(1), 176–201. https://doi.org/10.1037//0278-7393.27.1.176

Martínez-Ordaz, M. D. R. (2023). Scientific understanding through big data: From ignorance to insights to understanding. *Possibility Studies & Society*, *1*(3), 279–299. https://doi.org/10.1177/27538699231176523

Metcalfe, J., & Wiebe, D. (1987). Intuition in insight and noninsight problem solving. *Memory & Cognition*, *15*(3), 238–246. https://doi.org/10.3758/BF03197722

Miłkowski, M. (2022). Cognitive artifacts and their virtues in scientific practice. *Studies in Logic, Grammar and Rhetoric*, *67*(1), 219–246. https://doi.org/10.2478/slgr-2022-0012

Montuori, A., & Purser, R. E. (1995). Deconstructing the lone genius myth: Toward a contextual view of creativity. *Journal of Humanistic Psychology*, *35*, 69–112.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Prentice-Hall.

Novick, L. R., & Sherman, S. J. (2003). On the nature of insight solutions: Evidence from skill differences in anagram solution. *The Quarterly Journal of Experimental Psychology*, *56*(2), 351–382. https://doi.org/10.1080/02724980244000288

Ohlsson, S. (2011). *Deep learning: How the mind overrides experience*. Cambridge University Press.

Ormerod, T. C. (2023). Possible, yes, but useful? Why the search for possibilities is limited but can be enhanced by expertise. *Possibility Studies & Society*, *1*(1).

Ormerod, T. C. (2024). How many heuristics are enough? Testing a parsimonious theory of possibility generation in problem-solving. *Possibility Studies & Society*, 27538699241237321.

Ormerod, T. C., & MacGregor, J. N. (2017). Enabling spontaneous analogy through heuristic change. *Cognitive Psychology*, *99*, 1–16. https://doi.org/10/gcs256

Ormerod, T. C., MacGregor, J. N., & Chronicle, E. P. (2002). Dynamics and constraints in insight problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *28*(4), 791–799. https://doi.org/10.1037/0278-7393.28.4.791

Ormerod, T. C., MacGregor, J. N., Banks, A., & Rusconi, P. (2024, under review). PRODIGI: A theory and computational implementation of insight problem-solving through progress maximization and idea discovery. Unpublished ms.

Perkins, D. N. (2001). *The eureka effect: The art and logic of breakthrough thinking* (1. publ. as a Norton paperback). Norton.

Place, U. T. (1956). Is consciousness a brain process? *British Journal of Psychology*, *47*(1), 44-50

Ross, W. (2022a). Creative ignorance: Unknowing through doing. In S. Arfini & L. Magnani (Eds.), *Embodied, extended, ignorant minds: New studies on the nature of not-knowing* (pp. 37–59). Synthese library.

Ross, W. (2022b). Heteroscalar serendipity and the importance of accidents. In W. Ross & S. Copeland (Eds.), *The Art of Serendipity* (pp. 75–99). Palgrave MacMillan.

Ross, W. (2023). Serendipity. In V. P. Glăveanu (Ed.), *The Palgrave encylopedia of the possible*. Palgrave MacMillan.

Ross, W., & Arfini, S. (2023). Serendipity and creative cognition. In L. J. Ball & F. Vallée-Tourangeau (Eds.), *Routledge handbook of creative cognition*.

Ross, W., & Vallée-Tourangeau, F. (2018). For a good poet's made, as well as born: The relational ontology of Shakespeare's genius. *Creativity. Theories – Research - Applications*, *5*(1), 26–40. https://doi.org/10.1515/ctra-2018-0002

Ross, W., & Vallée-Tourangeau, F. (2021). Microserendipity in the creative process. *Journal of Creative Behavior*, *55*(3), 661–672.

Ross, W., & Vallée-Tourangeau, F. (2022). Insight with stumpers: Normative solution data for 25 stumpers and a fresh perspective on the accuracy effect. *Thinking Skills and Creativity*, *46, Article 101114*. https://doi.org/10.1016/j.tsc.2022.101114

Sadler-Smith, E. (2015). Wallas' Four-Stage Model of the Creative Process: More Than Meets the Eye? *Creativity Research Journal*, *27*(4), 342–352. https://doi.org/10.1080/10400419.2015.1087277

Salvi, C., Barr, N., Dunsmoor, J. E., & Grafman, J. (2022). Insight problem solving ability predicts reduced susceptibility to fake news, bullshit, and overclaiming. *Thinking & Reasoning*, 1–25. https://doi.org/10.1080/13546783.2022.2146191

Shen, W., Yuan, Y., Zhao, Y., Zhang, X., Liu, C., Luo, J., Li, J., & Fan, L. (2018). Defining insight: A study examining implicit theories of insight experience. *Psychology of Aesthetics, Creativity, and the Arts*, *12*(3), 317–327. https://doi.org/10.1037/aca0000138

Smaldino, P. E. (2017). Models are stupid, and we need more of them. In R. R. Vallacher, S. J. Read, & A. Nowak (Eds.), *Computational Social Psychology* (1st ed., pp. 311–331). Routledge. https://doi.org/10.4324/9781315173726-14

Smaldino, P. E. (2020). How to build a strong theoretical foundation. *Psychological Inquiry*, *31*(4), 297–301. https://doi.org/10.1080/1047840X.2020.1853463

Spiridonov, V., Loginov, N., & Ardislamov, V. (2021). Dissociation between the subjective experience of insight and performance in the CRA paradigm. *Journal of Cognitive Psychology*, 1–15. https://doi.org/10.1080/20445911.2021.1900198

Steffensen, S. V., Vallée-Tourangeau, F., & Vallée-Tourangeau, G. (2016). Cognitive events in a problem-solving task: A qualitative method for investigating interactivity in the 17 Animals problem. *Journal of Cognitive Psychology*, *28*(1), 79–105. https://doi.org/10.1080/20445911.2015.1095193

Thagard, P., & Stewart, T. C. (2011). The AHA! Experience: Creativity Through Emergent Binding in Neural Networks. *Cognitive Science*, *35*(1), 1–33. https://doi.org/10.1111/j.1551-6709.2010.01142.x

Vallée-Tourangeau, F. (2014). Insight, interactivity and materiality. *Pragmatics & Cognition*, *22*(1), 27–44. https://doi.org/10.1075/pc.22.1.02val

Vallée-Tourangeau, F., & March, P. L. (2019). Insight out: Making creativity visible. *The Journal of Creative Behavior*. https://doi.org/10.1002/jocb.409

Vallée-Tourangeau, F., Ross, W., Ruffatto Rech, R., & Vallée-Tourangeau, G. (2020). Insight as discovery. *Journal of Cognitive Psychology*, 1–20. https://doi.org/10.1080/20445911.2020.1822367

Wallas, G. (1926). *The art of thought*. Jonathan Cape.

Webb, M. E., Little, D. R., & Cropper, S. J. (2021). Unusual uses and experiences are good for feeling insightful, but not for problem solving: Contributions of schizotypy, divergent thinking, and fluid reasoning, to insight moments. *Journal of Cognitive Psychology*, *33*(6–7), 770–792. https://doi.org/10.1080/20445911.2021.1929254

Weisberg, R. W. (1986). *Creativity: Genius and other myths*. W.H. Freeman.

Weisberg, R. W. (2015). Toward an integrated theory of insight in problem solving. *Thinking & Reasoning*, *21*(1), 5–39. https://doi.org/10.1080/13546783.2014.886625