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Effects of guided immune-imagery: The moderating influence of openness to experience

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ABSTRACT

It is widely believed that personality has an important role in determining the effectiveness of guided imagery (GI) interventions. The primary aim of the current study was to examine whether the effect of GI on several outcome measures was dependent upon openness to experience, a theoretically relevant variable previously unexplored as a potential moderator. Thirty-five healthy participants were randomised to an animated imagery, verbal imagery or no-intervention control group, with imagery groups receiving 10 × 20 min sessions. Pre/post-assessments of cortisol, sleep, stress and creativity were administered along with the openness to experience scale. Regression analysis indicated a significant increase in cortisol and decrease in tiredness following verbal GI, but only for those high in openness. The efficacy of GI interventions may be dependent upon openness to experience and this variable should be accounted for in future studies.

1. Introduction

The use of guided imagery as a psychological intervention for modulating immune response has become increasingly common. The technique typically involves creating a state of deep relaxation, often through hypnosis, then guiding the user towards specific types of mental imagery. Interventions employing immune-specific imagery have resulted in improvements in immune function, mood and observable health indicators in both patient populations and healthy individuals (Bakke, Purtzer, & Newton, 2002; Fox, Henderson, Barton, Champion, & Rollin, 1999; Gruzelier, Smith, Nagy, & Henderson, 2001b).

Despite significant group effects, not all individuals have demonstrated benefits from guided imagery. Two studies observed significant effects of training on clinical outcome measures but also noted that approximately one-third of patients showed no improvement (Fox et al., 1999; Kwekkeboom, Huseby-Moore, & Ward, 1998). One possible explanation for this finding is that intervention efficacy is dependent upon personality. High levels of hypnotic susceptibility have been associated with improved immune responses to guided imagery interventions in some (Zachariae et al., 1994) although not all studies (Gruzelier et al., 2001b). In addition, Watanabe et al. (2006) found that cortisol changes with guided imagery were greater in those with an ability to generate vivid mental images. The related trait of absorption has also been examined, with increases in the antibody IgA following immune-imagery greater in high relative to low 'absorbers' (Gregerson, Roberts, & Amiri, 1996). There is also evidence that an 'activated' personality, a temperament characterised by high levels of cognitive activation (e.g. thinking quickly) and associated with left hemispheric bias may also be influential. Gruzelier et al. (2001b) found that guided imagery training buffered the reduction in white blood cell count shown in non-intervention controls in students at exam time, with higher cognitive activation predictive of higher white blood cell counts post-training. This finding was later replicated in chronic herpes sufferers (Gruzelier, 2002).

As a new approach, the current study aims to explore the relevance of openness to experience, one of the 'Big Five' personality dimensions, on the effectiveness of immune-imagery training. This personality dimension has putative salience for a number of reasons. Although a multi-faceted trait, openness to experience broadly represents an individual's openness to novel experiences and ideas (Costa & McCrae, 1992). As such, individuals high in this trait may engage more fully in mind-body type interventions with an enhanced perception of their efficacy, which could lead to greater therapeutic effects. In addition, openness to novel experiences has long been associated with hypnotisability, creativity and image generation (Lynn & Sivec, 1992), which should confer obvious advantages for imagery training. This association is reflected in several of the component facets of openness. The Fantasy and Aesthetics subscales, respectively, encompass a tendency towards a vivid imagination and an appreciation of artistic images, which could precipitate a greater involvement in the hypnotic experience and

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in mental imagery generation. Furthermore, the Ideas subscale reflects intellectual curiosity and thus may have affinities with cognitive activation identified as an important moderator by Gruzelier and colleagues. The primary objective of the current study is therefore to investigate whether the effectiveness of positive immune-imagery incorporated into self-hypnosis training is moderated by openness to experience.

In addition to effects on immune-based measures, some research has found that interventions involving hypnotic states (e.g. guided imagery), have also resulted in improvements on creativity measures (Bowers, 1967). It could be therefore that such improvements could be further enhanced by high levels of openness for the reasons previously outlined. A secondary objective was therefore to speculatively examine whether openness-moderated effects of guided imagery on creativity were also evident.

As individuals may differ in their preferred type of imagery, we included both auditory and visual immune-imagery groups along with a control group. Given inconsistency in previous research we also explored hypnotic susceptibility as a potential moderator. Our main outcome measures were based on Gruzelier et al. (2001b) and consisted of salivary cortisol, sleep quality and stress, with cognitive assessments of creativity also included. As our aim was to evaluate the effects of immune-imagery on healthy participants indices of ill-health symptomatology were not included.

2. Method

2.1. Participants

From an initial pool of 37 participants, two failed to return after initial pre-assessment for unknown reasons. The remaining sample of 35 consisted of 30 female and 5 male first-year psychology undergraduates with a mean age of 20.4 (SD = 3.8). Participation in the study was in exchange for course credits. Exclusion criteria were Sjörgren's syndrome which affects saliva production, and the use of corticosteroid drugs which can affect cortisol level (e.g. asthma/allergy medication).

2.2. Imagery groups

Participants were randomly assigned to the verbal ($n = 13$), animated ($n = 11$) or no-imagery group ($n = 11$). Pearson's chi-square test confirmed that gender distribution did not differ significantly across groups ($\chi_2 = 0.39$, df = 2, $p = .82$), with one-way ANOVAs revealing no significant group differences on any pre-assessment measures ($Fs_{2,32} < 1.4$, p = ns). The control group received no-intervention, with procedures for the verbal and animated imagery groups described below.

The verbal imagery group listened to a continuous 20-minute audio file consisting of three components: (i) 10 min of self-hypnosis, (ii) 5 min of positive immune-imagery and (iii) 5 min of relaxation with imagery reinforcement. The 10-minute self-hypnosis induction was based on Gruzelier, Levy, Williams, and Henderson (2001a) and aimed to create a state of deep relaxation with instructions also directed at improving energy levels, concentration and attention. The immune-imagery encouraged participants to generate mental images of a strong healthy immune system fighting off infection. Participants were also guided towards certain types of immune-imagery shown to have been effective in previous studies (Gruzelier et al., 2001b); e.g. 'imagine your immune system as strong healthy dolphins swimming around the blood stream destroying germ cells'.

The animation group underwent an identical procedure, except that animated imagery replaced verbal imagery. This imagery consisted of 3 × 1½ min sequences depicting white blood cells gradually destroying germ cells until none remained. All images used were symbolic representations developed in conjunction with the University's computer science department and medical illustrators at the Royal Free Hospital, London. Participants were asked to visualise animations as healthy white blood cells destroying weak germ cells.

2.3. Questionnaires

2.3.1. Openness to experience scale from the NEO PI-R (Costa & McCrae, 1992)

The 48-item scale can be scored to give a total openness score, broadly representing an openness to new experiences or phenomena, or as six constituent facet subscales of fantasy, aesthetics, feelings, actions, ideas and values. Good internal consistency has been demonstrated for both the total scale (.87) and subscales (.58–.80), with good test-retest reliability also observed for both total (.83) and subscales (.68–.79)(Costa & McCrae, 1992).

2.3.2. Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989)

The PSQI is a self-report measure of several components of sleep and has demonstrated good reliability and validity in clinical and healthy populations (Shochat, Tzischinsky, Oksenberg, & Peled, 2007). To minimise type I errors, only items that directly assessed sleep quality were included: overall sleep quality, tiredness and apathy. The 4-point ordinal rating scale was adapted to a more sensitive continuous scale of number of days that sleeplessness symptoms had been experienced over the previous week.

2.3.3. Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983)

The PSS is a self-report measure with scores on 14 items summated to form a single stress score. The original rating scale of stress experienced over the last month was adapted to the previous week to allow reasonable time for manifestation of therapeutic effects. Reliability and validity are well established (Cohen et al., 1983).

2.3.4. Guilford alternate uses task (Guilford, Christensen, Merrifield, & Wilson, 1978)

This task aims to provide an assessment of creative thinking. Respondents were given 5 min to name as many uses as possible for a household object (pre = 'toothbrush', post = 'paperclip'). Originality scores calculated based on the statistical rarity of each response. Test reliability has been reported as good with test-retest correlations ranging from .62 to .82 (Guilford et al., 1978).

2.3.5. Insight problems test (Dow & Mayer, 2004)

This consists of lateral-thinking items designed to measure creative insight. Assessment lasted 20 min and consisted of 10 items, with different items chosen for pre and post-assessment. There is currently limited data on the psychometric properties of this measure, as with many tests of this type, although the test does possess clear face validity.

2.3.6. Creative Imagination Scale (CIS; Barber & Wilson, 1978)

The CIS is a 20-minute test of hypnotic suggestibility. Ten suggestions (e.g. 'your arm is feeling heavy') are read aloud, with participants rating the impact of each suggestion on a 4-point scale. The CIS has been shown to be psychometrically sound with good internal consistency and test-retest reliability (Barber & Wilson, 1978).

2.3.7. Activation–Deactivation Adjective Check List (AD-ACL; Thayer, 1967)

The AD-ACL is a self-report instrument designed to measure four components of mood: energy, tiredness, tension and

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calmness. The AD-ACL has demonstrated good reliability and convergent validity (Thayer, 1967).

2.4. Cortisol assessment

Cortisol levels were assessed through salivary analysis, which provides a stress-free collection method and a reliable measure of the unbound hormone in the blood (Kirschbaum & Hellhammer, 1994). Sarstedt salivette swabs were used to obtain saliva, with salivettes stored at −20 °C. Salivary analysis was carried out at the conclusion of the study by Dr. Akira Naito of Imperial College, who was blind to group allocation. Cortisol levels were measured using a commercially available ELISA kit [IDS Ltd.]. Samples were analysed in triplicate with mean readings used for subsequent data analysis (intra-assay c.v. = 0.186; inter-assay c.v. = 0.282). Post-assessment collection time was matched to that of pre-assessment with all samples collected between 12 pm and 3 pm. Participants were asked to abstain from caffeine, alcohol, food, brushing their teeth and exercise at least 2 h prior to assessment, and to have been awake for at least 90 min. All participants reported compliance with these restrictions. No medication use was reported, with one-way ANOVA indicating no significant group differences in stress or hours of sleep the night before.

2.5. Procedure

All participants gave their informed consent to take part, with approval for the study granted by the department's Ethics Review Committee. Pre-assessment consisted of all tests and questionnaires with saliva samples collected at 30 and 50-minute periods. Participants in the imagery groups returned for 10 self-hypnosis sessions, with intersession intervals ranging from 2 to 5 days. The AD-ACL mood scale was completed immediately before and after each session. Post-assessment was administered within 5 days of the final self-hypnosis session and was identical to pre-assessment except for the omission of the CIS and openness scales. The pre/post-assessment interval for controls was time matched to the hypnosis groups.

3. Results

3.1. Analytical method

To investigate the primary hypothesis that the effects of imagery training would be moderated by openness to experience, separate regression analyses were performed on each change variable of cortisol, sleep, stress and creativity. Due to its categorical nature, imagery group was recoded into two separate dummy-coded predictors (Cohen, Cohen, West, & Aiken, 2003) of 'animation vs. control' and 'verbal vs. control'. Two interaction terms were then created by multiplying each dummy-coded predictor with centred openness scores. Hierarchical regression was performed by entering openness in step 1, the two dummy-coded predictors in step 2 and the interaction terms in step 3 (Cohen et al., 2003). A conservative significance threshold of $\alpha = .01$ was set to preserve a reasonable type I error rate given that multiple analyses were conducted (Tabachnick & Fidell, 2006). All tests were evaluated at two-tailed significance levels.

3.2. Data screening

Extreme cortisol values (>4 SDs) were recorded for one participant at both assessment periods, possibly reflecting the use of undisclosed medication, and were excluded. Cortisol readings for samples 1 & 2 were highly correlated across the remaining sample at both assessment periods (r's > .85, $p < .001$) and were therefore averaged to give mean cortisol readings. Change scores computed for all dependent measures satisfied assumptions for multivariate normality, although PSQI tiredness change scores for one participant demonstrated excessive leverage ($z > 3.3$, $p < .001$; Tabachnick & Fidell, 2006) and were deleted.

3.3. Analysis of outcome change scores

Table 1 shows predicted change scores for each imagery group at low (−1 SD) and high (+1 SD) openness, with scores calculated from regression analyses reported in the next section.

3.4. Cortisol, sleep and stress

Regression analysis on cortisol change scores revealed a significant group × openness interaction ($\Delta R^2 = .30$, $F_{2,28} = 6.48$, $p < .005$), with no significant main effects. Inspection of partial regression coefficients revealed a significant 'simple' interaction for verbal × openness ($\beta = .67$, $t = 3.51$, $p < .005$) but not for animation × openness ($t = 0.34$, p = ns), indicating that the effect of verbal imagery training may be moderated by openness. Fig. 1 shows the predicted cortisol changes across groups at low (−1 SD) and high (+1 SD) levels of openness, and suggests that the verbal imagery effects on cortisol may be more apparent at high openness.

Simple slopes analysis (Cohen et al., 2003) comparing cortisol across imagery groups was conducted at both low and high openness. In line with Fig. 1, cortisol change following verbal imagery was significantly greater relative to controls when openness was high ($t = 3.17$, $p < .005$), with no significant differences when openness was low ($t = -1.60$, p = ns). A rerun of the regression analysis with imagery group recoded to produce a 'verbal vs. animation' comparison revealed similar superior effects for the verbal group.

With respect to sleep, regression on PSQI tiredness change scores revealed a significant group × openness interaction ($\Delta R^2 = .29$, $F_{2,28} = 7.95$, $p < .005$), with partial regression coefficients again indicating a significant simple verbal × openness effect ($\beta = -.70$, $t = -3.97$, $p < .001$) with no animation × openness effect. Fig. 2 shows the predicted tiredness change scores across groups at low (−1 SD) and high (+1 SD) openness.

Consistent with Fig. 2, simple slope analysis revealed a significantly greater decrease in tiredness following verbal imagery (relative to control) only when openness was high ($t = -3.33$, $p < .001$). No significant effects emerged for the stress measure.

3.5. Creativity

Regression analyses on the two creativity measures revealed no significant main or interaction effects of imagery group or openness.

3.6. Subscale and other analyses

In order to examine which aspects of openness may have been most pertinent to the moderated openness effect, previous regressions on cortisol and tiredness were rerun each time replacing the total openness scale with one of the six openness subscales. Results revealed that the aesthetics, fantasy, ideas and feelings subscales produced the same pattern of moderated significant effects as the total openness scale, but actions and values scales produced no interactions approaching significance.

To explore whether the effect of imagery training was moderated by hypnotic susceptibility, as well as openness, regression analyses were repeated replacing openness with the CIS. No significant effects emerged on any measures, suggesting that hypnotic susceptibility did not moderate imagery training effects. To ensure

Table 1
Change in outcome measures across groups at low and high openness.

Openness	Group	Change Scores						
		Cortisol ng/ml	PSS	PSQI_T	PSQI_A	PSQI_Q	Alt Uses	IP
Low	Verbal	−1.5	3.0	0.4	0.5	−0.1	−0.5	0.5
	Animated	0.7	4.9	0.9	0.6	−0.6	1.0	0.8
	Control	0.9	−1.4	-0.7	0.7	−0.5	0.6	−0.1
High	Verbal	3.8	−0.3	−1.9	0.8	−0.2	1.5	0.6
	Animated	−0.1	−2.1	0.1	1.0	0.4	1.6	−0.1
	Control	−0.7	0.6	0.1	0.5	−0.4	1.7	−0.1
	Mean	0.6	0.8	−0.3	0.7	−0.2	1.0	0.3
	SD	2.8	6.2	1.3	1.4	0.6	1.3	1.1

PSS, Perceived Stress Scale; PSQI, Pittsburgh Sleep Quality Index (T, Tiredness; A, Apathy; Q, Quality); Alt Uses, Alternate Uses; IP, Insight Problems.

that group differences in cortisol and tiredness at high openness could not be a product of differences in baseline characteristics, regression analyses were rerun with all pre-assessment measures as separate DVs. No significant effects emerged suggesting that imagery effects on cortisol and sleep could not be attributable to differences in other recorded variables.

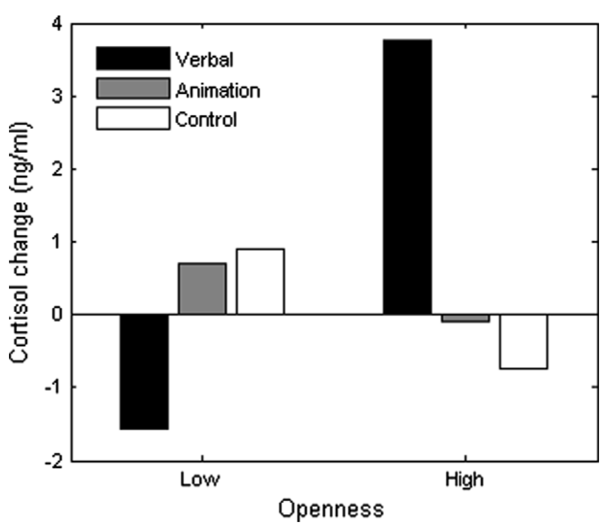

Fig. 1. Cortisol changes for group × openness.

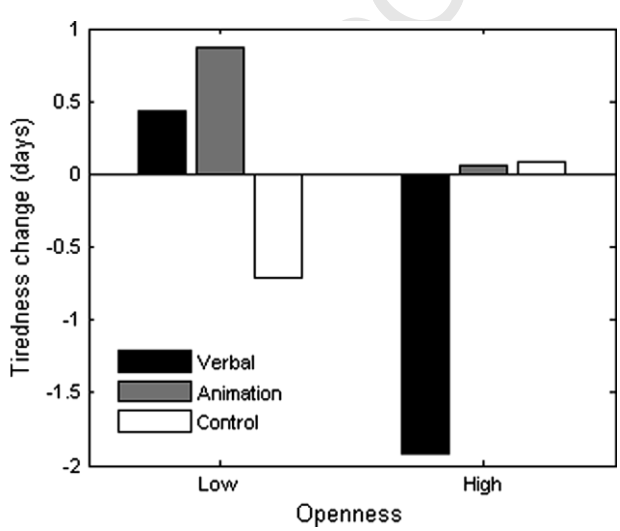

Fig. 2. PSQI tiredness changes for group × openness.

3.7. Mediated-moderation analysis

One reasonable model specification is that the observed tiredness decrease may have been mediated by the metabolic effects of increased cortisol. Mediated-moderation analysis was thus performed to determine whether the *moderation* effect of verbal × openness on tiredness was *mediated* by cortisol change. In line with Baron and Kenny (1986), the previous moderated regression analysis on tiredness was repeated with cortisol change (the mediator) as an additional predictor. Preconditions for analysis were met, with the mediator cortisol significantly associated with tiredness after controlling for other variables ($t = -2.7$, $p = .01$).

Analysis revealed that verbal × openness remained a significant predictor after controlling for cortisol ($B = -.05$, $t = -2.08$, $p < .05$), suggesting complete mediation did not occur. Nevertheless, the original regression coefficient ($B = -.09$) reduced in magnitude after controlling for cortisol ($B = -.05$) consistent with the possibility of a *partial mediation* effect. Given the moderate sample size, a bootstrapping procedure (Preacher & Hayes, 2004) was used to test for partial mediation and revealed a significant change in the original regression coefficient after controlling for cortisol ($\Delta B = .04$, $p < .05$). These findings are consistent with the possibility that cortisol may partially mediate the tiredness changes seen in the verbal imagery group at high openness.

3.8. Self-hypnosis sessions and mood

To examine whether mood was altered by self-hypnosis sessions, a 2 × 10 × 2 mixed ANOVA was performed on each of the four AD-ACL mood scales with independent variables of period (before/after session), session number (1–10) and group (animated/verbal). A significant main effect of period on energy, tension and calmness was revealed (F's$_{1,22} > 7.98$, $p < .01$), with a general reduction in arousal observed as exemplified in Fig. 3 with the tension subscale. The lack of significant period × group interactions suggests that the arousal decrease occurred independent of imagery group.

4. Discussion

The primary aim of the study was to determine whether the effectiveness of guided imagery training on immune-based measures was dependent upon openness to experience. Results indicated that training effectiveness was indeed moderated by openness, with the verbal imagery group demonstrating significantly greater cortisol increase and tiredness reduction relative to animated imagery and control groups when openness was high. No differences across groups were observed when openness was low. These results also suggest that imagery format is important, with only verbal imagery eliciting changes on outcome variables.

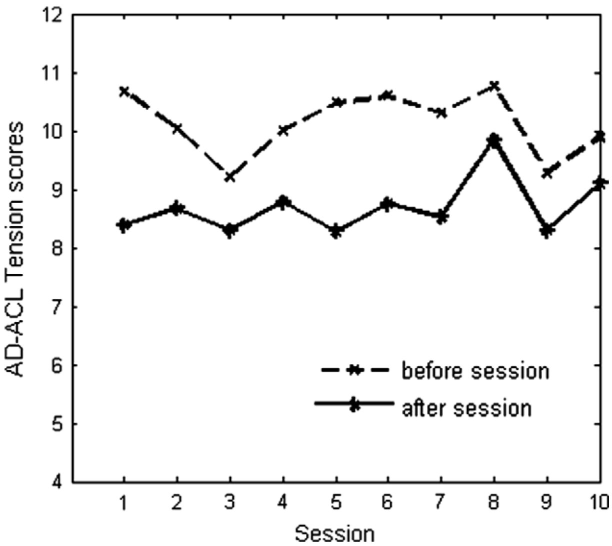

Fig. 3. AD-ACL tension scores before and after sessions.

A second objective of the study was to speculatively explore whether imagery training might result in improvements in creativity relative to the control group and whether openness moderates such an effect. However no differences in creativity assessment scores across groups were observed at either low or high openness, offering little support for the hypothesis that hypnotic training improves creativity as assessed in the current study.

Although the data does not easily allow determinations of why openness might moderate training efficacy on cortisol and tiredness, two explanations are speculatively considered. One possibility is that those high in openness exhibit more positive attitudes towards novel interventions of this type, promoting positive expectancy and a more positive outcome. However, only verbal and not animated imagery resulted in outcome change at high openness, despite the fact that expectancy levels should be similar for both imagery groups. This suggests that factors other than positive expectancy could be responsible. A second possibility is that openness facilitates the generation of the mental imagery that is central to the intervention. Subscale analyses suggested that, in addition to ideas, aesthetics (appreciation of art and beauty), fantasy (receptivity to inner imagination) and feelings (openness to feelings and emotions) could be the crucial components of openness. These facets could be important in assisting creative mental imagery generation. In support of this, recent neurological research has linked openness to experience with greater dorsolateral prefrontal cortex activity possibly via increased dopaminergic activation, with increased dopaminergic activation in this region linked to improvements in creative thinking and memory (DeYoung, Peterson, & Higgins, 2005). If openness is linked to creative image generation, this could also explain why openness appeared to advantage verbal but not animated imagery training. Verbal imagery training was likely to have required a higher degree of creative involvement, with the user expected to generate their own imagery (assisted by verbal description). The animated imagery training, in contrast, relied on the presentation of specific visual images, which could have imposed constraints on the ability of the individual to creatively generate their own imagery. Certainly it seems likely, given that verbal and animated groups differed only in the presented imagery, that it is the processing of the imagery that is the critical component in effecting outcome change, rather than other aspects of intervention such as relaxation state or expectancy. Although it is yet to be understood *how* imagery can result in immune change, the fact that hypnotic suggestion has been reliably linked to a range of autonomic effects (Lehrer & Woolfolk, 1993) does suggest that necessary connections between frontal cortex and biological mechanisms are in place. It is evident that identifying the precise mechanisms responsible for the apparent facilitatory effect of openness requires further research. Nevertheless, the current results do suggest that openness does provide this facilitatory effect and that such research is therefore warranted.

With respect to the observed outcome changes, the cortisol increase following imagery training is in contrast to research that has observed a cortisol *decrease* following relaxation imagery (e.g. Watanabe et al., 2006). Furthermore, given that cortisol has previously demonstrated negative correlations with immune measures (e.g. Hucklebridge, Clow, & Evans, 1998) this suggests that, contrary to its aims, the intervention could actually lead to suppressed immunity. Interestingly, however, a previous study employing *immune-specific* imagery also identified a cortisol increase following training along with increased white blood and natural killer cell counts (Gruzelier et al., 2001b). It could be argued that, given its metabolic properties, a cortisol increase in the Gruzelier and in the current study is consistent with instructions given to actively mobilise resources for increased alertness and energy. It may also be that while long-term cortisol elevation is associated with deleterious effects, short-term elevation may actually be beneficial (Di Padova, Pozzi, Tondre, & Tritapepe, 1991). Nevertheless, this interpretation of the cortisol increase following training is entirely speculative. Given that other immune parameters were not assessed in the current study, due primarily for the desire for a collection method (saliva) that minimised participant stress, there is little solid empirical support here for demonstrable beneficial effects of guided imagery on immune parameters. Perhaps a less ambiguous finding in terms of intervention benefit is the reported decrease in tiredness, with participants high in openness reporting being tired for nearly two days less in the week following verbal imagery training compared to controls, with analysis also consistent with the possibility that the tiredness decrease may have been partially mediated by cortisol. Overall, while interpretation of the observed outcome changes is not unproblematic, the current findings do, within a controlled experimental setting, suggest that the ability of immune-imagery interventions to elicit such changes may be crucially dependent upon openness to experience.

In addition to the difficulties with interpretation of cortisol change, the clinical applicability of the current findings is hard to ascertain given the aim of the study was to investigate intervention changes in a healthy sample. Future research should help determine the generalisability of the findings to immune-compromised populations. A further limitation is that the sample used consisted mainly of female participants, limiting the generalisability of the current findings across sex pending further empirical investigation. In addition, given that openness to experience is the least consistently identified factor of the "Big Five" across cultures (Saucier & Goldberg, 2001), and that cultural background was not recorded, the cross-cultural generalisability of the current findings is hard to determine.

Despite these limitations, the current study could have potential clinical and research implications. Firstly, it may help inform selection of those most likely to respond to guided imagery, with those low in openness possibly unsuitable candidates for such interventions. Secondly, insights into *how* guided imagery might modulate immune response may be gained by a further consideration of differences between those high and low in this trait, which could help elucidate key processes underlying moderated intervention effects. Given the widespread interest in guided imagery as an adjunctive treatment and as a research topic, openness to experience should be considered as a potentially important moderator in future studies examining intervention efficacy in healthy and immune-compromised populations.

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In summary, openness to experience may play a critical role in determining the effectiveness of verbal immune-imagery training which could have potential implications in identifying those for whom it is likely to be most effective. Further research is, however, needed to establish the reliability and generalisability of this finding in immune-compromised groups and to elucidate the nature of the underlying mechanisms.

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