‘Very small effects of an imagery-based randomized trial to promote adherence to wearing face coverings during the COVID-19 pandemic and identification of future intervention targets’

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**Abstract**

**Objective:** Mental imagery interventions are a cost-effective way of promoting health behaviour change. We tested a mental imagery intervention designed to promote adherence to wearing face coverings during the COVID-19 pandemic. **Design:** A four-arm randomized controlled trial to explore potential mechanisms of action. **Main outcome measures:** Measures of behaviour (frequency of self-reported face covering adherence), theory of planned behaviour constructs (i.e., intention, attitudes, subjective norms, and perceived behavioural control), personality traits, imagery ability and barrier self-efficacy were measured at baseline (T1). Behaviour was also assessed at four-week follow up (T2). **Results:** Of 297 participants, a majority always wore face coverings (*N =* 216, 73% overall sample). Logistic regression analyses revealed no intervention effects on changes in adherence to wearing face coverings, though T1 wearing of face coverings and being male predicted T2 behaviour. Subgroup analysis of participants with ‘suboptimal T1 adherence’, revealed that T2 non-adherence was predicted by being a non-student and by subjective norms and lower T1 intention to wear face coverings.**Conclusion:** Imagery-based interventions to increase face covering wearing adherence may exert significant public health effects but only when conducted on a very large scale. Our findings suggest that interventions should target men and disrupt habitual past behaviour.

**Key words:** mental imagery intervention; behaviour change; COVID-19; face coverings; habitual past behaviour

**Introduction**

The impact of the COVID-19 pandemic in the U.K. has resulted in over 4 million cases, nearly half a million hospitalizations and around 130,000 deaths within 28 days of testing positive as of November 2021 (UK Government 2021). Face coverings help protect non-wearers from infection and even limited wearing of face coverings should decrease transmission of the virus (Greenhalgh et al. 2020; Howard et al. 2020). Since July 2020, wearing face coverings in defined public areas (e.g., on public transport, in shops/supermarkets) has been a legal requirement enforced with fines of up to £6,400 ($8,700) (UK Government Cabinet Office 2020). However, there are many reasons why an individual may not wear a face covering, for example because they believe it is unnecessary to control the spread of COVID-19, because they are medically exempt from doing so, because they do not like wearing them or due to obstacles to wearing face coverings (e.g., forgetting them, losing them, finding them uncomfortable). Evidence has begun to support some of these intuitive reasons for non-adherence to wearing face coverings. For example, anti-mask attitudes have been found to be predicted by a perceived ineffectiveness of this protective measure and an aversion to being forced to wear masks (i.e., psychological reactance) in a survey of 2,078 U.S. and Canadian adults (Taylor and Asmundson, 2021). The main aim of the present study is to test a theory-based intervention to promote the wearing of face coverings.

Consistent with National Institute for Clinical Excellence guidelines (2021), behavioural science should be used to guide understanding of how to predict and encourage adherence to COVID-19 preventative measures (‘preventative behaviour’ hereafter). Understanding links between psychological theory and subsequent behaviour can support understanding of how practice and policy might steer increased adherence to preventative behaviours. Emerging evidence concerning COVID-19 protective behaviours has suggested how these behaviours might be contingent on variability in psychological beliefs and skills (e.g., Armitage et al., 2021; Hagger et al., 2021; Lin et al., 2020). For example, Armitage et al. (2021) have proposed that supporting people’s capabilities, opportunities and motivations is important in supporting COVID-19 preventive behaviours. Given the complexity of these behaviours, many researchers have sought to identify predictors of discrete COVID-19 protective behaviours, including studies focusing exclusively on face covering adherence as a singular COVID-19 protective behaviour. For example, evidence suggests that increased face covering adherence in public spaces is predicted by greater belief in science (Stosic et al., 2021) and more liberal political beliefs (Milad et al., 2021).

Several studies exploring face covering adherence during COVID-19 have drawn on constructs derived from the Ajzen’s (1991) Theory of Planned Behaviour (TPB). The TPB posits that the proximal determinant of any action (such as the action of wearing a face covering) is a person’s intention to act or not. Behavioural intention itself is predicted by attitudes (i.e., positive or negative evaluations of the focal behaviour); subjective norms (i.e., perceptions of approval or disapproval from significant others about the focal behaviour); and perceived behavioural control (PBC, perceptions of control over enactment of the focal behaviour). TPB also specifies that behaviour is predicted, independently, by PBC. Empirical evidence has suggested the value of TPB related constructs sometimes above demographic variable predictors of face covering adherent behaviour and behavioural intention (Bokemper et al., 2021; Freidin et al., 2021; Mahalik et al., 2021; Sun et al., 2021). For example, social norms towards mask-wearing have been found to predict observed and self-reported face covering use in public areas in two continents (Freidin et al., 2021; Sun et al., 2021). Other research supports TPB’s predictive value, with evidence that more favourable attitudes and greater PBC predicted intention to use face coverings among 477 international students at Chinese universities (Sun et al., 2021).

Very few studies have tested behaviour change intervention designed to increase adherence to wearing face coverings in public places. An exception is vignette-based experimental work revealing no effect, in two national settings (Italy, U.S.) of providing information concerning the protective properties of wearing face coverings on self-reported intention to wear face coverings (Bokemper et al., 2021). There are now several frameworks that have been used to develop behaviour change interventions, including the behaviour change wheel (Michie et al. 2014) and the intervention mapping approach (Kok et al. 2017). However, the process of developing such interventions involves several steps and can take several years to finish, which is not plausible in the context of a public health emergency (Faija et al. in press). In the absence of an established evidence base with which to develop an intervention specifically for increasing use of face coverings, we therefore tested the ability of an established behaviour change technique, namely, mental imagery to change behaviour at pace (e.g., Armitage 2015).

Mental imagery exercises involve “self-directed imagining or visualizing specific events, actions or outcomes, including concomitant feelings and responses, with the express purpose of increasing motivation toward a target action or task” and are simple, well-evidenced, behaviour change techniques for promoting physical health (Conroy & Hagger 2018, p. 669; Hagger & Conroy 2020). Mental imagery interventions involve imagining/visualizing and writing about health-related action focusing on anticipated positive outcomes of a behaviour (outcome imagery) or anticipated strategies required to successfully execute defined behaviour (process imagery). Mental imagery interventions might be appropriate solutions to encouraging face covering adherence given their proven effectiveness in helping people enact behaviours that may initially feel demanding/difficult. For example, imagery relating to social non-drinking has been linked to reducing subsequent alcohol consumption (Conroy et al. 2015) and to easing anxiety in the context of dental treatment (Armitage & Reidy 2012). Many health studies have focused solely on outcome imagery interventions; for example, Hagger et al. (2011) demonstrated how outcome imagery alongside implementation intention techniques could reduce alcohol consumption at month follow up among UK-based corporate employees. Other studies have supported the efficacy of process imagery; for example, in the context of increasing intentions to donate blood (Armitage & Reidy, 2008). Few studies examine both outcome and process imagery types, but some evidence points to discrete intervention effects of each imagery type. For example, Conroy et al. (2015) found distinctive effects of imagery on health apparent in outcome and process imagery reducing overall weekly UK alcohol unit consumption and the incidence of heavy drinking episodes respectively in their student sample.

A meta-analysis of twenty-six mental imagery interventions designed to promote health behaviours revealed nontrivial, small averaged corrected effect sizes on post-intervention behaviour (*d+ =* 0.23), and also suggested larger effects of imagery interventions in imagery studies based on older, nonstudent samples (Conroy & Hagger 2018). Recent meta-analytic evidence assessing imagery techniques across behavioural domains further supports their efficacy (Hedges’ (g = 0.49) in eliciting behaviour change and for modifying social cognitions (Cole et al. 2020). Many mental imagery interventions in the context of health behaviours have included measures of imagery ability; defined, broadly, as individual differences in dispositional skills for or experience/practice with using imagery in the context of a defined behaviour (Hagger & Conroy, 2020). Evidence from studies of health behaviour have suggested that differential skill/ability with visualizing (i.e., using imagery) may moderate imagery intervention effectiveness (e.g., Andrade et al., 2016; Chan & Cameron, 2012) and is therefore valuable to assess within imagery interventions.

Many health-related mental imagery interventions have included TPB measures (e.g., Armitage & Reidy, 2008; Hagger et al., 2011). While TPB specifies a set of core social cognitive predictors of human behaviour there are related psychological constructs worthy of investigation when considering predictors of adherence to wearing face coverings. Barrier self-efficacy refers to an individual's confidence to overcome such behavioural barriers. Barrier self-efficacy has been demonstrated as an important mediator of intervention effects on maintaining physical activity/ exercise behaviour (Higgins et al., 2014) and has recently been explored in a mental imagery intervention context (Hamilton et al., 2019). The incorporation of TPB measures and barrier self-efficacy in imagery interventions are of theoretical interest. For example, given that attitudes are underpinned by outcome beliefs, outcome imagery might affect attitudes more than other TPB constructs. Relatedly, process imagery might enhance PBC or barrier self-efficacy by simulating personal mastery experiences. It follows that measurement of these theory-based psychological constructs are also of clinical interest in that targeting these may help promote change in the target behaviour. Various self-efficacy related measures have been included in studies of COVID-19 protective behaviours. For example, survey evidence of 3,059 respondents across six U.S. states has revealed that response efficacy and perceived self-efficacy better predicted mask wearing behaviours than sociodemographic variables (Koebele et al., 2021). Exploring the predictive role of barrier self-efficacy intuitively makes sense in the context of face covering adherent behaviour: individuals may also face obstacles or barriers to the consistent wearing of face coverings where required during the COVID-19 pandemic (e.g., feeling preoccupied in a situation; difficulty remembering to pack and wear a face covering).

Personality traits have been widely researched in relation to health and are recognised as central to the field of health psychology (Ferguson, 2013). Personality is also known to hold close links with varied health behaviours including, illustratively, physical activity (e.g., Terracciano & Costa Jr, 2004) and alcohol use (Mezquita et al., 2021). Two U.S. studies have reported evidence that increased conscientiousness, openness and/or extraversion may predict increased adherence to wearing face coverings in public spaces (Milad & Bogg, 2021; Heyman, 2021). However, many personality facets might co-vary with the extent to which an individual is motivated to (and ultimately does) wear face coverings during the COVID-19 pandemic. For example, individuals scoring more highly in subclinical narcissism (Ames et al., 2006) might be less likely to adhere to face covering requirements given their sense of entitlement (to not wear coverings) and/or atypically excessive interest in physical appearance (and therefore displeasure in the requirement to wear a face covering). On the flip-side, individuals with higher scores on the recently proposed 'light triads' (Faith in humanity, Kantianism, Humanism) would be predicted to adhere to requirements to wear face coverings given their disposition to positive, collectively-orientated life approaches.

*The current study*

The primary aim is to evaluate the efficacy of a mental imagery intervention designed to promote increased and sustained wearing of face coverings. Given evidence discussed above to support both outcome and process imagery types in the context of health behaviour change, we will explore outcome and/or process imagery types in our intervention. A secondary objective is to identify potential behavioural correlates and mechanisms of action by measuring TPB constructs (intentions, attitudes, subjective norms, PBC), barrier self-efficacy and imagery ability. Given meta-analytic evidence of heterogeneity of mental imagery effects highlighted above (Conroy & Hagger 2018), a third objective is to explore potential demographic and personality traits discussed above as moderators of intervention effects. It is hypothesized that, relative to the control condition, individuals randomized to complete an outcome and/or a process mental imagery task at baseline (T1) will report greater wearing of face coverings at T2 (*Hypothesis 1*); and that the effects of mental imagery will be mediated through self-reported attitudes, subjective norms, perceived control and self-efficacy toward wearing face coverings (*Hypothesis 2*). In addition, we will explore whether imagery intervention effects (where found) are conditional on demographic factors, imagery ability and personality traits.

**Method** 1105/1200

***Participants***

Deaths following a COVID-19 diagnosis have been greater among Black, Asian, and Minority ethnic (BAME) communities; for example, all-cause mortality was almost four times higher in Black men, but only 1.7 times higher among White men, during the Spring 2020 period of the pandemic relative to 2014-2018 death rates (Patel et al. 2020). Promoting COVID-19 preventative behaviours is therefore important but understanding how to encourage preventative action within the BAME community is an urgent health promotion issue. Moreover, Armitage et al. (2021) have shown that people from BAME communities may need targeted interventions to support uptake and sustain adherence to COVID-19-related instructions. We therefore recruited students, employees from two higher education institutions in areas known to have diverse populations and recruited additional responses from within authors’ social networks.

Eligible participants were 18+ year old adults residing in the UK at both baseline (T1) and four-week follow-up (T2). Participants were recruited in bi-weekly email and social media drives between September 2020 and February 2021. The final sample consisted of 297 individuals aged 18-81 years who provided data at T1 and T2. Most participants lived in London (54%, *N =* 159) and self-identified as White British (58%, *N =* 171). Notably, and relevant to the importance of recruiting from BAME communities in a pandemic-related context, the final sample included a high proportion of BAME individuals (22.6%, n = 67) relative to the proportion of individuals from BAME backgrounds in the overall UK population (13.0% population) (Office for National Statistics (ONS), 2020). In total, 313 incomplete questionnaires were excluded from analysis (completion rate of 67%). The number of eligible people who received the invitation is not known and therefore the response rate cannot be calculated. The flow of participants through the intervention is shown on the CONSORT (Schulz et al. 2010) flow diagram (Figure 1).

> Figure 1<

***Procedure***

Ethical approval was granted by both participating institutions and the intervention was registered online (ClinicalTrials.gov ID: [NCT04583449](https://clinicaltrials.gov/ct2/show/results/NCT04583449?view=results)). A published protocol article is available (Conroy, 2021). A factorial trial design was adopted. Participants were randomized to one of four groups (outcome, process, outcome and process, control) via the Qualtrics randomizer feature (set up by Author 1) which operates via a Mersenne Twister pseudorandom number generator method. This method meant that the allocation sequence could not be determined until the participant was assigned. Imagery exercises involved receiving information about wearing face coverings in indoor public places being requested to visualize themselves wearing a face covering where required by UK law and then to write about these mental images as visualized. One imagery group was asked to imagine positive outcomes of having successfully worn face coverings (i.e., outcome imagery); another group was asked to imagine strategies involved in successfully wearing face coverings (i.e. process imagery); and a third imagery group was asked to complete outcome and process imagery exercises. A fourth condition viewed a social media image from August 2020 showing a UK Government public health message about the importance of wearing face covering while in public places representative of UK Government public health guidance on wearing face coverings in public places during the COVID-19 pandemic.All data were collected via Qualtrics. This study draws on data which contained no missing data on any of the variables of interest. As a data quality check, attentive responding was assessed using three items adapted from previous work (Maniaci & Rogge 2014) where incorrect responses would indicate inattention (e.g., ‘please choose option four to ensure you are paying attention’). Seven responses were excluded where incorrect responses were provided to any item.

***Measures***

All TPB measures were developed following standard guidance (Ajzen 2006). All demographic, psychological and behavioural variables were measured at baseline (T1) except for behaviour which was measured at both baseline/T1 and at four-week follow up (T2). Behaviour – the frequency of self-reported face covering adherence where required – was our primary outcome variable.

*Behaviour* Self-reported frequency of face covering adherence was measured using one item: “In the past week, when you have gone outside your home for work, grocery shopping, or other activities that involved using public transport, visiting shops/supermarkets, being in enclosed public spaces where social distancing may be difficult, or being in public spaces where you came into contact with people do not normally meet, how often did you wear a cloth face covering[[1]](#footnote-1) that covered your nose and mouth?” on a scale from 1 (never) to 5 (always). This item was based on a measure described in previous work (Fisher et al. 2020) and adapted for a UK policy/guidelines context incorporating then-current guidelines on wearing face coverings from August 2020 (UK Government Cabinet Office, 2020).

*Intention* (*3 items, α=*.93)towards wearing face coverings (e.g., Over the next week, wearing a face covering while in public spaces where this is required is something I intend to do) was self-reported on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

*Attitudes* (*3 items, α =*.93)Participants self-reported attitudes towards wearing face coverings via a stem statement (i.e., Wearing a face covering while in public spaces where this is required over the next week is something…) followed by three separate response anchors (e.g.) 1 (not worthwhile) to 5 (worthwhile).

*Subjective norms* (*2 items, r=*.77)about wearing face coverings (e.g., Most people who are important to me (e.g., friends, family) would want me to wear a face covering while in public spaces where this is required over the next week) was self-reported on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

*Perceived behavioural control* (*3 items, α =*.61)towards wearing face coverings (e.g., How much personal control do you think you have in wearing a face covering while in public spaces where this is required over the next week) was self-reported on a scale from (e.g.) 1 (no control at all) to 5 (complete control).

*Barrier self-efficacy* (*6 items, α =*.90)towards wearing face coverings was self-reported via a stem (Rate your degree of confidence in wearing a face covering under the following conditions) followed by six conditions (e.g. ‘When I feel stressed/frustrated’) on a scale from 1 (cannot do at all) to 5 (highly certain can do) (adapted from Hamilton et al. 2019).

*Personality traits* Participants self-reported conscientiousness (*10 items, α =*.85)(e.g. Typically I am always prepared) (Goldberg 1990); and narcissism (*18 items, α =*.65) (e.g. People always seem to recognize my authority) (Ames et al., 2006). Participants also self-reported light triad traits including Faith in humanity (*4 items, α =*.74)(e.g. I think people are mostly good); Kantianism (*4 items, α =*.67)(e.g. I prefer honesty over charm); and Humanism (*4 items, α =*.76)(e.g. I tend to treat others as valuable) via scales ranging from 1(very inaccurate of me) to 5 (very accurate of me) (Kaufman et al. 2019). All trait responses were made using a scale from 1 (very inaccurate of me) to 5 (very accurate of me). Conscientiousness and narcissism had 4 and 9 reverse scored items, respectively.

*Imagery ability* (*4 items, α =*.94) was gauged via a stem statement (i.e. When I think about wearing a face covering while in public spaces where this is required over the next week the imagery around this that occurs to me is) on scale items (e.g.) 1 (not clear) to 5 (clear). (Knäuper et al. 2011).

***Data re-coding and randomization checks***

An a priori power analysis conducted using G\*Power V.3.1 (Faul et al. 2007) indicated that 254 participants were required to detect medium effect sizes (f = 0.25) with power set to 0.80 and alpha set to 0.01 (adjusted to control for type I error rate inflation). Data indicated that a large proportion of participants had maximum scores indicating that they *always* wore face coverings where required and reflecting strong intentions, favorable attitudes/norms and high levels of control/skill about wearing face coverings. This was understandable: high levels of adherence might be explained for legal, health and moral reasons. To address these ceiling effects, all scale measures except personality trait scales were recoded as categorical variables. For the behavioural measure, this involved creating one category for response scores of ‘1’ to ‘4’ (labelled as ‘suboptimal adherence’) and creating another category for response scores of ‘5’ (labelled as ‘full adherence’). Given ceiling effects, ‘suboptimal adherence’ and ‘full adherence’ binary categories were also created for social cognition variables.

 Differences between complete, incomplete or lost-to-follow-up responses were assessed via a series of chi-square analyses using three dummy variables (complete vs incomplete; complete vs lost-to-follow-up; incomplete vs lost-to-follow-up). Compared with responses that were lost-to-follow-up, complete responses tended to be provided by participants who were White, who were non-students and who held stronger intentions, subjective norms and perceived behavioural control to adhere to wearing face coverings (*χ2*(1) = ≥4.60, *p* = ≤ .032). Group differences on age and personality traits, assessed using one-way ANOVAs and Games-Howell post hoc tests, revealed that individuals included in the final analysis were significantly older than individuals who did not provide a follow-up response (*M,Diff =* -3.01, *p* = .013).

 Randomization checks were conducted to examine and identify potential differences between study outcome variables and demographic variables across intervention conditions. Between-condition analyses revealed statistically significant differences indicating associations between being randomized to the ‘process imagery’ condition (vs being randomized to the ‘outcome imagery’ condition) and adherent face covering intention (vs suboptimal adherence) and having stronger imagery abilities (vs weaker imagery abilities), *χ2*(1) = ≥ 3.89, *p* = ≤ .049. Associations were also apparent between being randomized to the ‘combined imagery’ condition (vs being randomized to the ‘outcome imagery’ condition) and adherent face covering intention (vs suboptimal adherence), *χ2*(1) = 4.01, *p* = .045; and between being randomized to the ‘process imagery’ condition (vs being randomized to the control condition) and being a student (vs being a non-student), *χ2*(1) = 4.69, *p* = .030. Among these 66 comparisons, no differences were significant at a *p* < .01 or lower level and, accordingly, participants appeared to have been, overall, randomized successfully. Where evidence was apparent of non-random distribution of a variable across intervention groups (i.e., for intention, imagery ability and Student vs non-student variables) these variables were controlled for in all subsequent analyses. Responses to imagery exercises were content analyzed by the first author to assess sufficient engagement levels with the mental imagery exercise. Responses (n = 7) with insufficient evidence of engagement (e.g., unclear/irrelevant or indifferent responses) were excluded from analysis.

***Data analytic approach***

The core analyses involved logistic regressions, with T2 behaviour as the dependent variable, conducted via a hierarchical block entry method. The independent variables were entered in the following sequence: three dummy variables denoting factorial representations of intervention conditions (outcome imagery = yes/no; process imagery = yes/no; outcome and process imagery = yes/no) [block 1]; demographic and personality trait variables [block 2]; and T1 behaviour, TPB variables, barrier self-efficacy and imagery ability [block 3]. Given that statistically significant predictor variables were identical across blocks, only results from block 3 in the hierarchical analyses are reported (see Table 1). To permit comparison, we also conducted analyses of intervention conditions on T2 behaviour *without* covariates.

>Table 1<

**Results**

***Descriptive analyses***

A data file that supports the findings of this study (Conroy, 2021) is openly available at [figshare](http://doi.org/10.6084/m9.figshare.14535294). The final sample included 54 men (*M*age = 36.4, *SD* = 15.1) and 241 women (*M*age = 34.6 years, *SD* = 12.7) (details for gender were missing from two responses). Consistent with our sampling frame, differences were noted between the demographic characteristics of our sample and those of the UK general population. Our participants were mainly female (82% vs 51% nationally), were less likely to be White (58% vs 81% nationally) and were more typically younger (65% vs 29% aged 18-39 years nationally) (ONS, 2020). While our sample did not, therefore, closely represent the UK general population, it provided an opportunity to understand potential co-variability between face covering adherence in the context of demographic factors including gender, age and ethnicity. Occupationally, most participants self-identified as part- or full-time students (64%), and otherwise self-defined as part- or full-time employed (29%) or 'other' (6.5%). Table 2 presents additional demographic information and descriptive statistics for behavioural and psychological outcome variables. A sample majority always adhered to wearing face coverings (n = 216, 73% overall sample).

>Table 2<

***Effects of the intervention***

Correlations between all study variables and imagery interventions are reported in Table 3. Reported analyses were based on the complete cases sample (n = 297)[[2]](#footnote-2). Logistic regression analyses revealed no statistically significant effects of outcome imagery (*b* = .294, Wald *χ2*(1) = .441, *p* = .507), process imagery (*b* = -.234, Wald *χ2*(1) = .303, *p* = .582) or combined imagery (*b* = -.340, Wald *χ2*(1) = .285, *p* = .594) intervention exercises on T2 behaviour. The odds ratio indicated that full adherence to wearing face coverings at four-week follow-up (T2) was nearly four times more likely (81% full adherence at T2) among individuals who were fully adherent at baseline compared with individuals who had suboptimal adherence at baseline (19% full adherence at T2). Analyses also indicated that full adherence at T2 was predicted by gender with a higher proportion of women participants identifiable as ‘fully adherent’ as opposed to ‘suboptimally adherent’ (80% vs 20%) when compared with male participants (50% vs 50%), (*b* = -1.172, Wald *χ2*(1) = 9.139, *p* = .003). Analyses of potential intervention condition effects on T2 behaviour *without* covariates also showed no intervention effects.3

***What sample size is required for future mental imagery studies?***

In reviewing our findings of non-significant effects of study imagery interventions we were mindful of examining a behaviour change intervention conducted in the context of frequency of face covering adherence as a behaviour that could, for varied reasons, be anticipated to have unusually high levels of adherence. For example, high levels of adherence might be anticipated given the associated protective effects on self/others and given that the behaviour was legally mandated. In considering these issues, we postulated that effects, were present, could be expected to be "very small" (i.e., potentially well below Cohen's 1988 threshold of around d = 0.10 for "small effects"). However, we were also mindful that our intervention had, crucially, provided a platform for understanding study effect sizes and identifying minimum sample sizes to detect statistically significant effects. Accordingly, we computed effect sizes for the discrete imagery condition intervention effects (each versus the control condition) using a suitable online calculator (https://lbecker.uccs.edu/). Post hoc effect size calculations indicated that our sample was powered, at best, to detect very small effect sizes for process imagery and combined imagery conditions (both r = 0.03) and was powered to detect even smaller effect sizes for the outcome imagery condition (r = 0.02, outcome imagery vs control condition).

***Suboptimal adherence subsample analysis***

We finally explored predictors of T2 behaviour among non-adherers only (n = 81). Due to limited statistical power, only key (modifiable) social cognitive predictors were included in regression models. Analyses indicated that T2 behaviour (i.e., at four-week follow-up) was predicted by increased T1 intention (*b =* 1.452, *p* < .05) and strongly normative endorsement of the importance of consistently wearing face coverings (i.e., stronger subjective norms) (*b =* 0.307, *p* < .05).

>Tables 3 and 4<

**Discussion**

The primary goal of the present study was to evaluate a mental imagery intervention designed to promote the wearing of face coverings during the COVID-19 pandemic, and to explore potential mechanisms of action. Contrary to hypotheses 1 and 2 we did not find statistically significant main or mediated effects of the mental imagery intervention, and attribute this to ceiling effects, whereby in excess of 70% of the sample always wore face coverings (similar ceiling effects have been discussed; Xu & Cheng, 2021). Standard comparisons of face covering adherence across studies is difficult because of differing timepoint measures, different types of behavioural measure, and differing national contexts in terms of the timing and emphasis of policy decisions concerning COVID-19 related protective measures. These differences notwithstanding, the current evidence base reports quite divergent highface covering adherence. For example, two U.S. surveys have reported 24-41% behavioural adherence (Fisher et al., 2020; Haischer et al., 2020). As high as 84% adherence has been reported in a study of 4,688 U.S. adults (Hearne et al., 2021) while, by contrast, findings of 60-66% adherence have been reported in two further U.S. studies (Heyman, 2021; Koebele et al., 2021). However, our exploratory analyses revealed potential targets for future intervention, namely: men and disruption of habitual past behaviour. Subgroup analyses suggested that interventions designed to target intentions and subjective norms may prompt behaviour change among those less adherent to wearing face coverings. Two of these targets for future intervention are considered in the following paragraphs.

**Implications**

 *Interventions to target men.* Consistent with previous research, we found that men were less likely to be adherent to government-related COVID-19-related instructions (Armitage et al., 2021). Men in general are less likely to adhere to medical advice such as attending GP consultations when needed (Wang et al. 2013) and the present research may reflect this broader trend. Similarly, in the UK context, there are no national routine screening programmes for men in contrast with (for example) breast and cervical cancer screening for women. Relatedly, failure to establish habitual behaviour patterns has been demonstrated in other work on adherence to COVID-19-related measures, so not only are men less likely to be targeted by health information but they are less likely to adhere to it (Armitage et al., 2021).

Our findings accord with evidence that men may be less likely to adhere to wearing face coverings where required (Haischer et al., 2021, Hearne and Niño, 2021). Another study reported no gender differences in adherence but suggested that men were more likely than women to perceive mask covering wearing as infringing independence (Howard, 2021). According with prior evidence, we found proportionally more male suboptimal adherers (50% of men) than female suboptimal adherers (20% of women). The gendered pattern of our findings arguably illustrates recent discussion concerning the role of 'toxic masculinity' (particularly apparent among white men) and a 'post truth' backdrop as cultural factors relevant to the spread of COVID-19 (Harsin, 2020). Understanding how gendered differences (where apparent) in wearing face coverings, including how cultural notions of mask wearing may be seen as running in opposition to hegemonic masculinity (e.g., Connell, 2005; Courtenay, 2000) requires further investigation using qualitative research methods. Likewise, the social meaning attributed to face coverings in different settings needs to be further explored using qualitative methodology (van der Westhuizen et al., 2020).

*Interventions to target habitual past behaviour.* Our findings demonstrated a four-fold likelihood of subsequent (one month later) adherence to wearing face coverings among those individuals already fully adherent at baseline. Habits (i.e., repeated behaviour in recurring contexts) have been conceptualized in terms of cognitive, motivational, and neurobiological components (Wood & Rünger, 2016). UK Government public health mandates as part of the COVID-19 response have included periods where it has been a legal requirement to wearing face coverings (e.g., with substantial penalties applied to non-adherence). Relatedly, the UK national lockdowns have witnessed general public viewpoints characterised, mainly, by perceptions/norms that have been supportive of face covering adherence in defined spaces where contagion spread may be successfully limited. In the context of these restrictions, COVID-19 lockdowns can be considered ultra-stable contexts, which means that habit formation within these contexts is very likely.

Suboptimal adherence to wearing face coverings was, however, apparent in a sizable proportion of our sample (26-27%). Non-adherence to wearing face coverings reflects detachment from motivational or volitional control over (potentially compelling) intentions to routinely wear face coverings where needed to limit viral transmission and protect those vulnerable from viral contagion. Habit-formation ~~comprises~~ has been conceptualised as involving ‘initiation’, ‘learning’ and ‘stability’ phases and interventions might target the ‘learning’ phase, which is characterized by repetition of the target behaviour in a given context (leading to automaticity). For example, a self-monitoring daily ticksheet (Gardner 2012) might prove an effective resource for individuals struggling to consistently adhere to face covering use by recording the incidence of adherence over a time period until behavioural practice becomes automatic. An alternative intervention to target habitual past behaviour might adopt an environmental modification approach involving in-class activities or learning materials accessible online designed. Such habit-based interventions have been successful in other behavioural contexts such as weight loss (Carels et al. 2011). For example, a habit intervention to promote optimal face covering usage adopting an environmental modification approach might include components to encourage participants to keep face coverings in accessible, clearly visible places (e.g., by the front door); to pack spare face coverings in work bags; and to systematize plans for washing and drying reusable face coverings. Recent meta-analytic evidence drawing on five weight loss interventions supports the effectiveness of habit-based interventions in promoting behaviour change over a 2–3-month period though their role in securing longer-term behaviour change remains to be established (Cleo et al. 2019).

**Limitations and future research directions**

Although our research provides new insights into how to promote the consistent wearing of face coverings, it is important to note some potential limitations. Our data violated parametric assumptions and most behavioural and TPB-related variables indicated high levels of accordance with public health message requirements to wear face coverings in required public places. Detecting intervention effects is difficult in this setting where individuals were under duress to wear face coverings from a range of factors not least moral obligation and the legal requirement to wear face coverings. The young age of the current sample may explain the high adherence to face coverings as communication barriers are experienced by older adults (Knollman-Porter & Burshnic 2020). The method of recruitment via University staff and social media is most likely the reason for the younger sample in which the majority were students. Future qualitative research might helpfully explore and successfully probe, among purposively recruited samples of men identifiable as ‘optimal’ and ‘sub-optimal’ face covering wearers, how wearing face coverings (or not wearing them) is understood and equated with issues around masculine identity, social practice, morality and citizenship. Consistently links between masculinity and defined health behaviours are apparent from prior work (Sloan et al. 2010) including research concerning alcohol consumption and non-consumption (Conroy & de Visser 2013; de Visser & Smith 2007a; 2007b) and in the context of diet, physical activity and smoking behaviours (Sloan et al. 2010). Such future work will inform the design of interventions targeting men that successfully challenge restricting masculine roles and practices to have a positive impact on face covering behaviours (Fleming, Lee & Dworkin 2014).

Although our measure of face covering behaviour was based on Fisher et al.’s (2020) empirical materials and incorporated then-current UK Government guidelines, we acknowledge that our one item behavioural measure was relatively crude. For example, our measure privileged behavioural frequency without gauging other behavioural facets including extent to which face covering was worn correctly (i.e., nose and mouth covered) or extent to which face coverings had been worn consistently (i.e., worn for the full duration of an occasion where wearing a face covering would be required). None-the-less, the clearly defined, uncluttered approach of our one item face covering adherence measure may have offered an appropriate level of accessibility and simplicity to respondents the great majority of whom would have been engaging with this as an entirely new behaviour in the weeks immediately prior to study participation.

We recognize the limited degree of variance in our behavioural measure and note that recoding variables into dichotomous categorical data is a suboptimal strategy which may bias findings (MacCallum et al., 2002). However, we reflect here that, given the legally mandated nature of the behaviour, ceiling effects were near inevitable and also note the relatively high parity between cell numbers for most dichotomous variables. In addition, despite mainly highly satisfactory scale reliability scores (α = ≥0.70 in 8 of 11 measures), somewhat low reliability (though always α = ≥0.60) was apparent for three measures (Perceived behavioural control, narcissism, Kantianism). However, we note here that lower reliability may be more acceptable in exploratory/novel study contexts (Hair et al., 2010), and recommend that future research should now refine our novel TPB scales (available within Supplementary Online Materials in Conroy, 2021) designed for exploration in subsequent empirical work concerning face covering adherence.

An important study strength was producing initial evidence concerning required sample sizes to detect minimum effect sizes. Current study evidence can therefore help guide researchers to power accordingly in future intervention studies. Our power calculations assumed medium sized effects given the changing policy/legal context surrounding wearing face coverings as a discrete behaviour and the uncertain times of 2020 and the COVID-19 pandemic in which data was collected. Post hoc effect size calculations indicated that our sample was powered to detect only a very small effect size (r = 0.01 - 0.03) meaningful at a population level. Discussion here holds critical implications for a clinical context and evokes discussion of the confusion surrounding where thresholds should be defined in terms of effect sizes that would be of clinical significance (West, 2007). We note again here though that our effect size was estimated for a behaviour that is both socially visible (and therefore regulated by community/societal norms and expectations) and, moreover, enforced by strict policies and significant penalties. Future imagery interventions to change legally mandated behaviours such as COVID-19 protective behaviours (e.g., wearing face coverings) might need be based on a “very small” effect size (*r* = 0.05 or lower) in order to detect effects meaningful at a population level.

**Conclusion**

The current study provides support for an intervention designed to develop awareness of past behavioural patterns to promote consistent face coverings usage, and supports the view that men should be targeted with such interventions. The imagery-based intervention tested in the current study was not efficacious in promoting subsequent behaviour, and we interpret this as reflecting the challenges to achieve adequately-powered samples to detect complex, legally-mandated and publicly visible (and therefore carrying social penalties for non-adherence) behaviours like wearing face coverings. Subgroup analyses suggested that interventions designed to target intentions and subjective norms may elicit behaviour change among relatively non-adherent individuals.

**Disclosure Statement**

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**Data Availability Statement**

The data that support the findings of this study are openly available on figshare at http://doi.org/10.6084/m9.figshare.14535294.The authors affirm that participants provided informed consent for publication of their anonymized/de-identified responses in a dataset on a secure, publicly available online repository.

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| --- |
| Table 1. Hierarchical regression model: odds ratios (ORs) and significance levels for final model on T2 behavior controlling for intervention and T1 psychological variables |
| Entry block | Variables entered | B (SE) | OR | 95% CI1 |
| 1 | Outcome | 0.294 (0.442) | 1.341 | 0.564, 3.191 |
|  | Process | -0.234 (0.424) | 0.792 | 0.345, 1.819 |
|  | Outcome × Process | -0.34 (0.636) | 0.712 | 0.205, 2.478 |
| 2 | Age | 0.019 (0.015) | 1.02 | 0.991, 1.049 |
|  | Gender (female vs male) | -1.172 (0.388) | 0.31\*\* | 0.145, 0.662 |
|  | Ethnicity (white vs non-white) | 0.45 (0.383) | 1.568 | 0.740, 3.321 |
|  | Student vs non-student | 0.309 (0.373) | 1.363 | 0.656, 2.831 |
|  | Conscientiousness | -0.216 (0.233) | 0.806 | 0.510, 1.273 |
|  | Narcissism | -0.724 (0.42) | 0.485 | 0.213, 1.104 |
|  | Faith in humanity | 0.208 (0.214) | 1.232 | 0.809, 1.874 |
|  | Kantianism | -0.245 (0.274) | 0.783 | 0.457, 1.339 |
|  | Humanism | -0.081 (0.274) | 0.922 | 0.538, 1.578 |
| 3 | Behavior T1 | 1.16 (0.351) | 3.191\*\*\* | 1.603, 6.352 |
|  | Attitudes | 0.493 (0.422) | 1.637 | 0.716, 3.744 |
|  | Subjective norms | -0.103 (0.372) | 0.902 | 0.435, 1.869 |
|  | Perceived behavioral control | 0.273 (0.359) | 1.314 | 0.650, 2.658 |
|  | Intention | 0.424 (0.504) | 1.528 | 0.569, 4.108 |
|  | Barrier self-efficacy | 0.471 (0.368) | 1.602 | 0.779, 3.296 |
|  | Imagery ability | -0.259 (0.348) | 0.771 | 0.390, 1.525 |
| *Note.* \* p < .05, \*\* p < .01, \*\*\* p < .001; entry block 3 only shown of a three-step hierarchical logistic regression; complete case analysis, n = 2971All confidence intervals are percentile based. |

Table 2. Participant characteristics (*n =* 297)

|  |  |  |
| --- | --- | --- |
| *Study variables* | *Mean (SD)* | *% total sample* |
| Age (years) | 35 (13.2) |  |
|  |  |  |
| Gender (%Female) |  | 82% |
|  |  |  |
| Ethnicitya |  |  |
|  | White |  | 71% |
|  | BAME |  | 22.6% |
|  | Missing data |  | 6.4% |
|  |  |  |  |
| Occupation |  |  |
|  | Student  |  | 64% |
|  | Non-student (part-time) |  | 35.4% |
|  | Missing data |  | 0.7% |
|  |  |  |  |
| Behavior and psychological variablesb |  |  |
|  | Baseline (T1) behavior (% full adherence) |  | 72.7% |
|  | Follow-up (T2) behavior (% full adherence) |  | 74.4% |
|  | Attitudes | 4.62 (0.86) |  |
|  | Subjective norms | 4.52 (0.9) |  |
|  | Perceived behavioral control | 4.47 (0.74) |  |
|  | Barrier self-efficacy | 4.50 (0.77) |  |
|  | Intention | 4.80 (0.68) |  |
|  | Conscientiousness | 3.68 (0.75) |  |
|  | Narcissism | 2.36 (0.42) |  |
|  | Faith in humanity | 3.44 (0.80) |  |
|  | Kantianism | 4.12 (0.74) |  |
|  | Humanism | 4.16 (0.68) |  |

*Notes.* aEthnicity measured as a binary variable;bMeasures recorded at baseline unless otherwise stated.

Table 3. Correlations between imagery intervention and T1 behaviour and psychological variables. Variables 4-11 are dichotomous/categorical.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | Outcome | - |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Process | .04 | - |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Outcome x Process | .58\*\* | .58\*\* | - |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Behaviour T1 | .08 | .09 | .08 | - |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Behaviour T2 | .03 | -.02 | .00 | .27\*\* | - |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Intention | -.03 | .08 | .06 | .29\*\* | .19\*\* | - |  |  |  |  |  |  |  |  |  |  |
| 7 | Attitude | .05 | -.01 | .04 | .25\*\* | .17\*\* | .35\*\* | - |  |  |  |  |  |  |  |  |  |
| 8 | Subjective norms | -.03 | .05 | .02 | .25\*\* | .13\* | .27\*\* | .37\*\* | - |  |  |  |  |  |  |  |  |
| 9 | PBC | -.02 | .04 | .01 | .23\*\* | .13\* | .24\*\* | .38\*\* | .22\*\* | - |  |  |  |  |  |  |  |
| 10 | Barrier self-efficacy | -.05 | .03 | -.00 | .26\*\* | .15\*\* | .21\*\* | .26\*\* | .15\* | .28\*\* | - |  |  |  |  |  |  |
| 11 | Imagery ability | .02 | .09 | .11 | .22\*\* | .07 | .16\*\* | .33\*\* | .22\*\* | .26\*\* | .35\*\* | - |  |  |  |  |  |
| 12 | Faith in humanity | .01 | .06 | .08 | .06 | .07 | .07 | .03 | .12\* | .10 | .08 | .17\*\* | - |  |  |  |  |
| 13 | Kantianism | .00 | -.02 | .05 | .06 | .01 | .08 | .03 | .13\* | .17\*\* | .09 | .12\* | .28\*\* | - |  |  |  |
| 14 | Humanism | -.03 | -.06 | -.01 | .11 | .06 | .07 | .15\* | .11 | .17\*\* | .05 | .14\* | .41\*\* | .46\*\* | - |  |  |
| 15 | Conscientiousness | -.10 | -.01 | -.10 | .12\* | .00 | .06 | .16\*\* | .14\* | .20\*\* | .00 | .07 | .13\* | .26\*\* | .18\*\* | - |  |
| 16 | Narcissism | .00 | -.09 | -.06 | -.03 | -.14\* | -.15\* | -.01 | -.07 | -.05 | -.06 | -.01 | -.11 | -.34\*\* | -.15\*\* | .09 | - |

*Note. n =* 297 \* *p* < .05 \*\* *p* < .01; all variables are T1 unless otherwise indicated.

Table 4. Predictors of T2 behaviour among suboptimal adherence participants only (n = 81)

|  |  |  |  |
| --- | --- | --- | --- |
| Variables entered | B (SE) | OR | 95% CI1 |
| Age | 0.01 (0.025) | 1.01 | 0.961, 1.061 |
| Gender (female vs male) | -0.868 (0.622) | 0.42 | 0.124, 1.421 |
| Student vs non-student | 0.564 (0.586) | 1.758 | 0.558, 5.545 |
| Attitudes | 0.902 (0.683) | 2.465 | 0.647, 9.396 |
| Subjective norms | -1.18 (0.6) | 0.307\* | 0.095, 0.996 |
| Perceived behavioral control | -0.006 (0.66) | 0.994 | 0.273, 3.625 |
| Barrier self-efficacy | -0.208 (0.667) | 0.812 | 0.22, 3.004 |
| Imagery ability | -0.423 (0.615) | 0.655 | 0.196, 2.188 |
| Intention | 1.452 (0.656) | 4.273\* | 1.181, 15.463 |

*Note.* \* p < .05, \*\* p < .01, \*\*\* p < .001; All social cognitive variables shown measured at T1. 1All confidence intervals are percentile based.



**CONSORT 2010 Flow Diagram**

Assessed for eligibility (n=950)

## Enrollment

## Allocation

Excluded (n=509)

  Enrolment incomplete (n=271)

  Ineligible (n=36)

* Not UK based (n=32)
* Younger than 18 years old (n=1)
* Exempt from wearing coverings (n=3)

  Incomplete responses (n=195)

  Duplicate responses (n=7)

Randomized (n=441)

Allocated to process imagery (n=110) 25%

 Excluded (n=14)

* Incomplete responses (n=5)
* Non-engagement in imagery exercise (n=6)
* Unengaged responses (n=3)

Allocated to both imagery exercises (n=110) 25%

 Excluded (n=26)

* Incomplete responses (n=8)
* Non-engagement in imagery exercise (n= 18)
* Unengaged responses (n=0)

Allocated to outcome imagery (n=107) 24%

 Excluded (n=12)

* Incomplete responses (n=6)
* Non-engagement in imagery exercise (n=3)
* Unengaged responses (n=3)

## Follow-Up

Contacted at one-month (T2) follow-up (n=96) 25%

 Excluded (n=24)

* No response at T2 (n=22)
* Incomplete responses (n=2)
* Not UK based (n=0)

Contacted at one-month (T2) follow-up (n=95) 25%

 Excluded (n=25)

* No response at T2 (n=21)
* Incomplete responses (n=2)
* Not UK based (n=2)

Contacted at one-month (T2) follow-up (n=84) 22%

 Excluded (n=17)

* No response at T2 follow-up (n=16)
* Incomplete responses (n=1)
* Not UK based (n=0)

## Analysis

Analysed at T2 (n=70)

24%

Analysed at T2 (n=72)

24%

Figure 1. Consort 2010 diagram showing allocation of participants to imagery intervention conditions

Analysed at T2 (n=67)

23%

Analysed at T2 (n=88)

30%

Allocated to control

(n=114) 26%

 Excluded (n=4)

* Incomplete responses (n=3)
* Unengaged responses (n=1)

Contacted at one-month (T2) follow-up (n=110) 28%

 Excluded (n=29)

* No response at T2 follow-up (n=19)
* Incomplete responses (n=1)
* Not UK based (n=2)
1. In the context of the coronavirus (COVID-19) outbreak, a face covering is something which safely covers the nose and mouth. You can buy reusable or single-use face coverings. You may also use a scarf, bandana, religious garment or hand-made cloth covering but these must securely fit round the side of the face. [material adapted from UK Government Cabinet Office (2020)] [↑](#footnote-ref-1)
2. To maximise the analytic possibilities held by available data, we conducted an intention-to-treat analysis (n = 465). In this analysis, we imputed estimated relevant T2 study variables based on T1 study variable values for missing values where participants had not provided a complete T2 response. Logistic regressions were then re-run. Intention-to-treat findings were very similar to the complete case analysis (right hand column, Table 3) with gender and T1 behaviour highly significant predictors of T2 behaviour and a new statistically significant (p < .05 level) predictive effect of T1 attitudes on T2 behaviour (*b =* 0.84, SE = 0.38, O.R. = 2.32, 95% C.I. 1.096, 4.919).

3 Analysis re-run including covariates revealed no apparent effects for allocation to either outcome imagery (*b =* .178, *p =* .635), process imagery (*b = -*.083, *p =* .816) or outcome and process imagery (*b =* -.054, *p =* .920). [↑](#footnote-ref-2)