Does Latent Inhibition Underpin Creativity, Positive Schizotypy and Anomalous Cognition?

Nicola J. Holt, University of Northampton

Christine A. Simmonds-Moore, Liverpool Hope University

Stephen L. Moore, University of Northampton

Nicola J. Holt, Department of Psychology, University of Northampton; Christine A. Simmonds-Moore, Department of Psychology, Liverpool Hope University; Stephen L. Moore, Department of Psychology, University of Northampton.

Nicola J. Holt is now at the Department of Health and Social Sciences, University of the West of England; Christine A. Simmonds-Moore is now at the Psychology Department, University of West Georgia; Stephen L. Moore is now at the School of Arts and Sciences, West Georgia Technical College.

The authors gratefully acknowledge a bursary from the Bial Foundation (155/04) which enabled this research. We would like to thank Serena-Roney Dougal for her assistance with Experiment 2.

Correspondence concerning this article should be addressed to Nicola Holt, Department of Health and Social Sciences, University of the West of England, Frenchay Campus, Bristol, BS16 1QY. E-mail: Nicola.holt@uwe.ac.uk

Abstract: This paper presents two experiments in which an experimental paradigm developed to examine the efficacy of filtering mechanisms of attention, Latent Inhibition (LI), was adapted to include a psi component. LI assesses the processing of irrelevant stimuli, thus we tested whether a psi-stimulus might be processed akin to the irrelevant stimulus. Because the processing of the irrelevant stimulus has been shown to be moderated by creativity and positive schizotypy, we hypothesized that these same variables would also moderate the processing of any psi effect. In Experiment 1, a significant LI effect was observed but no psi effect. However, non-linear cognition in the creative process (NLCC) (e.g., intuition and hypnagogia) was significantly associated with a psi-LI-like effect. In Experiment 2 there was a significant psi effect that seemed to operate under the same conditions as LI (being attenuated with a high attentional load). However, creativity and positive schizotypy did not moderate the strength of this psi-LI-like effect. The LI effect was significantly enhanced by NLCC and attenuated by originality.

Keywords: Latent inhibition; implicit psi; creativity; positive schizotypy; paranormal belief; cognitive complexity

This research explored the links between creativity, unusual experiences (such as pseudo-hallucinations), weak filters of attention, and ostensible psi-performance. Weak stimulus barriers have been suggested to underpin creativity and unusual experiences, where irrelevant, creative or anomalous stimuli are not filtered from attention (Gianotti, Mohr, Pizzagalli, Lehmann, & Brugger, 2001; Gray, Fernandez, Williams, Ruddle, & Snowden, 2002; Hartmann, Harrison, & Zborowski, 2001;). We tested whether psi information might be processed in the same way as weak (or irrelevant) perceptual information using a latent inhibition protocol – and whether people who score highly on creativity, unusual experiences, and belief in the paranormal are more likely to attend to irrelevant and anomalous stimuli.

Latent Inhibition

Latent inhibition (LI) has been defined as: "the capacity to screen from conscious awareness stimuli previously experienced as irrelevant" (Carson, Peterson, & Higgins, 2003, p. 499), an unconscious process that adaptively reduces the load on working memory, selecting relevant stimuli, and ignoring irrelevant stimuli (Wuthrich & Bates, 2001). The term latent inhibition was introduced over 60 years ago (Lubow & Moore, 1959) to describe an effect, found in animal research, where the repeated presentation of a stimulus without consequence would reduce the ability of an animal to form new associations to that stimulus. This effect was later shown to be robust in human children and adults (for a review see Lubow, 1989). LI is usually assessed in a learning paradigm, testing the effect of exposure to an inconsequential stimulus on the future ability to learn an association between this stimulus and another (Gray & Snowden, 2005). In a typical LI experiment with humans there are two stages. Stage one consists of what is called a "masking task", a distracting task in which participants engage, the nature of which is not directly relevant to the overall experiment. This is immediately followed by stage two, the

experimental task, in which participants are required to solve a problem. There are two experimental conditions in which, during the masking task, participants are either: 1) repeatedly exposed to an irrelevant stimulus, such as a geometric shape or bursts of white noise (the pre-exposure [PE] condition); or 2) not exposed to this stimulus (the non-pre-exposure [NPE] condition). The stimulus is irrelevant to this masking task and serves no function. However, in the subsequent experimental task, this stimulus assumes relevant status; it must be attended to in order to solve the problem, that is, it must enter into cognitive associations. Typically, participants in the NPE condition, for whom the stimulus is novel, solve the problem faster, while participants who have been pre-exposed to the stimulus, without focusing on it, take longer to solve the problem. This is presumed to be because the "irrelevant stimulus" has been inhibited from awareness (Gray et al., 2002). The term latent inhibition refers to the fact that any "learning decrement" (i.e., an inability to learn an association with the inconsequential stimulus) is not visible until subsequent testing occurs (Lubow, 1989).

Although there are competing theories of LI (Escobar, Oberling, & Miller, 2002; Gray & Snowden, 2005; Lubow & Kaplan, 2005), attentional theories predominate. For instance, in Lubow's (1989) conditioned attention theory (CAT) repeated stimulus pre-exposure leads to the latent learning of a "stimulus-no-consequence" rule, thus reducing the amount of attention subsequently given to that stimulus, i.e., conditioned inattention. This model distinguishes between automatic (rapid, effortless, and unconscious) and controlled (slow, effortful, voluntary, and conscious) information processing. It proposes that the masking task is attended to with the controlled mode, and the stimulus-no-consequence rule is acquired through automatic processing. Conditioned inattention is explained by a stimulus specific bias against the transfer

from processing this stimulus, from the automatic to controlled mode in the test phase, making it unavailable to conscious awareness.

The LI effect is sensitive to the attentional load of the masking task (Braunstein-Bercovitz, Hen, & Lubow, 2004). For example, when the masking task is complex, requiring all attentional resources to focus on it, the LI effect is abolished (Braunstein-Bercovitz et al., 2004). This is thought to be because, in this case, the inconsequential stimulus is not processed automatically, and consequently, conditioned inattention is not learnt (Braunstein-Bercovitz & Lubow, 1998). Thus, LI is "an index of the ability to ignore irrelevant stimuli" (Lubow & Kaplan, 2005, p. 231). However, automatic attentional capacity is thought to be required for this to work effectively.

Anomalous Cognition and Attention

Anomalous cognition ("psi"), consciousness of information thought to have been gained without the use of the five senses or logical inference, has been considered in terms of "weak filters of awareness," analogous to reduced LI (e.g., Bergson, 1913; Hartmann et al., 2001; Thalbourne, Bartemucci, Delin, Fox, & Nofi, 1997). For instance, it has been proposed that psi-mediated information may register in the cognitive-perceptual system (i.e., be present below the level of conscious awareness), but be filtered out of conscious awareness by attentional mechanisms (e.g., Honorton, 1977; Stanford, 1990). This could potentially explain why psi-performance is associated with altered states of consciousness (Alvarado, 1998; Luke, 2015; Storm, Tressoldi, & Di Risio, 2010), where inhibitory (filter) mechanisms are weaker; and why some authors have argued for implicit (e.g., psychophysiological) measurements of psi-performance (Beloff, 1974; Bem, Tressoldi, Rabeyron, & Duggan, 2016; Palmer, 2015). Previous research has examined

whether psi operates in a similar way to awareness of subliminal stimuli or perception without awareness (e.g., Hitchman, Roe, & Sherwood, 2015; Roney-Dougal, 1986; Wilson, 2002), providing some evidence for parallels between them. However, the current research corresponds more closely to theoretical work by Schmeidler (1986), who questioned whether psi-mediated information might be processed like incidental stimuli that do not directly reach the focus of attention because attention is directed elsewhere. This notion, where awareness of the stimulus is a function of its relevance, has clear parallels with LI, which assesses the degree to which attention is unconsciously directed away from irrelevant information, irrespective of its liminal status. Carpenter (2004) has suggested that psi preconsciously alerts the mind in terms of potential meaning that may help interpret the sensory events which will follow and notes that: "If something elected to be an ESP target does not pass this test of 'probably most useful' in a given instant, it will pass on only a sense of avoidance in favor of the other thing being selected instead" (p. 231). This sounds like the irrelevant stimulus in LI, in which something inconsequential ends up being inhibited.

Shared Correlates of Latent Inhibition and Anomalous Cognition

An important aim of our research was to examine whether LI and psi effects share common correlates, focusing on creativity (Dalton, 1997; Holt, 2013; 2015; Holt, Delanoy, & Roe, 2004), the unusual experiences dimension of schizotypy (Mason, Linney, & Claridge, 2005) and belief in the paranormal (Thalbourne & Delin, 1993). These three factors correlate moderately with each other, especially with creative involvement in the arts (Holt, 2019). Further, all constructs have been modelled in terms of cognitive disinhibition (e.g., Eysenck, 1995; Gianotti et al., 2001; Lindeman, Riekki, & Hood, 2011). For example, Gianotti et al. (2001) propose a

continuum of associative processing, from creative thinking, through paranormal ideation in healthy individuals, to psychopathological delusion, disordered thought processes, and apophenia. It is therefore of interest to examine whether creativity, unusual experiences, and paranormal beliefs correlate with both latent disinhibition and any LI-like-psi-effect.

Eysenck (1995) argued that both creative cognition and psychoticism are underpinned by overinclusive thinking, where the boundaries of concepts overextend so that they are vague, broad, and associated with remote or irrelevant items, and suggested latent disinhibition as a mechanism for this. Studies have subsequently tested this model but have met with mixed success. Psychology undergraduates with high levels of creative achievement and professional actors have demonstrated attenuated LI, suggesting that they are more likely to attend to the irrelevant stimulus in the testing phase (Carson et al., 2003; Fink, Slamar-Halbedl, Unterrainer, & Weiss, 2012; Kéri, 2011). This effect has been associated with the originality component of divergent thinking and with creative personality scales (Carson et al., 2003; Fink et al., 2012). However, cognitive and trait predictors of creativity have not correlated with attenuated LI in some studies (e.g., Burch et al., 2004; Burch et al., 2006; Wuthrich & Bates, 2001). Similarly, despite artistic populations performing well in free-response ESP studies (e.g., Dalton, 1997; Schlitz & Honorton, 1992) divergent thinking and creative personality have been unreliable predictors of psi-performance (Dalton, 1997; Holt, 2007; McGuire, Percy, & Carpenter, 1973; Schmeidler, 1963, 1964).

Holt, Delanoy and Roe (2004) found that only the reported use of cognitive styles that involve intrapersonal openness in the creative process (e.g., the use of dreams and intuition – "non-linear creative cognition" [NLCC]) and emotional creativity (Averill, 1999) significantly predicted the reporting of paranormal experiences. This concurs with the idea that people with

"internal sensitivity" are more likely to have psi experiences (Honorton, 1977). Such non-linear creative styles might be more likely than cognitive and trait measures to be associated with reduced LI and any psi-LI-like effect. Holt (2013) reported that NLCC significantly predicted psi-missing, in a free response study that required the conscious reporting of and elaboration on inner experience. In such cases, creativity might have produced "cognitive noise", masking weak stimuli (Schlitz & Honorton, 1992). An implicit psi task, assessing behavior in response to unconscious or unattended psi-mediated information, may be a more efficient paradigm for assessing the relation between creativity and psi, without the need to introspect or deliberately encourage an overly fertile up-rush of ideas.

Schizotypy has been defined as a set of traits analogous to symptoms of schizophrenia (Mason & Claridge, 2015). The trait that most consistently relates to creativity and belief in the paranormal is "unusual experiences," analogous to the positive symptoms of schizophrenia (and hence, sometimes termed "positive schizotypy"). This includes the reporting of magical or religious beliefs, altered sensations and perceptions of one's own body and the world, hypersensitivity to sounds and smells, déjà vu, and pseudo-hallucinations (Holt, 2019; Mason et al., 2005).

These experiences are thought to be underpinned by a dysfunction at the interface of automatic/preconscious processes and controlled/conscious processes (Frith, 1979), characterized by weak gating (at the sensory or cognitive level) (Claridge & Davis, 2003), which may lead to flooding of the contents of consciousness. Decreased latent inhibition (or attenuated LI), the less efficient filtering of irrelevant information from awareness, has been found among the highly schizotypal (Gray et al., 2002) and people with acute schizophrenia (Gray, Hemsley, & Gray, 1992). Gray et al. (2002) reported that most of the variance in reduced LI among high

schizotypes was explained by unusual experiences; and reduced LI has been associated with unusual experiences in subsequent studies (Burch, Hemsley, & Joseph, 2004; Burch, Hemsley, Pavelis, & Corr, 2006; Evans, Gray, & Snowden, 2007; Granger, Prados, & Young, 2012; Schmidt-Hansen, Killcross, & Honey, 2009), although null outcomes have also been reported (Haselgrove et al., 2016; Kéri, 2011; Shrira & Kaplan, 2009). Investigations considering psi and positive schizotypy have had mixed outcomes, some rstudiesfinding it to correlate with above chance psi-performance (e.g., Parker, 2000; Parker, Grams, & Pettersson, 1998) and others not (e.g., Simmonds, 2003; Simmonds & Holt, 2007).

Belief in the paranormal has not previously been considered in relation to LI. However, such belief has been consistently related to creativity (Thalbourne, 2005), unusual experiences (e.g., Dagnall, Munley, Parker, & Drinkwater, 2010; Goulding, 2005) and psi-performance (Lawrence, 1993; Luke & Zychowicz, 2014). So, it is of interest to examine whether, like creativity and positive schizotypy, it may be associated with latent inhibition.

The Current Research

Given the theoretical overlaps between the attentional models of LI and psi, the current research aimed to test, for the first time, whether a psi-stimulus may be processed in the same way as the unattended stimulus in the LI paradigm. Two studies were planned. In Experiment 1 a standard visual LI protocol was used, but two conditions were added: 1) psi-pre-exposure (ψPE), where a sender attempted to transmit the stimulus telepathically during the initial masking task; and 2) non-psi-pre-exposure (NψPE). Hence, we assessed whether psi-mediated information might be inhibited from awareness when it is irrelevant, by testing whether subsequent cognitive performance requiring the associability of this stimulus was affected.

In Experiment 2, this design was repeated and an additional factor was added – complexity of the masking task – with: 1) a complex masking task; and 2) an ordinary masking task (Braunstein-Bercovitz, Hen, & Lubow, 2004). We tested whether, if psi does operate like LI, it is limited by the same attentional constraints. If this is the case, with a complex masking task any inhibition effects should be abolished, presumably because allocating all attentional resources to the masking task would prevent automatic processing of, and subsequent inhibition of, both the psi and LI stimulus. In both studies, we evaluated whether the same individual difference variables moderated any LI and psi effect, including measures of positive schizotypy, belief in the paranormal, and creativity (trait, cognitive, behavioral, affective, and reports of non-linear creative cognition).

Experiment 1

In Experiment 1 a standard LI paradigm was employed, but in half of the trials a sender attempted to transmit the stimulus telepathically during the initial masking task. We hypothesized that: 1) performance on the experimental task would be impaired in the PE condition compared to the NPE condition; 2) there would be a significant difference in performance on the experimental task between the ψPE and the NψPE conditions. We hypothesized that, if psi-mediated information is processed in the same way as irrelevant stimuli, then, similar patterns across respective conditions would be obtained, i.e., an LI effect and a psi-LI-like effect. Because with insufficient pre-exposures in the LI paradigm a facilitation effect has been found (Burch, Hemsley, & Joseph, 2004), the direction of the psi-effect was not hypothesized, because a weak effect might facilitate performance, while a stronger effect, as found in the classic LI research, might inhibit performance. Further hypotheses predicted that

creativity characterized by NLCC, unusual experiences (UE) and belief in the paranormal would all: 3) correlate significantly with enhanced performance on the experimental task in the PE condition; and 4) correlate significantly with performance in the ψPE condition; and that these correlations would differ significantly from those in the NPE and NψPE conditions respectively.

Method

Design.

The experiment had a 2 x 2 design, with two independent factors: 1) pre-exposure (with two levels: PE and NPE; and 2) psi-pre-exposure (with two levels: ψPE and NψPE). Participants were randomly allocated to one of these conditions. The dependent variable was the "learning score," the number of exposures of the stimulus (a white equilateral triangle in this study) on the experimental task that were required to solve the problem.

Participants.

Participants were recruited through opportunity sampling with psychology and sociology undergraduate and graduate students at three universities in the UK: Northampton, Liverpool Hope, and York (26 males, 54 females; median age = 28 [range = 18 to 60]). Participants were remunerated with £10. NH and SM acted as experimenters, running 40 trials each; and acted as senders when not an experimenter. Both experimenters were in their early 30s with a friendly and professional demeanor. SM rated belief in demonstrating psi in this study as a 4 (moderate belief) and NH as a 3 (neutral).

Materials and measures.

Latent inhibition program. The LI task was based on that used by Gray et al. (2002) and written in E-prime by SM. Stage one (the initial task) consisted of a series of trigrams (three unrelated letters, e.g., WQL), in black capitals measuring 1cm^2, separated by 1mm, and displayed in the center of the computer screen against a solid grey background. In the PE condition these trigrams were surrounded by the outline of a white equilateral triangle (with sides measuring 7.5 cm). In the NPE condition the triangle did not appear. The trigrams were shown for 1.5 seconds, with a .25s delay between exposures. There were 40 different trigrams. All 40 were presented in a pseudo-random order, twice, so that there were 80 presentations, each trigram appearing two times. Stage two was the experimental task. The same trigrams were presented again, with up to 160 exposures (40 trigrams four times each). The trigrams were surrounded by the outline of an inverted white equilateral pentagon (with sides measuring 4.5 cm) on up to 140 presentations, and by the triangle (as described above) on 20 presentations (pseudo-randomly interspersed). The trigrams were shown for 2 seconds, with intervals of .25 seconds between exposures. In stage two a counter stimulus (in a white typeface, measuring 1cm^2) was continually present in the top right corner of the computer screen. The number constituting the counter began at 50 and incremented concurrent to the onset of the .25 second interval that followed the presentation of a triangle. The program registered a press of a spacebar as a prediction of the counter incrementing before the next presentation.

Randomization envelopes. CSM prepared two sealed envelopes for each trial, containing a note delineating either: 1) sender condition; or 2) LI condition, based on an algorithmic random sequence.

The Emotional Creativity Inventory **(Averill, 1999).** A 30-item inventory scale that assesses emotional awareness and manipulation of cognitive content concerning affect, which may be used to solve interpersonal and intrapersonal problems. Good reliability and construct validity has been established (Averill, 1999; Ivcevic, Brackett, & Mayer, 2007).

The Creative Cognition Inventory, CCI **(Holt, 2007).** A 29-item measure with a 5-point Likert response scale to assess the use of different cognitive styles in the creative process, including five scales that assess non-linear cognition: internal awareness (attending to affect, bodily feelings, and meditative states); playful cognition (imagistic, associative, absorbed cognition); oneiric cognition (ideas arising in states along the dream-wake continuum); intuition (hunches, instincts, and moments of inspiration); and beyond the self (a sense of ideas coming from "something other"). The CCI has demonstrated good internal consistency and a stable factor structure, and it has adequate construct, convergent, and discriminant validity (Holt, 2007).

Creative Personality Scale, CPS **(Gough, 1979).** A 30-item measure, consisting of 12 adjectives that are antithetical to, and 18 that are associated positively with, creative personality. The CPS has good internal reliability, test-retest reliability, concurrent, and construct validity (Gough, 1979; Gough & Heilbrun, 1983). Gough and Heilbrun (1983, p. 18) describe a higher scorer as: "venturesome, aesthetically reactive, clever, and quick to respond" with a "breadth of interests, cognitive ability, and ideational fluency".

Shapes **(Holt, 2007).** A divergent figural transformation task, similar to the Repeated Figures and Picture Completion tasks of the Torrance Tests of Creative Thinking (Torrance, 2000). It

consists of three simple shapes (a curve, an open square, and a triangular cross), each repeated three times on a sheet of paper. Participants are asked to draw on these shapes, transforming them into something else (e.g. the curved shape is commonly transformed into a bird's wing) . Following Torrance (2000) responses are scored by: flexibility, the total number of different ideas produced; and originality, the unusualness of the object made, according to normative responses (Holt, 2007). It has good concurrent and discriminant validity (Holt, 2007).

The Creative Activities and Interests Checklist **(Griffin & McDermott, 1998; Hocevar, 1981).** A 54-item checklist that focuses on writing and the visual, performance, and domestic arts, with a dichotomy between an active interest in these activities and recent experience of these activities. This checklist was based on the 90-item Creative Behavior Inventory (Hocevar, 1981), and has good concurrent and construct validity (Griffin & McDermott, 1998; Holt, 2007). A 14-item scientific activities subscale was added by the current authors, based on Hocevar (1981).

The Australian Sheep-Goat Scale **(Thalbourne & Delin, 1993).** This 18-item scale was developed to assess degree of belief in paranormal phenomena, including extrasensory perception (e.g., believing in precognitive dreams), psychokinesis, belief in an afterlife and the possibility of contact with spirits. The scale has adequate concurrent validity, test-retest reliability, and internal consistency (Thalbourne & Delin, 1993).

The Short Oxford-Liverpool Inventory of Feelings and Experiences, O-LIFE **(Mason et al., 2005).** This 43-item scale assesses four dimensions of the schizotypal personality trait: unusual experiences; cognitive disorganization; introvertive anhedonia; and impulsive non-conformity. Good reliability and concurrent validity with the long version of the O-LIFE has been demonstrated (Mason, Claridge, & Jackson, 1995).

Procedure.

Potential participants were given an information sheet, or emailed a link to a website, describing the study and explaining that the authors were investigating the relation between belief in the paranormal/anomalous experiences and different types of creativity and problem-solving. If they wished to participate, they completed the above questionnaires in their own time. An appointment was then made for the completion of a series of problem-solving tasks, typically in a quiet room at one of the universities.

At the start of the experimental session, the stages of the protocol were described to the participant. These consisted of the LI task (described as two computerized problem-solving tasks) and the figural divergent-thinking task. After being so informed, and being made aware of participant rights (in accordance with British Psychological Society ethical guidelines), the participant read a written version of this introductory information and signed a consent form.

Meanwhile the experimenter opened a randomization envelope for the trial which allocated the participant to either the PE or NPE condition. They then opened the appropriate program on the laptop and, when the participant was ready, instructed them on how to perform the two tasks.

In the first task the participant was asked to choose one trigram and count how many times it appeared. At the end of this task there was a one-minute break, in which the participant was asked to record their answer on a piece of paper and prepare for the next task. In the second task, the participant was asked to discern the rule that caused the counter on the screen to increment. The experimenter explained that the rule could be deduced from the information presented on the screen. The solution was that the counter incremented after the stimulus (triangle) appeared. The participant was asked to press the spacebar every time that they

predicted that the counter would increment. The counter also incremented if the spacebar was pressed at an incorrect time (i.e., at any time other than when a triangle was present on the screen) and decremented if the spacebar was pressed at the correct time (while a triangle was presented). Thus, participants were told that the aim was to try to make the counter's number as low as possible. When they correctly predicted the increment five times in a row the program stopped and thanked them for completing the task. Otherwise, the program ran through all 160 presentations of the trigrams before thanking them for completing the task.

The participant initiated each task by pressing the spacebar, after reading written instructions for it on the screen. The experimenter left the room when the participant was ready to begin the first task. The experimenter (NH/SM) had already arranged with the sender-experimenter (SM/NH) to be prepared to "send" or "not send." The experimenter immediately phoned the waiting sender to notify them that the participant was reading the instructions for the initial task. The "sender" opened the randomization envelope informing them whether to send or not send. In the sending (ψPE) condition the sender opened a computerized image of the white equilateral triangle and focused on sending this telepathically to the participant for three minutes (the length of the initial task plus the one-minute break in-between the tasks). They also opened a text, sent to them by the experimenter, containing the name of the participant. In the NψPE condition the sender read the *New York Times* for three minutes and deleted the text concerning the participant without opening it. The experimenter read the *New York Times* during this period irrespective of the sending condition. After a further 30 minutes (the estimated time to complete the remaining tasks) the sender texted the experimenter to inform them of the sending condition.

When the participant had finished the LI task the experimenter returned and guided them through the completion of the divergent thinking task. Participants were asked to "Please see

how many objects or pictures you can make from the shapes below, drawing on them to transform them. Within five minutes try to think of as many things as you can that no one else will think of and give names or titles to the objects you create." Volunteers were left alone for five minutes to work on this task. Once the task was completed, participants were thanked for taking part. They were informed of the experimental conditions and which one they were allocated to and of hypotheses concerning filters of attention. The ψPE and NψPE conditions were described to them in terms of being either "remotely helped" or "not helped" to solve the experimental task by one of the authors from a different university via telepathy. Participants were encouraged to ask any questions about the study before being given £10 in appreciation of their time and effort. The research received ethical approval from both the University of Northampton and Liverpool Hope University Ethics Committees.

Pre-planned statistical analyses.

In LI research the distribution of learning-scores is typically bimodal, with many participants solving the problem either very quickly (after a minimum of two exposures of the triangle) or obtaining the maximum score of 20, so we planned to conduct between group comparisons using non-parametric Mann-Whitney U tests. Following previous research (e.g., Gray et al., 2002), in order to assess whether individual differences moderate performance, we measured the correlations between learning-scores in the exposure and non-exposure conditions separately and with Spearman rank correlations because this test makes no assumptions about the distribution of data. The locus of any attentional effect should be in the exposure conditions in contrast to the non-exposure conditions. This would indicate that the psychometric variable modulates attention given to the irrelevant/psi stimulus, rather than with faster associative learning (indicated by

changes in the baseline, non-exposure condition). Thus, we evaluated statistical differences between the correlation coefficients in exposure and non-exposure conditions (computed using the method described in Howell [1992]) as the main criterion for a moderation effect.

Results

Latent inhibition and sender effects.

As expected, the distribution of learning scores was bimodal, hence analyses proceeded as planned. Figure 1 shows the median learning-scores in each experimental condition. A significant latent inhibition effect was obtained (z = -1.70, p = .045, one-tailed, d = .39), where participants who were pre-exposed to the triangle during the masking task took longer to learn the association between the triangle and the incrementing counter (median LI score = 6.5; range = 18) than participants in the non-pre-exposure condition (median = 4; range = 18). Learning scores were also higher in the ψPE condition (median = 6; range = 18) than the NψPE condition (median = 5; range = 18), however, this was not statistically significant (z = -1.33, p = .18, d = .301). Hypothesis one, that performance on the experimental task would be impaired in the PE condition compared to the NPE condition was supported, but hypothesis two, that there would be a significant difference between the ψPE and the NψPE conditions was not.

INSERT FIGURE 1 HERE

Psychometric correlates of performance.

Correlation coefficients and associated probabilities between psychometric measures and learning-scores are delineated in Table 1. These are presented for NPE and PE conditions and for

sending and no-sending conditions separately. Effect sizes (z) and probabilities for the differences between the pairs of correlations are displayed in the adjacent columns.

INSERT TABLE 1 ABOUT HERE

In the LI conditions, learning-scores were not significantly moderated by any of the creativity measures. Hence, the hypothesis that non-linear creative cognition would be associated with enhanced LI was not supported. However, as hypothesized, non-linear cognition did appear to moderate performance across the sending conditions (z = -2.30, p = .02). Being more likely to use playful thinking and anomalous experiences in the creative process was associated with a psi-LI-like effect. No other aspects of creativity were significantly associated with performance across the sending conditions.

The hypothesis that UE would correlate significantly with faster learning in the PE condition in contrast to the NPE condition was not met (z = 1.09, p = .28), nor was the hypothesis that UE would moderate scoring across the sending conditions (z = .70, p = .48).

The final hypothesis was that being open to the existence of paranormal phenomena would be associated with reduced LI and a psi-LI-like effect. This hypothesis was not supported (see Table 1 for the relevant statistics).

Discussion

In Experiment 1, a significant LI effect was obtained, but no significant LI-like-psi-effect. Neither creativity, unusual experiences, nor belief in the paranormal were associated with attenuated LI as hypothesized. However, scoring highly on non-linear cognition in the creative process was associated with taking significantly longer to solve the problem in the ψPE

condition. These results suggest that if creative, paranormal, and schizotypal ideation do lie along a continuum of loose associative thinking (Gianotti et al., 2001), attentional processes underlying LI do not underpin this continuum. LI was not attenuated by unusual experiences, originality, creative behavior, or creative personality, as has been reported previously (Carson et al., 2003; Fink et al., 2012; Gray et al., 2002; Kéri, 2011). Various reasons may be postulated for this, including sample characteristics and masking task complexity. The overall sample may have had limited variance, representing "medium" schizotypes, with insufficient numbers of high schizotypes to find a relation with attenuated LI (Wuthrich & Bates, 2001). The current sample had mean scores on UE that were within 1SD of published norms (Mason et al., 2005), supporting this interpretation. Similar arguments could apply to creativity, where attenuated LI may be a characteristic of particular samples such as high creative achievers or professional artists (Carson et al., 2003). Further, differential LI-schizotypy interactions have been found according to gender (Lubow & De la Casa, 2002), hence in the current experiment gender/LI/trait interactions could have masked any significant effects. Alternatively, the nature of the LI task itself might have affected outcomes. With high masking task complexity high schizotypes have demonstrated intact (rather than attenuated) LI (Braunstein-Bercovitz & Lubow, 1998). In the current experiment a standard visual LI masking task was used, which is considered to be low load in Lubow's model, and yet, Wuthrow and Bates (2001) describe a similar task as high load in order to explain curvilinear effects in their data. The LI effect appears to be complex with differential outcomes emerging from the interaction of trait dependent (creativity and schizotypy) attentional resources and attentional demands of the masking task.

Although there was no overall psi effect, non-linear creative cognition, associated with attending to inner experience and reporting anomalous experiences, and altered states in the

creative process, was associated with a psi-LI-like effect. For high scorers on this dimension, pre-exposure to the psi-stimulus appeared to affect subsequent performance on the learning task in the same way as visual pre-exposure. In terms of Lubow's conditioned attention model, this suggests that the masking task was processed with controlled attention and the psi-stimulus was unconsciously processed with automatic attention, enabling repeated exposure of a psi-stimulus to condition attention, with a "psi-stimulus-no-consequence rule." Extending this interpretation further would suggest that representation of the psi-stimulus (presumably sufficiently similar to the pictorial version of the stimulus) would be inhibited from entering conscious awareness in the subsequent learning task, thus inhibiting solution of the problem. This interpretation suggests that certain profiles (i.e., those with internal sensitivity, Honorton, 1977) may be more likely to be unconsciously affected by psi-mediated information, and that this processing relates to the relevance of the information, for in this case irrelevant psi-mediated information appears to have been inhibited.

Experiment 2

Experiment 2 sought to replicate the findings of Experiment 1 and test whether processing of both the psi- and the perceptual-stimulus were moderated by the complexity of the masking task. An optimal LI-effect occurs when the masking task requires controlled processing but is not too demanding, thus enabling automatic processing of the inconsequential-stimulus (Lubow & Gewirtz, 1995). When the masking task is complex, it is theorized that all attentional resources are allocated to it, preventing the inconsequential-stimulus from being processed automatically, so that it does not need to be inhibited in order to facilitate selective attention – thus LI does not occur. Experiment 2 examined whether a psi-effect would likewise be attenuated by a complex

masking task, which would suggest that psi-mediated information is processed with automatic attention in the same way. Thus, an extra condition was added: Masking Task Load, with two levels: Ordinary Load (as in Experiment 1) and High Load (following Braunstein-Bercovitz & Lubow, 1998). Further, based on feedback following a conference presentation of Experiment 1 (Etzel Cardeña, personal communication, (August, 2007)), we employed an experienced meditator as the sender in the ψPE condition with the expectation that she would be better able to better attend to the stimuli/sending task.

Because previous research has reported that schizotypy has differential implications for performance based on the complexity of the masking task load (Braunstein-Bercovitz, Hen, & Lubow, 2004), Experiment 2 examined whether similar effects would be observed for unusual experiences (UE), creativity, and belief in the paranormal. When attentional demands are increased, Braunstein-Bercovitz et al. (1998; 2004) argue, high schizotypes are no longer distracted during the masking task and give no controlled attention to the irrelevant stimulus. Rather, they allocate all controlled attention to the complex task, allowing the irrelevant stimulus to be processed automatically, filtering it from attention. In this experiment we examined whether this effect would be replicated with UE alone, and whether those scoring high on creativity (in particular, non-linear cognitive styles) would show similar attentional patterns, across both LI and psi conditions. It has not previously been examined whether creativity has differential implications for LI according to masking task complexity. If the same patterns were obtained for schizotypy and creativity, the hypothesis that both are underpinned by latent inhibition would be supported. Due to gender being a potential confound, Experiment 2 only included female participants (Lubow & De la Casa, 2002).

We hypothesized that, with an ordinary masking task load: 1) performance on the

experimental task would be impaired in the PE compared to the NPE condition; 2) there would be a significant difference in performance on the experimental task between the ψPE and the NψPE conditions; and 3) both the LI and psi-LI-like effects would be attenuated in the high masking task load conditions. Additional hypotheses predicted that with an ordinary masking task load, creativity, non-linear cognition, UE and belief in the paranormal would all: 4) correlate significantly with enhanced performance on the experimental task in the PE condition; and 5) correlate significantly with performance in the ψPE condition; and that these correlations would differ significantly from those in the NPE and NψPE conditions respectively. We further hypothesized that with a complex masking task load, non-linear cognition, UE and belief in the paranormal would be associated with a stronger LI/psi effect (taking longer to solve the problem in the PE and ψPE conditions than the NPE and NψPE conditions).

Method

Design.

The experiment had a 2 x 2 x 2 design, with three independent factors: 1) pre-exposure (with two levels: PE and NPE); 2) psi-pre-exposure (with two levels: ψPE and NψPE); and 3) masking task complexity (High and Low). Participants were randomly allocated to one of these conditions. The dependent variable was the number of exposures of the stimulus on the experimental task that were required to solve the problem.

Participants.

Eighty female participants were recruited through opportunity sampling with undergraduate and graduate students at the universities of Northampton, Liverpool Hope and York (median age = 20 (range = 18 to 82). Participants were each remunerated with £10. Serena Roney-Dougal acted

as a sender for all trials, invited due to her long-term experience of both meditation and research in parapsychology. NH and SM acted as experimenters, running 40 trials each.

Materials.

Latent inhibition program. The LI program described in Experiment 1 was modified, using an algorithm, to randomly allocate participants to an experimental condition for exposure (NPE or PE) and complexity (high/low). Further, in the High Load conditions each trigram during the masking task appeared at one of four angles, according to a pseudo-random sequence: 0°, 90°, 180° or 270° (following Braunstein-Bercovitz, & Lubow, 1998).

Psychometric measures. Please refer to those described in Experiment 1.

Procedure.

The procedure was identical to that of Experiment 1, except for a few minor amendments. First, after being informed that the trial was about to start, SRD opened a word document indicating whether or not she should "send" in this trial or not (based on a randomized sequence prepared in advance by CSM and emailed to the sender, so that the experimenters were masked to all trial conditions). If she was sending, SRD opened a document with the participant's name, e-mailed in advance by the experimenter. Finally, on half of the NPE trials and half of the PE trials the trigrams in the masking task appeared at different angles, as if rotating.

Results

Latent inhibition and sender effects.

Figure 2 shows the median learning scores in each of the experimental conditions, according to masking task load. The LI-effect was present with an ordinary masking task load (PE: median = 8, range = 18; NPE: median = 4, range = 17), a difference that was significant (z = 1.77, p = .038, d = .58). However, the LI-effect was attenuated in the high masking task load condition (z = -.55,

p = .22, d = .17). Participants solved the problem more quickly in the PE condition (PE: median = 6, range = 18; NPE: median = 10, range = 19).

An apparent sending effect was obtained in the ordinary masking task load condition (ψPE: median = 17, range = 17; NψPE: median = 4, range = 18), where z = -3.06, p = .002, d = 1.105. The sending effect also approached significance in the high masking task load condition, where z = -1.95, p =.051, d = .65 (ψPE: median = 12.5, range = 19; NψPE: median = 3, range = 18). Increased attentional demands appeared to reduce the strength of any psi-LI-like effect. All hypotheses were supported: 1) an LI effect was obtained with an ordinary masking task load; 2) an LI-like-psi effect was obtained with an ordinary masking task load; and 3) both effects were attenuated with a high masking task load.

INSERT FIGURE 2 HERE

Psychometric correlates of performance.

Correlation coefficients and associated probabilities and effect sizes between psychometric measures and learning-scores are delineated in Table 2. These are presented for NPE and PE conditions and for sending and no-sending conditions separately, across both High and Low masking task complexity conditions.

INSERT TABLE 2 ABOUT HERE

Ordinary masking task load.

We hypothesized that with an ordinary masking task load, creativity, UE and belief in the paranormal would be associated with enhanced performance in both the LI and psi conditions (solving the problem more quickly when pre-exposed to the stimulus). As can be seen in Table 2, for the LI condition this was the case for the originality component of divergent thinking, which was associated with solving the problem more quickly in the PE than the NPE condition (z = -

2.91, p =.004), as reported in previous studies (e.g., Carson et al., 2003). However, for other variables (UE, NLCC and belief in the paranormal), the opposite effect was found, where it took longer to solve the problem in the PE exposure condition. This was significant, however, only for non-linear creative cognition (NLCC) (z = 4.07, p < .001). It appears, then, that creativity dimensions related differentially to LI. However, none of the psychometric predictors were associated with performance across the psi conditions. Overall, the hypothesis was not supported, LI and psi conditions were not associated with creativity, schizotypy, or belief in the paranormal as predicted.

Complex masking task load.

We hypothesized that with a complex masking task, creativity, UE, and belief in the paranormal would be associated with a stronger LI and LI-like-psi effect, taking longer to solve the problem when pre-exposed to the stimulus. As can be seen in Table 2, none of the psychometric variables significantly moderated performance across conditions. However, it is of note that involvement with creative activities, and unusual experiences, were significantly correlated with faster problem solving in the NPE condition, suggesting that these variables facilitated problem solving in general. The hypothesis that psychometric variables would be associated with enhanced LI and psi-effects with a complex masking task load was not supported.

Discussion

In Experiment 2, both significant LI and LI-like-psi effects were obtained, and only with an ordinary masking task load, as hypothesized. This accords with Braunstein-Bercovitz and Lubow's (1998) finding that increased attentional load attenuates the LI-effect. These effects were not moderated by creativity, schizotypy, or belief in the paranormal as predicted. With an ordinary masking task those scoring highly on non-linear creative cognition showed enhanced

LI, while originality was associated with attenuated LI. There were no significant correlations with the LI-like-psi-effect.

That a significant psi-LI-like effect was obtained supports the hypothesis that psi-mediated information may be processed like the inconsequential-stimulus in LI studies, being inhibited from conscious awareness when not needed. Both the LI-effect and the psi-effect were attenuated by attentional capacity. This would suggest that the psi-stimulus was processed with automatic attention, which, with a more complex task, was not available to process the psi-stimulus. However, it must be noted that the outcome for the psi-effect under high cognitive load was borderline (z = -1.95, p =.051), leaving open the possibility that psi might not be processed in the same way as inconsequential perceptual stimuli. Figure 2 suggests that the psi-stimulus appeared to "add" to the effect of the perceptual inconsequential-stimulus on learning, akin to adding extra perceptual exposures, supporting the interpretation that the psi-stimulus was processed in the same way as the visual stimulus.

In Experiment 2, reports of anomalous and altered experiences in the creative process (NLCC) was significantly associated with enhanced LI, suggesting more efficient filtering of irrelevant information from conscious awareness. Results suggested that with ordinary cognitive load, NLCC enabled controlled cognition to be given to the masking task (and automatic attention to irrelevant stimulus), an effect that was abolished with high task complexity. The enhanced LI effect for those scoring high on NLCC might be explained in part by previous research suggesting that creative individuals shift their attentional focus to meet task requirements (Fink & Benedek, 2014; Martindale, 1999) and are able to filter out irrelevant information when required to do so, unlike those diagnosed with

schizophrenia (Merten & Fischer, 1999). Hence, creativity might be a more reliable correlate of attenuated LI if task demands required cognitive disinhibition (i.e., the masking task requires original ideation).

The outcomes for originality replicated those of previous research that the production of remote and unusual ideas is associated with attenuated LI (Carson et al., 2003; Fink et al., 2012). That this effect was reversed with a high task load again aligns with previous findings for schizotypy, supporting the hypothesis that schizotypy and original ideation share a common mechanism (Braunstein-Bercovitz et al., 1998; 2004). However, given that the opposite effect was found for unusual experiences and self-report measures of creativity in the current experiment, this interpretation is somewhat problematic. Different components of creativity may affect attention in different ways (as different dimensions of schizotypy do; Granger et al., 2016; Gray et al., 2002). Original ideation may be associated more with cognitive dysfunction or disinhibition than creativity, which is commonly defined as "adaptive novelty" (Eysenck, 1995), and requires the selection and testing of appropriate ideas (which originality alone does not). The possibility that different types of creativity might be associated with different attentional resources deserves further exploration.

Given that creativity variables appeared to affect attentional resources in Experiment 2, it is unclear why any psi effect appears to have operated independently of such effects, and why attention was not moderated by the same variables. It may be that by recruiting female participants only in the current experiment and by working with a female long-term meditator as the sender, the psi-stimulus was more salient, so that the sample as a whole showed a psi-effect, rather than a sub-sample that scored highly on non-linear

creative cognition. Alternatively, some other factor may explain the psi outcome, such as a statistical fluke. An examination of person characteristics that might bias performance between the experimental conditions revealed no significant differences. However, repeated measures LI protocols, controlling for individual differences across conditions, might be of value in future research.

General Discussion

Our research suggests that the modelling of psi as an analogue to the inconsequential stimulus in attention is profitable and worthy of further consideration, especially since in Experiment 2, a significant LI-like-psi effect was obtained that appeared to be subject to the same attentional constraints as the LI effect. This provides support for models where psi-mediated information is described as a weak stimulus filtered out of conscious awareness due to the more pressing needs and demands of everyday life, yet may be present in the neurocognitive system at an unconscious level, thereby potentially affecting behavior (e.g., Carpenter, 2004; Palmer, 2015; Stanford, 1990).

Nevertheless, the individual difference parameters of this putative LI-like-psi effect were not clear. Creativity, unusual experiences, and belief in the paranormal were not reliable predictors across experiments. This accords with patterns in prior studies with similar variables and both implicit (Luke & Zychowicz, 2014) and explicit psi studies (Zdrenka & Wilson, 2017) that suggest that most individual difference measures are actually inconsistent predictors of psi.

LI was not consistently attenuated by schizotypy or creativity as reported in previous research (Burch et al., 2004; Carson et al., 2003; Gray et al., 2002). Indeed, at times variables correlated with LI in the opposite direction to that predicted.This is similar to the findings by

Granger, Moran, Buckley, and Haselgrove (2016), where unusual experiences were associated with enhanced LI. The current research supports previous comments that the relation between LI and individual differences is complex, and may depend on factors such as level of creativity, intelligence, gender, and the demands of the masking task (Carson et al, 2003; Braunstein-Bercovitz, & Lubow, 1998; Lubow & Gewirtz, 1995; Wuthrich & Bates, 2001), as well as the type of LI paradigm employed (of which there are several) (Byrom, Msetfi, & Murphy, 2018; Granger et al., 2016). Future research could explore such potential effects, although, the creativity/schizotypy-LI effect may not be as robust as portrayed in the literature and a meta-analysis might be of value.

There are several limitations to the current study design. Using a between-subjects design meant that different volunteers composed the comparison groups and, although randomly allocated to a condition, the comparison groups may not have been adequately matched. A within-subject design, in particular the visual search LI protocol developed by Lubow and Kaplan (2005), may profitably be used in the future to eliminate between group sources of error. Future studies might also pre-select high scorers on individual difference variableswhich may allow for a clearer understanding of LI and psi-LI effects. For example, it may be useful to repeat the research with professional artists to enhance the likelihood of finding both LI and psi-LI effects. Further, the statistical power in Experiment 2 was relatively low, and future work examining correlates of performance across levels of masking task complexity would benefit from a larger sample size.

The interaction between schizotypy dimensions might also be important, since negative and positive symptoms may affect LI in opposite directions (Shrira & Tsakanikos, 2009). For example, healthy schizotypes (who score highly on only the positive symptoms) might be better

able to control their cognition and therefore be more likely to demonstrate enhanced LI (unlike those scoring highly on both positive and negative symptoms) (Mohr & Claridge, 2015). More work is needed to elucidate how different types of schizotypy interact in any relation with both LI and psi-performance. Pre-selecting healthy and high schizotypes could assist with this goal.

Conclusion

This research used the latent inhibition paradigm to measure implicit psi-performance and to investigate how creativity, unusual experiences, and paranormal belief correlate with LI and psi-LI effects. There was some support for the hypothesis that psi information is processed in a manner akin to the unattended stimulus and is impacted by attentional load in a similar way. Replicating these effects would suggest that psi information may register within the system and interact with cognitive processes. However, individual difference measures were inconsistent in terms of their relation with LI and psi-LI effects. It cannot be concluded from the current research that weak attentional filters, as assessed by the LI paradigm, underpin creative, positive schizotypal or anomalous cognition. However, some interesting patterns were observed, where, for example, intrapersonal openness in the creative process was associated with a psi LI-like effect in Experiment 1 and enhanced LI in Experiment 2. Future work is needed to replicate and further explore the parameters of any effects, including employing within-participants designs, working with artists and "healthy schizotypes" who are prone to unusual experiences, and using masking tasks that encourage a creative, playful state.

References

Alvarado, C. (1998). ESP and altered states of consciousness: An overview of conceptual and research trends. *Journal of Parapsychology*, *62*, 27-63.

Averill, J. (1999). Individual differences in emotional creativity: Structure and correlates. *Journal of Personality, 67*, 331-371.

Beloff, J. (1974). ESP: The search for a physiological index. *Journal of the Society for Psychical Research*, *47*, 403-20.

Bem D., Tressoldi P., Rabeyron, T., & Duggan M. (2016) Feeling the future: A meta-analysis of 90 experiments on the anomalous anticipation of random future events. *F1000Research 4*:1188. doi.org/10.12688/f1000research.7177.2

Bergson, H. (1913). Presidential address. *Proceedings of the Society for Psychical Research*, *27*, 157-175.

Braunstein-Bercovitz, H., & Lubow, R. (1998). Are high-schizotypal normal participants distractible or limited in attentional resources? A study of latent inhibition as a function of masking task load and schizotypy level. *Journal of Abnormal Psychology*, *107,* 659-670.

Braunstein-Bercovitz, H., Hen, I., & Lubow, R. E. (2004). Masking task load modulates latent inhibition: Support for a distraction model of irrelevant information processing by high schizotypal participants. *Cognition and Emotion, 18*(8), 1135-1144. doi.org/10.1080/02699930441000058

Burch, G., Hemsley, D., & Joseph, M. (2004). Trials to criterion latent inhibition in humans as a function of stimulus pre-exposure and positive schizotypy. *British Journal of Psychology*, *95,* 179-196. doi.org/10.1348/000712604773952412

Burch, G., Hemsley, D., Pavellis, C., & Corr, P. (2006). Personality, creativity and latent inhibition. *European Journal of Personality, 20,* 107-122. doi.org/10.1002/per.572

Byrom, N., Msetfi, R., &. Murphy, R. (2018). Human latent inhibition: Problems with the stimulus exposure effect. *Psychonomic Bulletin & Review, 25,* 2102-2118. doi.org/10.3758/s13423-018-1455-4

Carpenter, J. (2004). First sight: Part one, a model of psi and the mind. *Journal of Parapsychology*, *68,* 217-254.

Carson, S., Peterson, J., & Higgins, D. (2003). Decreased latent inhibition is associated with increased creative achievement in high functioning individuals. *Journal of Personality and Social Psychology*, *85*, 499-506. doi.org/10.1037/0022-3514.85.3.499

Claridge, G., & Davis, C. (2003). *Personality and psychological disorders*. London, UK: Arnold.

Dalton, K. (1997). *The relationship between creativity and anomalous cognition in the ganzfeld.* Unpublished Doctoral dissertation. University of Edinburgh.

Dagnall, N., Munley, G., Parker, A., & Drinkwater, K. (2010). Paranormal belief, schizotypy, and transliminality. *Journal of Parapsychology, 74*(1), 117-141.

Escobar, M., Oberling, P., & Miller, R. (2002). Associative deficit accounts of latent inhibition and blocking in schizophrenia. *Neuroscience and Behavioral Reviews*, *26,* 203-216. doi.org/10.1016/S0149-7634(01)00067-7

Evans, L. H., Gray, N. S., & Snowden, R. J. (2007). A new continuous within-participants latent inhibition task: Examining associations with schizotypy dimensions, smoking status and gender. *Biological Psychology*, *74*(3), 365-373.

Eysenck, H. (1995). *Genius: The natural history of creativity.* Cambridge, UK: Cambridge University Press.

Fink, A., & Benedek, M. (2014). EEG alpha power and creative ideation. *Neuroscience & Biobehavioral Reviews, 44,* 111-123. doi.org/10.1016/j.neubiorev.2012.12.002

Fink, A., Slamar-Halbedl, M., Unterrainer, H. F., & Weiss, E. M. (2012). Creativity: Genius, madness, or a combination of both? *Psychology of Aesthetics, Creativity, and the Arts*, *6*(1), 11-18. doi.org/10.1037/a0024874

Frith, C. (1979). Consciousness, information processing and schizophrenia. *British Journal of Psychiatry*, *134,* 225-235.

Gianotti, L., Mohr, C., Pizzagalli, D., Lehmann, D., & Brugger, P. (2001). Associative processing and paranormal belief. *Psychiatry and Cognitive Neurosciences*, *55*, 595-603.

Gough, H. (1979). A creative personality scale for the Adjective Check List. *Journal of Personality and Social Psychology, 37*(8), 1398-1405. doi.org/10.1037/0022-3514.37.8.1398

Gough, H., & Heilbrun, A. (1983). *The adjective checklist manual.* Palo Alto, CA: Consulting Psychologists Press.

Goulding, A. (2005). Healthy schizotypy in a population of paranormal believers and experients. *Personality and Individual Differences*, *38,* 1069-1083. doi.org/10.1016/j.paid.2004.07.006

Granger, K. T., Prados, J., & Young, A. M. J. (2012). Disruption of overshadowing and latent inhibition in high schizotypy individuals. *Behavioural Brain Research*, *233*(1), 201-208. doi.org/10.1016/j.bbr.2012.05.003

Gray, N., Fernandez, M., Williams, J., Ruddle, R., & Snowden R. (2002). Which schizotypal dimensions abolish latent inhibition? *British Journal of Clinical Psychology, 41*, 271-284.

Gray, N., Hemsley, D., & Gray, J. (1992). Abolition of latent inhibition in acute, but not chronic, schizophrenics. *Neurology, Psychiatry and Brain Research*, *1,* 83-89.

Gray, N., & Snowden, R. (2005). The relevance of irrelevance to schizophrenia. *Neuroscience and Biobehavioral Reviews*, *29,* 989-999. doi.org/10.1016/j.neubiorev.2005.01.006

Griffin, M., & McDermott, M. (1998). Exploring a tripartite relationship between rebelliousness, openness to experience and creativity. *Social Behavior and Personality: An International Journal, 26*(4), 347-356. doi.org/10.2224/sbp.1998.26.4.347

Hartmann, E., Harrison, R., & Zborowski, M. (2001). Boundaries in the mind: Past research and future directions. *North American Journal of Psychology, 3*, 347-368.

Haselgrove, M., Le Pelley, M. E., Singh, N. K., Teow, H. Q., Morris, R. W., Green, M. J., ... Killcross, S. (2016). Disrupted attentional learning in high schizotypy: Evidence of aberrant salience. *British Journal of Psychology*, *107*(4), 601-624. doi.org/10.1111/bjop.12175

Hitchman, G. A., Sherwood, S. J., & Roe, C. A. (2015). The influence of latent inhibition on performance at a non-intentional precognition task. *Explore: The Journal of Science and Healing, 11*(2), 118-126. doi.org/10.1016/j.explore.2014.12.004

Hocevar, D. (1981). Measurement of creativity: Review and ritique. *Journal of Personality Assessment, 45*(5), 450-464. doi.org/10.1207/s15327752jpa4505_1

Holt, N. (2007). *Creativity, states of consciousness and anomalous cognition: The role of epistemological flexibility in the creative process*. Unpublished Doctoral thesis, University of Northampton.

Holt, N. (2013). Comparing artists with controls on a free-response experience-sampling task: Creativity and anomalous cognition. *Journal of the Society for Psychical Research, 77* (1), 1-18.

Holt, N. (2015). Schizotypy: A creative advantage? In Mason, O. & Claridge, G. (Eds.), *Schizotypy: New dimensions* (pp. 197-214). Oxford: Routledge.

Holt, N. (2019). The expression of schizotypy in the daily lives of artists. *Psychology of Aesthetics, Creativity and the Arts, 13*(3), 359-371. doi.org/10.1037/aca0000176

Holt, N., Delanoy, D., & Roe, C. (2004). Creativity, subjective paranormal experiences and altered states of consciousness. *Proceedings of the Parapsychological Association 47th Annual Convention*, 433-436.

Honorton, C. (1977). Psi and internal attention states. In B. B. Wolman (Ed.), *Handbook of parapsychology* (pp. 435-472). NY: Van Nostrand Reinhold.

Howell, D. (1992). *Statistical methods for psychology*. Belmont, CA: Duxbury Press.

Ivcevic, Z., Brackett, M., & Mayer, J. (2007). Emotional intelligence and emotional creativity. *Journal of Personality*, *75,* 199-235.

Kéri, S. (2011). Solitary minds and social capital: Latent inhibition, general intellectual functions and social network size predict creative achievements. *Psychology of Aesthetics, Creativity, and the Arts*, *5*(3), 215-221. doi.org/10.1037/a0022000

Lawrence, T. (1993). Gathering in the sheep and goats: A meta-analysis of forced-choice sheep-goat ESP studies, 1947-1993. *Proceedings of the Parapsychological Association 36th Annual Convention,* 75-86.

Lindeman, M., Riekki, T., & Hood, B. M. (2011). Is weaker inhibition associated with supernatural beliefs? *Journal of Cognition and Culture*, *11*(1), 231-239. doi.org/10.1163/156853711X570038

Lubow, R. (1989). *Latent inhibition and conditioned attention theory*. Cambridge, UK: Cambridge University Press.

Lubow, R., & De la Casa, G. (2002). Latent inhibition as a function of schizotypality and gender: Implications for schizophrenia. *Biological Psychology*, *59*, 69-86. doi.org/10.1016/S0301-0511(01)00124-7

Lubow, R., & Gewirtz, J. (1995). Latent inhibition in humans: Data, theory, and implications for schizophrenia. *Psychological Bulletin*, *117,* 87-103. doi.org/10.1037/0033-2909.117.1.87

Lubow, R., & Kaplan, O. (2005). The visual search analogue of latent inhibition: Implications for theories of irrelevant stimulus processing in normal and schizophrenic groups. *Psychonomic Bulletin and Review, 12,* 224-243.

Lubow, R., & Moore, A. (1959). Latent inhibition: The effect of non-reinforced preexposure to the conditioned stimulus. *Journal of Comparative and Physiological Psychology*, *52,* 415-419.

Luke, D. (2015). Altered states of consciousness and psi. *Psi encyclopedia*. London, UK: The Society for Psychical Research. https://psi-encyclopedia.spr.ac.uk/articles/altered-states-consciousness-and-psi. Retrieved 5 June 2020.

Luke, D., & Zychowicz, K. (2014). Comparison of outcomes with nonintentional and intentional precognition tasks. *Journal of Parapsychology, 78*(2), 223-234.

Martindale, C. (1999). Biological bases of creativity. In R. Sternberg (Ed.). *Handbook of creativity* (pp. 137-152). Cambridge, UK: Cambridge University Press.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for measurement of schizotypy. *Personality and Individual Differences*, *18,* 7-13. doi.org/10.1016/0191-8869(94)00132-C

Mason, O., Linney, Y., & Claridge, G. (2005). Short scales for measuring schizotypy. *Schizophrenia Research*, *78,* 293-296. doi.org/10.1016/j.schres.2005.06.020

Merten, T., & Fischer, I. (1999). Creativity, personality and word association responses: Associative behavior in forty supposedly creative persons. *Personality and Individual Differences, 27*, 933-942. doi.org/10.1016/S0191-8869(99)00042-2

McGuire, K., Percy, E., & Carpenter, J. (1974). A multivariate approach to prediction of ESP test performance. *Research in Parapsychology*, *1973*, 34-35. Metuchen, NJ: Scarecrow Press.

Mohr, C., & Claridge, G. (2015). Schizotypy—do not worry, it is not all worrisome. *Schizophrenia Bulletin, 41*(suppl.2), S436-S443. doi.org/10.1093/schbul/sbu185

Palmer, J. (2015). Implicit anomalous cognition. In E. Cardeña, J. Palmer, & D. Marcusson-Clavertz. (Eds.), *Parapsychology: A handbook for the 21st Century* (pp. 215-229). Jefferson, NC: McFarland and Company.

Parker, A. (2000). An experimental study of the influences of magical ideation and sense of meaning on the attribution of telepathic experience. *Journal of Mental Imagery*, *24,* 97-110.

Parker, A., Grams, D., & Pettersson, C. (1998). Further variables relating to psi in the ganzfeld. *Journal of Parapsychology, 62,* 319-337.

Roney-Dougal, S. (1986). Subliminal and psi perception: A review of the literature. *Journal of the Society for Psychical Research*, *53*, 405-434.

Schlitz, M. J., & Honorton, C. (1992). Ganzfeld psi performance within an artistically gifted population. *Journal of the American Society for Psychical Research, 86*(2), 83-98.

Schmeidler, G. (1963). Tests of creative thinking and ESP scores. *Indian Journal of Parapsychological Research, 4,* 51-57.

Schmeidler, G. (1964). An experiment on precognitive clairvoyance part IV: Precognition scores related to creativity scores. *Journal of Parapsychology, 28,* 102-108.

Schmeidler, G. (1986). Subliminal perception and ESP: Order in diversity? *Journal of the Society for Psychical Research, 80,* 241-263.

Schmidt-Hansen, M., Killcross, A. S., & Honey, R. C. (2009). Latent inhibition, learned irrelevance, and schizotypy: Assessing their relationship. *Cognitive Neuropsychiatry*, *14*(1), 11-29. doi.org/10.1080/13546800802664539

Shrira, A., & Kaplan, O. (2009). Latent inhibition in within-subject designs: The roles of masking, schizotypy, and gender. *Personality and Individual Differences*, *47*(8), 922-927. doi.org/10.1016/j.paid.2009.07.019

Shrira, A., & Tsakanikos, E. (2009). Latent inhibition as a function of positive and negative schizotypal symptoms: Evidence for a bi-directional model. *Personality and Individual Differences, 47*(5), 434-438. doi.org/10.1016/j.paid.2009.04.015

Simmonds, C. (2003). *Investigating schizotypy as an anomaly-prone personality.* Unpublished Doctoral thesis. University of Leicester/University College Northampton.

Simmonds-Moore, C., & Holt, N. (2007). Trait, state and psi: An exploration of the interaction between individual differences, state preference and psi performance in the ganzfeld and a waking ESP control. *Journal of the Society for Psychical Research, 71*, 197-215.

Stanford, R. (1990). An experimentally testable model for spontaneous psi events: A review of related evidence and concepts from parapsychology and other sciences. In S. Krippner (Ed.), *Advances in parapsychological research, Vol. 6* (pp. 54-167). Jefferson, NC: McFarland.

Storm, L., Tressoldi, P. E., & Di Risio., L. (2010). Meta-analysis of free-response studies, 1992-2008: Assessing the noise reduction model in parapsychology. *Psychological Bull*etin, *136*(4), 471-485. doi:10.1037/a0019457.

Thalbourne, M. (2005). Research note: Creative personality and belief in the paranormal. *European Journal of Parapsychology*, *20,* 79-84.

Thalbourne, M., Bartemucci, L., Delin, P., Fox, B., & Nofi, O. (1997). Transliminality: Its nature and correlates. *Journal of the American Society for Psychical Research*, *91*, 305-332.

Thalbourne, M., & Delin, P. (1993). A new instrument for measuring the sheep-goat variable: Its psychometric properties and factor structure. *Journal of the Society for Psychical Research*, *59,* 172-186.

Torrance, E. (2000). *Research review for the Torrance Tests of Creative Thinking figural and verbal forms A and B*. Bensenville, IL: Scholastic Testing Service.

Wilson, S. (2002). Psi, perception without awareness, and false recognition. *Journal of Parapsychology*, *66*, 271-289.

Wuthrich, V., & Bates, T. (2001). Schizotypy and latent inhibition: Non-linear linkage between psychometric and cognitive markers. *Personality and Individual Differences*, *30,* 783-798. doi.org/10.1016/S0191-8869(00)00071-4

Zdrenka, M., & Wilson, M. S. (2017). Individual difference correlates of psi performance in forced-choice precognition experiments: A meta-analysis (1945-2016). *Journal of Parapsychology, 81*(1), 9-32.

Figure 1

Median learning-scores in PE and NPE conditions for both Sending and No-sending trials

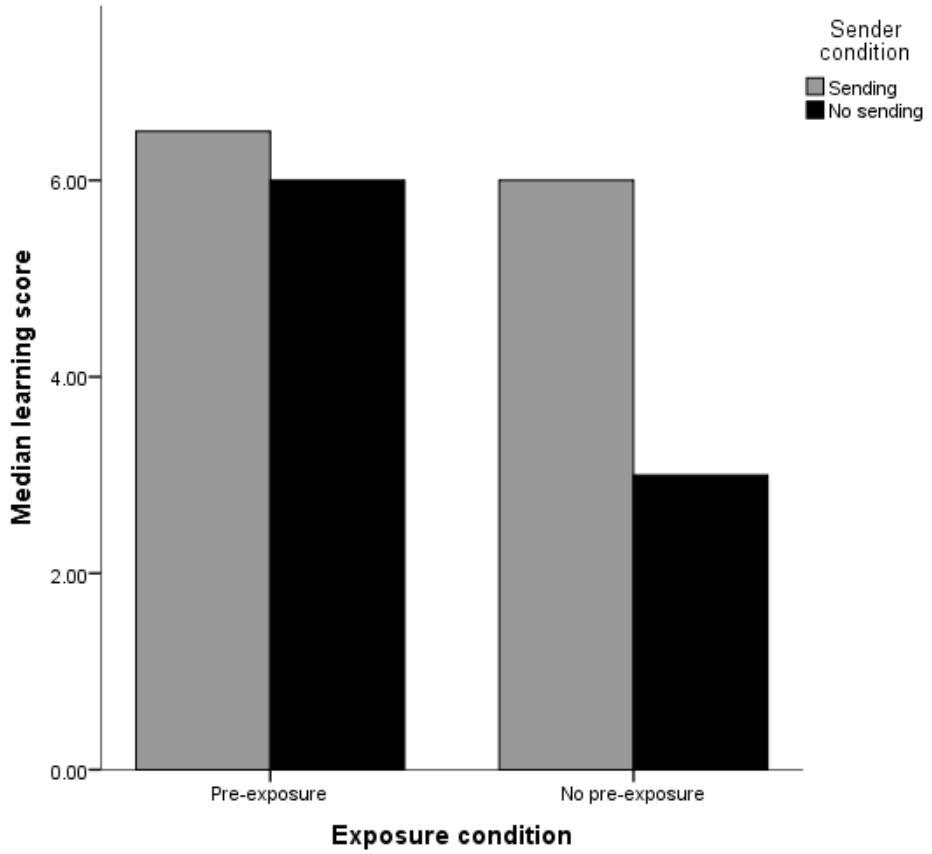

Figure 2

Median learning-scores in PE and NPE conditions for both sending and no-sending trials, across low and high masking task load conditions

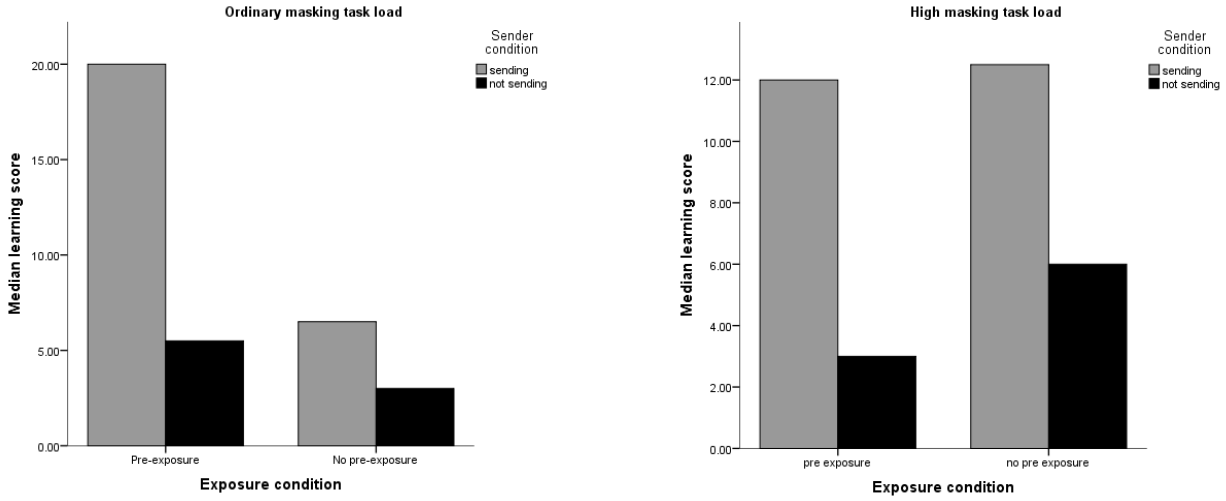

Table 1

Correlation coefficients and associated probabilities for the relationship between scores on psychometric measures and learning-scores in PE versus NPE conditions and sending versus no-sending conditions

Predictors	LI conditions			Sending conditions		
	PE	NPE	Difference between correlations *z* (*p*)	ΨPE	NΨPE	Difference between correlations *z* (*p*)
Unusual Experiences	.05 (.78)	-.15 (.37)	.87 (.38)	-.07 (.68)	.02 (.91)	-.39 (.70)
Emotional creativity	.17 (.29)	-.12 (.48)	1.26 (.21)	.07 (.64)	.01 (.96)	.26 (.79)
Non-linear cognition	.01 (.96)	-.04 (.80)	.21 (.83)	.26 (.12)	-.27 (.09)	2.3* (.02)
Originality (divergent thinking)	-.11 (.48)	.03 (.87)	-.60 (.55)	-.15 (.36)	.13 (.43)	-1.20 (.23)
Creative personality	-.05 (.75)	-.16 (.33)	.48 (.63)	-.21 (.20)	-.03 (.85)	-.78 (.44)
Creative activities	-.11 (.52)	-.28 (.08)	.76 (.44)	-.13 (.44)	-.21 (.20)	.35 (.73)
Paranormal belief	.02 (.92)	.03 (.84)	-.04 (.97)	.05 (.77)	-.01 (.95)	.26 (.79)

Note. * indicates statistical significance where $p < .05$. All *p*-values are two-tailed.

Table 2

Correlation coefficients and associated probabilities for the relationship between unusual experiences, creativity and belief in the paranormal across the conditions of Experiment 2

Predictors	Ordinary masking task load						High masking task load					
	PE	NPE	Difference between PE and NPE	ΨPE	NΨPE	Difference between ΨPE and NΨPE	PE	NPE	Difference between PE and NPE	ΨPE	NΨPE	Difference between ΨPE and NΨPE
Unusual experiences	.482 * (.031)	.123 (.250)	1.15 (.250)	.172 (.468)	.356 (.134)	-.057 (.569)	-.111 (.631)	-.624 ** (.003)	1.83 (.067)	-.271 (.248)	-.302 (.172)	.100 (.920)
Emotional creativity	.268 (.254)	.250 (.303)	.060 (.952)	.294 (.209)	.307 (.201)	-.040 (.968)	-.073 (.754)	-.213 (.354)	.420 (.675)	-.292 (.211)	-.021 (.927)	-.840 (.401)
Non-linear creative cognition	.865 ** (.000001)	-.103 (.674)	4.07 ** (< .001)	.193 (.416)	.366 (.124)	-.540 (.589)	.196 (.408)	-.389 (082)	1.80 (.072)	-.207 (.382)	.095 (.682)	-.910 (.363)
Originality	-.534* (.015)	.394 (.086)	-2.91** (.004)	.138 (.562)	-.053 (.828)	.55 (.582)	.173 (.454)	.126 (.581)	.140 (.889)	.377 (.101)	-.109 (.631)	1.52 (.129)
Creative personality	.213 (.368)	.339 (.156)	-.039 (.697)	.082 (.732)	.330 (.167)	-.035 (.726)	-.132 (.569)	-.360 (.109)	.026 (.472)	-.280 (.232)	-.270 (.224)	.030 (.976)
Creative activities	.234 (.321)	-.189 (.438)	1.23 (.219)	.083 (.729)	.345 (.148)	-.790 (.430)	-.190 (.410)	-.611 * (.003)	1.22 (.222)	-.350 (.130)	-.296 (.182)	.180 (.427)
Belief in the paranormal	.537* (.015)	.263 (.276)	.95 (.342)	.139 (.558)	.198 (.417)	-.17 (.865)	.149 (.520)	-.229 (.317)	.115 (.250)	-.003 (.991)	.044 (.845)	-.14 (.889)

Note. Statistics indicate in order of rows in each cell: 1) spearman's *rho*; 2) *p*-value (in parentheses) of correlation coefficient, except for columns which show the difference between correlations in sending and exposure conditions, which show *z*-statistics with

associated *p*-values in parentheses. In each cell $n = 20$. * indicates statistical significance where $p \leq .05$, and ** indicates $p \leq .01$. All *p*-values are