The relationship between latent inhibition and performance at a non-intentional precognition task

ABSTRACT

Context: Many spontaneous cases of extra-sensory perception (ESP) seem to occur without the conscious intent of the experient to manifest any anomalous phenomena. Indeed, Stanford's psi-mediated instrumental response (PMIR) theory, which frames ESP as a goal-oriented function, goes as far as to suggest that such intent may be counterproductive to psi. **Objectives:** The present study was the latest to build on the successful paradigm developed by Luke and colleagues in testing the non-intentional psi hypothesis and potential covariates of psi task success. This study focused on the ability of latent inhibition - an organism's cognitive tendency to filter out apparently irrelevant information - to predict an individual's sensitivity to psi stimuli. **Method:** Fifty participants completed a two-part auditory discrimination performance measure of latent inhibition, a battery of questionnaires and a 15-trial, binary, forced-choice, non-intentional precognition task. They were then either positively or negatively rewarded via images from subsets which they had pre-rated, seeing more images from their preferred subsets the better they performed at the psi task and vice-versa. **Results:** Participants scored a mean hit rate of 7.96 (MCE = 7.50), which just failed to reach a statistically significant level, $t(48) = 1.62$, $p = .06$, one-tailed, $ESr = 0.23$. However, latent inhibition was found to be unrelated to participants' precognitive performance.

Keywords: extra-sensory perception; non-intentional precognition; latent inhibition

INTRODUCTION

Researchers in the field of parapsychology are concerned with the investigation of the potential existence of what have been termed 'psi phenomena'. According to Palmer,[1] psi can be defined as "a correspondence between the cognitive or physiological activity of an organism and events in its external environment that is anomalous with respect to generally accepted *[basic] limiting principles* of nature" (p. 139). One example of a purported psi phenomenon is known as extra-sensory perception (ESP), defined by Thalbourne[2] as "The acquisition of information about, or response to, an external event, object or influence (mental or physical past, present or future) otherwise than through any of the known sensory channels." The importance of studying ESP is highlighted by the prevalence of the general public's belief in the phenomenon as well as the volume of anecdotes of purported manifestations, whether wilful or unintended, of extra-sensory phenomena. Fairly recent surveys conducted by the market research company MORI[3,4] found that 64% and 54% respectively of UK adult respondents indicated that they believed in ESP/premonitions, with 41% and 48% respectively of those canvassed claiming to have personal experience of the phenomena. Furthermore, data from Gallup polls[5,6] and Icelandic research[7] indicate that Americans and Europeans have a similar profile of belief in ESP.

L. E. Rhine[8] highlighted that a property of spontaneous cases of extra-sensory perception, as distinct from those instigated or sought after, is the absence of the conscious intention of the experient to manifest any kind of anomalous cognition. Indeed, Broughton[9,10] has argued that psi, as it occurs naturally, may be an entirely unconscious process that has an evolutionary origin in helping to facilitate adaptive outcomes. One theory of extra-sensory perception which reflects this non-intentional, need serving conceptualisation of psi is Stanford's[11,12,13,14] psi-mediated instrumental response (PMIR) model. The PMIR model can be summarised as suggesting that psi is primarily a goal-oriented, unconscious function that can serve to help organisms achieve positive outcomes or avoid negative outcomes by triggering pre-existing behavioural responses. In detailing the model, Stanford noted that the conscious use of will or intent to manifest extra-sensory effects may be counterproductive to the psi process.

Recent empirical studies which have, in part, provided tests of Stanford's model include a series of four experiments conducted by Luke and colleagues.[15,16,17] These four studies employed a computer based, non-intentional, forced-choice psi paradigm in which participants were asked to complete a picture preference task by indicating their favourite image from amongst four fractal patterns. Unbeknown to the participants, this was actually a covert precognition task as, immediately after they indicated their selection, the computer would randomly choose one of the images as a target, with the participant's selection being scored as a 'hit' if it matched with the computer's selection, and as a 'miss' if it did not. After 10 such tacit precognition trials, participants were 'rewarded' or 'punished' based on their performance in relation to the mean chance expectation (MCE = 2.5), thus capturing the goal-oriented nature of psi proposed by Stanford. Participants who scored more hits than would be expected by chance were rewarded by being shown either erotic or humorous cartoon images, whereas those who scored below chance were punished by having to take part in a boring number vigilance task. Mean hit rates were above chance in each of the four studies, significantly so for three of them. The four studies combined yielded a mean psi score of 2.92 (*SD* = 1.46) hits, significantly greater than the MCE of 2.50 ($t[197] = 4.04$, $p = .000078$, two-tailed), with an effect size of $ESr = .28$[1].

[1] Throughout this paper, effect sizes for t-tests are calculated according the following formula: $ESr = \sqrt{\frac{t^2}{t^2+df}}$

Given the promise of the main psi effects reported by Luke and colleagues, Hitchman, Roe and Sherwood[18,19] were interested to see if the results could be replicated by alternate investigators. The Hitchman et al.[18] study maintained the same experimental approach, but employed a rewritten computer program to rule out the possibility that the results obtained in previous studies were due to a software artefact and a refined contingent outcome task structure to provide a more sensitively graded level of punishment or reward. Additionally, the number of experimental trials per participant was increased from 10 to 15. Their subsequent study[19] built upon this protocol but was further adapted to contain intentional as well as non-intentional precognition trials and employed a trial-by-trial rather than end-of-run feedback mechanism.

Participants in the Hitchman et al.[18] study scored more hits on the non-intentional precognition task than the mean chance expectation (mean hit rate = 4.02 vs. MCE = 3.75), but their performance did not significantly exceed chance, $t(49) = 1.14$, $p = .13$, one-tailed. Hit rates in the subsequent study[19] were at near-chance levels in both non-intentional and intentional trials. Despite the poorer performance of participants in the two studies reported by Hitchman and colleagues, a combined analysis of the 6 Luke and colleagues and Hitchman and colleagues studies together suggests that the paradigm overall has yielded significant evidence of tacit psi, Stouffer $Z = 3.75$, $p = .00008$, mean $ESr = .19$. This approach can therefore be considered worthy of further attention, especially with respect to its relevance to the PMIR theory.

In specifying the PMIR model, Stanford noted a number of factors which he believed to be key in determining the likelihood that a person would exhibit a psi-mediated instrumental response. In particular, he identified a person's sensitivity to extrasensory information and their capacity to respond freely to such information as potentially being among the strongest predictors. With respect to a person's psi sensitivity, the focus on the present study, the latent inhibition construct was proposed as an indicator of receptivity to extra sensory information. Latent inhibition is popularly conceptualised as a cognitive inhibitory mechanism that serves to screen out information which has previously been learned as irrelevant from receiving conscious attention.[20] Lubow[20] stated that individuals vary markedly in their capacity to exhibit latent inhibition, suggesting there may be substantial individual differences in people's sensitivity to psi.

The theoretical links between latent inhibition and Stanford's conceptualisation of the functionality of psi appear to be well founded. For example, Eysenck[21] suggested that the generation of specific ideas and behaviours may be related to a deficit in cognitive filtering mechanisms which would serve to limit the associations made between incoming information to only those processes which are relevant to situational and ongoing concerns. Whilst it is not known how (or even if) extra-sensory information might be processed within the cognitive system, this theoretical assertion would certainly appear to provide a sensible basis on which latent inhibition could relate to the generation of psi-mediated instrumental responses: Incoming extrasensory information would stand less chance of being filtered out within the cognitive system of individuals with lower levels of latent inhibition and hence would have a greater propensity to be associated with subsequent cognitive processes involved in the generation of instrumental behaviours.

Despite the conceptual appeal of the latent inhibition construct, it is relatively complex and not straightforward to measure experimentally. The aforementioned studies by Luke and colleagues and Hitchman and colleagues employed Goldberg's[22] Openness to Experience scale as an indirect experimental proxy of latent inhibition on the basis that those with greater levels of openness tend to exhibit diminished latent inhibition.[23,24] Luke, Roe and Davison[16] reported a significant positive correlation between Openness to Experience and precognition scores ($r = .46$, $p = .01$, two-tailed), although this result was not replicated in the subsequent study by Luke and Morin[17] ($r = -.08$, $p = .64$, two-tailed). In their replication attempt, Hitchman et al.[18] reported a significant

positive correlation between participants' tacit precognitive performance and their levels of Openness to Experience, $r = .29$, $p = .02$, one-tailed. Unexpectedly, however, in the subsequent Hitchman et al. study,[19] it was found that males' non-intentional precognition scores were *negatively* correlated with their levels of Openness to Experience ($r = -0.46$, $p = .04$). In considering these findings, Hitchman et al. (under review) noted that internal effects in the parapsychological literature are characteristically inconsistent,[25] and also expressed concerns over the use of a questionnaire proxy to give an indicative measure of latent inhibition. The main focus of the current study was therefore to identify a more direct, performance-based measure of latent inhibition to enable a more sensitive evaluation of its hypothesised effect upon non-intentional precognition.

Within the latent inhibition literature, a typical performance measure consists of a two-part auditory discrimination task.[26] The principle of the test is to measure how quickly a participant can recognise that a previously irrelevant stimulus is the key to predicting the occurrence of a monitored stimulus. In the first section, participants are instructed to monitor a series of nonsense syllables being spoken through headphones for a specific syllable. During this section, irrelevant stimuli of bursts of white noise are also played. In the second section of the task, participants are played the same audio stimuli, but this time are required to watch a video recording of yellow circles appearing on a display. The appearance of the yellow circles is programmed to coincide with the bursts of white noise (the previously irrelevant stimuli). Participants are asked to identify the contingency between the auditory and visual stimuli, with the dependent variable being the number of yellow circles which are on the screen when the participant correctly identifies the association between the white noise bursts and the appearance of the yellow circles. This serves as a representation of the time it has taken them to learn the contingency between the previously irrelevant stimuli and the present task, with higher scores denoting a higher level of latent inhibition.

With respect to other methodological considerations, Hitchman et al.[18] noted the difficulty in identifying rewards and punishments that were suitably pleasant/unpleasant for all participants. For the present study, 5 subsets of internally homogenous but externally heterogeneous images were developed, ranging from very pleasant animal pictures (subset 1) through to very unpleasant images depicting dead/injured/mutilated human bodies (subset 5). Before the psi task, participants rated a sample of images from each subset, and the mean scores from each participant's own ratings were then used to rank order the subsets. The remaining unseen images were then used to reward or punish participants; the better their performance at the tacit psi task, the more images from their preferred subsets they were able to view and vice-versa.

The final deviation from the aforementioned established tacit psi protocol concerned the stimuli used within the precognition trials themselves. Concern had previously been expressed that the fractal images used in initial studies[15,16,17,18] lacked ecological validity, and the authentic images used in the most recent study[19] potentially introduced systematic response biases due to lacking homogeneity. Consequently, the present study utilised paired, mirrored images which were identical in every detail bar their orientation (similar to those employed by Bem[27]).

Given the use of emotionally potent images in the negative reward condition of the present study, it was deemed particularly important to have a gauge of whether individuals who were more reactive to negative emotive content would be more averse to these images, and hence avoid the negative reward condition more frequently. Therefore, Bem's[28] measure of Emotional Reactivity was included to assess whether individuals with higher levels of emotional reactivity exhibited a higher propensity to avoid the negative rewards.

As in the non-intentional precognition studies described above, it was predicted that participants would score more hits on the non-intentional precognition task than would be

expected by chance. For the present study, it was also hypothesised that there would be a negative correlation between participants' precognitive hit rates and their latent inhibition scores. In order to validate the purported relationship between latent inhibition and Openness to Experience, it was also predicted that there would be a significant negative correlation between participants' scores on the performance measure of latent inhibition and Goldberg's measure of Openness to Experience. Finally, it was predicted that there would be a positive correlation between participants' non-intentional psi scores and their scores on the measure of Emotional Reactivity.

METHOD

Design

A quasi experimental design was employed in which participants completed a 15-trial, binary, forced-choice, non-intentional precognition task. The dependent variable was the number of direct hits they scored on the task, where the mean chance expectation (MCE) was 7.5 hits for each participant. A contingent reward manipulation was utilised such that participants who scored above chance were administered with a positive reward of seeing images from sets they had previously indicated a preference for, whereas those who scored below chance were given a negative reward of seeing pictures from sets they least preferred. To assess the main experimental hypotheses, questionnaire and performance measures were also used to collect individual difference data regarding participants' Openness to Experience and latent inhibition. Following Hitchman et al.,[19] a measure of Emotional Reactivity was also included.

Participants

A sample size of 50 participants was pre-specified in order to preclude the possibility of optional stopping[29]. Nineteen male and thirty-one female participants (mean age = 23.06 years; *SD* = 7.00) were selected by opportunity sampling from friends, colleagues, associates and students from the University of Northampton.

Materials

Latent inhibition task[2]: a commonly used and well validated latent inhibition task after Lubow et al.,[25] comprising a 13:06 minute computerised video file consisting of two parts. In the first part, a series of nonsense syllables are spoken, during which time the participant is instructed to monitor the sounds for a specific target syllable. Concurrently, bursts of white noise are played at random intervals. During the second part, the same audio stimuli are reproduced whilst participants watch an array of yellow circles appear sequentially across the computer screen. The yellow circles are programmed to appear at the same time as the bursts of white noise, and the participant is asked to derive the association between the sounds they hear and the appearance of the yellow circles. Peterson & Carson[23] reported a significant negative correlation between participants' scores on the LI task and their levels of Openness to Experience ($r = .44$, $p = .0001$), whereas Peterson et al.[24] found those characterised by decreased latent inhibition were significantly more open ($t = 1.80$, $p < 0.04$, one-tailed).

Openness to Experience scale (OE)[22]: a 20-item questionnaire addressing an individual's openness to new experiences. Participants respond to statements such as "Believe in the importance of art" and "Have a rich vocabulary" by indicating the extent to which each statement

[2]We should like to thank Dr Shelley Carson for providing these materials for use in this experiment

is an accurate description of themselves. Each item is rated on a five-point Likert scale from very inaccurate to very accurate, yielding a score which can range from 0 to 80. Coefficient alphas for subscales of Openness to Experience were found to range from .77 to .86[22], and scores have been found to correlate with those on the equivalent scale of the NEO personality inventory[30] (r = .56).

Emotional Reactivity items[28]: Two items which address individuals' awareness of their emotional reactivity to violent, scary or gruesome content in photographs, movies and videos. Participants respond on a scale from 1 (not at all intensely aware) to 5 (very intensely aware).

PMIR Visual Basic program: A software program developed specifically for the purpose of this experiment by the first author[3]. The program was based on the software used in the Hitchman et al. (under review) study, but was adapted to reflect the new design elements for the present study. It was used to present images from the following set:

International Affective Picture System (IAPS)[31]: a large set of emotive colour photographs, the contents of which span numerous semantic categories including awe, excitement, contentment, amusement, fear, sadness, disgust, and anger. During the development of the set, all images were rated by a large number of independent judges using Self-Assessment Manikins for their perceived valence, arousal and dominance, enabling them to be categorised according to these criteria. For the present study, these ratings were used to sort the images into 5 categories: very pleasant (9 >= pleasantness > 6.5), mildly pleasant (6.5 >= pleasantness > 5.5), neutral (5.5 >= pleasantness > 4.5), mildly unpleasant (4.5 >= pleasantness > 3.5) and very unpleasant (3.5 >= pleasantness > 0.0). From each of these categories, 8 pictures were then selected which, in the opinions of the authors, best conformed to similar semantic themes. The final picture sets each contained 8 images and consisted of the following: very pleasant pictures – animals; mildly pleasant pictures – relaxed city scenes; neutral picture – household tools/utensils; mildly unpleasant pictures – broken/decaying items/landscapes; very unpleasant images – dead/injured/mutilated human bodies. The mean arousal ratings within each set were closely matched and it was ensured that the sum of the standard deviations of pleasantness and arousal ratings for each image did not exceed 3.5 units (implying that the majority of individuals should have similar emotional responses to the images). These five image sets were used to derive appropriate contingent reward stimuli. Of the remaining neutral pictures, 15 images were selected on the basis that they could easily be mirrored without either orientation looking any more natural than the other. Mirror images of these 15 pictures were then created which, along with the original images, comprised the target stimuli for tacit precognition trials.

Procedure

Participants were invited to take part in what was described to them as 'a psychological investigation into auditory and visual perception, and how this relates to an individual's personal characteristics.' They were welcomed in a private room within the University of Northampton and were fully briefed on what they would be required to do within each part of the experiment. However, at no point during the briefing was it mentioned to them that the experiment had anything to do with a test of precognition or psychic ability. Participants were given ample opportunity to ask any questions before being taken to a research cubicle where they operated the software program on a laptop computer.

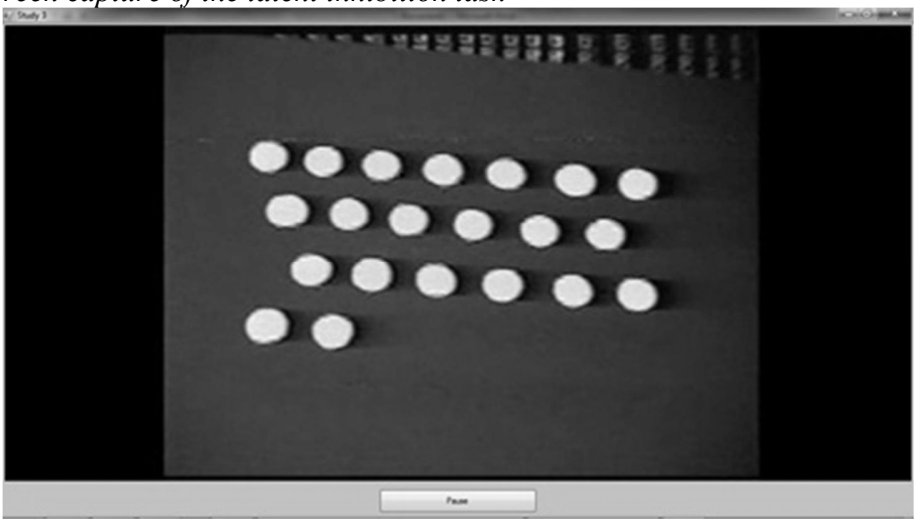
The program provided a written introduction to remind participants of the basic elements of the study before digitally collecting their informed consent. Participants then proceeded to complete the performance based latent inhibition task, which consisted of two sections. In the first section, participants listened to a series of nonsense syllables being spoken to them through

[3] Available from the first author on request.

headphones. They were instructed that the third syllable they heard in the sequence was their target syllable, and they should count how many times they heard this target syllable throughout the recording, including the first time. During the recording, irrelevant stimuli of bursts of white noise were also played at random intervals. At the end of the recording, participants were asked to report the number of times they heard the target syllable. The experimenter ensured that participants' responses approximated the correct answer to verify that they had understood and carried out the instructions appropriately.

Participants then continued to the second section of the auditory discrimination task. They were instructed that they would be seeing a number of yellow circles appearing on the screen in front of them, and that the appearance of the circles would have something to do with the sounds they would be hearing through the headphones. Participants were asked to listen to the recording (which was exactly the same as during the first section of the task) whilst watching the number of yellow circles increase (see Figure 1), and raise their hand the moment they had identified the rule which caused the number of yellow circles to increase. They were also asked to raise their hand again each time they expected another yellow circle to appear based on the identified rule. When participants had correctly predicted the appearance of 5 circles, the experimenter stopped the recording and asked the participant to describe the rule. The task continued until they were able to accurately report the rule that the yellow circles appeared immediately after each time the white noise (i.e. the previously irrelevant stimulus) sounded or the end of the recording was reached. The computer automatically recorded the number of circles which were present on the screen when the participant had finished the task.

Figure 1: Screen capture of the latent inhibition task



Participants were then asked to remove the headphones before being left alone in the cubicle to complete the remainder of the tasks. The next stage of the computer program involved participants rating 2 randomly selected images from each of 5 subsets (see Figure 2) in order that their subsequent reward or punishment task could be tailored to their own preferences. The participants' ratings were used to rank order the image subsets, with the subset from which the 2 randomly chosen images received the highest mean score being assigned a rank of 1, and the subset from which the 2 randomly chosen images received the lowest mean score being assigned a rank of 5. In the event of a tie between 2 subsets, the subset with the highest corresponding IAPS mean pleasantness rating was given the lower rank.

Figure 2: Screen capture of image rating task[4]

Participants were then presented with digitised versions of the questionnaire battery before being guided through an image preference task. Here, participants were sequentially presented with 15 pairs of mirror images side-by-side (see Figure 3). They were asked to indicate their favourite image by clicking on the one they most preferred, and to do so as quickly as possible. The side of the screen on which each of the mirrored images appeared was randomised across trials, and the order in which each pair of images appeared in sequence was randomised for each participant. Furthermore, the position of the cursor was reset to the centre of the screen between each pair of trials to avoid any unintended response bias associated with the cursor already being closer to one of the images. Unbeknown to the participants, this constituted a forced choice, implicit precognition task as each time they indicated a preferred image, the computer would select one of the images at random as the target, with participants scoring a point if their selection matched the target image.

Figure 3: Screen capture of image preference task

[4]For contractual reasons, indicative images are displayed rather than genuine IAPS pictures in all figures.

As in previous studies,[18,19] randomisation of the image array positions and computer target selections was achieved using the random number generation function within VB.NET, which is seeded by the CPU timer. A 1 x 2 chi-square analysis indicated there were no systematic patterns in the computer's selection of the targets, χ^2 (1, N = 750) = 0.90, p = .34.

After the 15th trial, the program calculated the participant's score and administered a final task contingent upon their performance. The final task was a further image rating task, as per the initial image rating task, with 10 image stimuli being selected from the remaining unrated images of the 5 aforementioned subsets. Participants who scored above the mean chance expectation (MCE = 7.5) were rewarded by being able to rate images from their three most preferred subsets whereas participants who scored below the MCE were negatively rewarded by being asked to rate images from their three least preferred subsets. The exact composition of these 10 images depended on their performance at the precognition task, as outlined in Table 1:

TABLE 1: COMPOSITION OF CONTINGENT REWARD PICTURES BY NON-INTENTIONAL PRECOGNITION SCORE

	Number of images from each rank subset				
Psi score	1st	2nd	3rd	4th	5th
> 9	6	2	2	0	0
9	2	6	2	0	0
8	2	2	6	0	0
7	0	0	6	2	2
6	0	0	2	6	2
< 6	0	0	2	2	6

After the contingent positive or negative reward task was completed, the program informed participants that they had finished all of the tasks and requested them to call back the experimenter who provided a full debrief, including an explanation that the image preference task was, in fact, a covert psi task.

Ethics

The project was designed to adhere to the British Psychological Society's Code of Ethics and Conduct[32] and received ethical approval from the University of Northampton Research Ethics Committee. All data were collected anonymously and participants were made aware of their right to withdraw from the experiment at any time without having to provide a reason. Participants were forewarned in the briefing period that they may see negative, gruesome and scary images during the experiment. It was mandatory that they ticked a box indicating that this had been explained to them and they were happy to continue to take part in the study in order to proceed past the digital consent form.

Results

The hit rates for each participant along with their scores on the individual difference measures were recorded. One participant misunderstood the instructions for the latent inhibition task, so her data were excluded from analyses considering the relationship between latent inhibition and tacit psi scores. Another participant's data were entirely removed on request as she reported not having differential responses to any of the pictures or questions throughout the experiment.

In order to check the efficacy of the experimental manipulation of assigning participants to different levels of positive and negative contingent reward conditions, the relationship between their performance on the implicit precognition task (which determined the type and level of contingent reward or punishment they received) and the mean score they gave to the 10 images they rated in the final (contingent) task was assessed. Table 2 shows that, as expected, those who partook in a positive reward condition generally rated the contingent task images as significantly more pleasant than those who completed a negative reward condition (positive condition mean = 6.57, negative condition mean = 4.04; $t[47] = 9.90$, $p = 2.3 \times 10^{-13}$, one-tailed). In order to validate the progressive severity of the ordinally scaled contingent reward conditions, Spearman correlations between the level of reward conditions (i.e. hit rate) and participants' subjective ratings of the pleasantness of the outcome task were calculated. For this analysis, participants were divided into those who received a positive reward and those who received a negative reward as the combined relationship could potentially be nonlinear.[18] For those who received a positive reward, there was a small, positive correlation between their psi scores (and hence reward conditions) and their ratings of the contingent reward images, but the relationship was not

significant, r_s = .24, p = .13, one-tailed. For those who received a negative reward, there was also a positive correlation between participants' psi scores and their ratings of the contingent reward images, but the relationship just failed to reach statistical significance, r_s = .33, p = .06, one-tailed.

TABLE 2: MEAN AND STANDARD DEVIATION OF PARTICIPANTS' SUBJECTIVE RATINGS OF THE PLEASANTNESS OF THE CONTINGENT TASK BY TASK TYPE

Reward condition	Mean pleasantness rating	Standard deviation
Positive (n = 24)	6.57	0.96
Negative (n = 25)	4.04	0.82

The primary hypothesis predicted a non-intentional precognition effect. After exclusions, 49 participants each completed 15 tacit precognition trials with an associated probability of correctly selecting the target image of .50. Overall, participants scored a mean hit rate of 7.96 (SD = 1.99) where they would be expected to score 7.50 (SD = 1.94) hits on average by chance alone. The result a of a one-sample t-test revealed that although participants achieved more hits than the MCE, their scoring just failed to reach statistical significance, $t(48) = 1.62$, p = .06, one-tailed. The effect size observed in the present study was ESr = 0.23, similar to Luke's original study using this paradigm (ESr = .24) and approaching that of the four studies reported by Luke and colleagues combined (ESr = .28).

Table 3 presents this result in the context of the aforementioned studies which tested the non-intentional psi hypothesis. Whilst other researchers (e.g. Bem[27]) have conducted similar tests of non-intentional psi, the studies surveyed here are limited to those which cited Stanford's PMIR model as providing the theoretical basis for their test of tacit precognition. A meta-analysis considering all 7 of the listed studies weighted by degrees of freedom suggests that, despite the present study failing to yield independently significant evidence of non-intentional precognition, this paradigm continues to present significant evidence of tacit psi, Stouffer Z = 3.66, p = .0001, mean ESr = .20. In interpreting this result, it should be noted that the studies included in this analysis contained minor methodological differences in the nature of the target stimuli and the number of response options available in the main psi task. Consequently, they should not be considered as direct replications, but nevertheless participants in each case were required to make relatively arbitrary choices of their preferred images from sets of closely matched options in what was presented to them as a 'preparatory image preference task'.

TABLE 3: SUMMARY OF THE RESULTS OF NON-INTENTIONAL PRECOGNITION STUDIES THEORETICALLY UNDERPINNED BY THE PMIR MODEL

Study	N	Mean hit rate	MCE	One-sample t test statistic	p (one-tailed)	z	Effect size (r)
Luke, Delanoy & Sherwood (2008)	100	2.85	2.50	2.51	.01	2.45	.24
Luke, Roe & Davison (2008) Study 1	25	3.40	2.50	2.60	.01	2.34	.47
Luke, Roe & Davison (2008) Study 2	32	2.90	2.50	2.01	.03	1.92	.34
Luke & Morin, 2009	41	2.80	2.50	1.19	.12	1.15	.12

Hitchman, Roe & Sherwood (2012)	50	4.02	3.75	1.14	.13	1.14	.16
Hitchman, Roe & Sherwood (under review)	50	4.94	5.00	-0.36	.72*	-0.36	-.05
Present study	49	7.96	7.50	1.62	.06	1.59	.23

* Two-tailed significance value is reported as the direction of the relationship was contrary to the hypothesis

Secondary hypotheses predicted relationships between participants' performance on the implicit precognition task and their scores on the performance measure of latent inhibition and the questionnaire measures of Openness to Experience and Emotional Reactivity. Figure 4 shows the distribution of participants' latent inhibition scores. Following Peterson and Carson[23] and Peterson et al.[24] participants were dichotomised into 'decreased' (≤20) and 'intact' (≥25) latent inhibition categories, on the basis that there is an established natural split within the bimodal distribution of scores.[33]

Figure 4: Distribution of latent inhibition scores

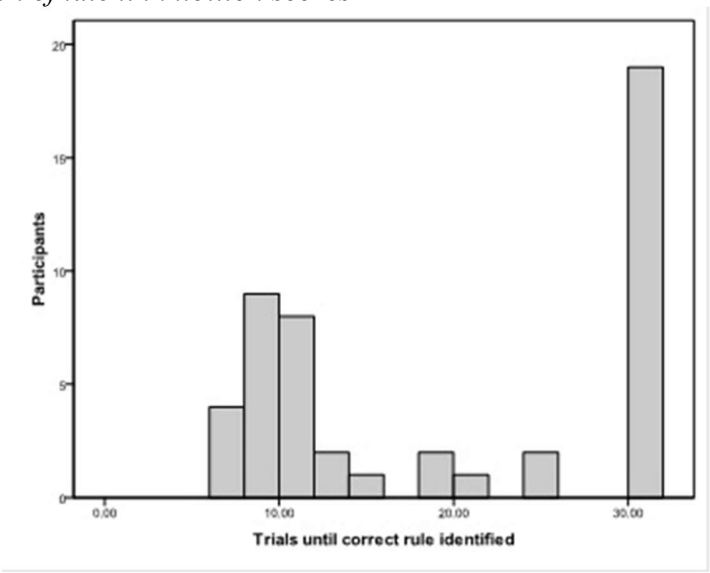


Table 4 shows that, as expected, those with decreased latent inhibition performed better at the tacit precognition task (8.18 vs. 7.75 hits) hits, but the difference was not statistically significant, $t(46) = .73$, $p = .23$, one-tailed.

TABLE 4: MEAN AND STANDARD DEVIATION OF PARTICIPANTS' NON-INTENTIONAL PRECOGNITION SCORES BY LATENT INHIBITION CATEGORY

Latent inibhition category	Mean precognitive hits	Standard deviation
Decreased ($n = 28$)	8.18	2.13
Intact ($n = 20$)	7.75	1.80

Table 5 shows that the correlation between psi and Openness to Experience scores were found to be small and non-significant. However, contrary to predictions, a *negative* correlation was

found between performance at the tacit precognition task and Emotional Reactivity which just failed to reach statistical significance, $r(49) = -.27$, $p = .06$, two tailed[5].

TABLE 5: PEARSON CORRELATIONS AND TWO-TAILED SIGNIFICANCE VALUES BETWEEN PSI TASK SCORE AND LATENT INHIBITION, OPENNESS TO EXPERIENCE AND EMOTIONAL REACTIVITY

	Correlation Coefficient	Significance (two-tailed)
Openness to Experience ($n = 49$)	.01	.96
Emotional reactivity ($n = 49$)	-.27	.06*

It was also of interest to validate the purported relationship between latent inhibition and Openness to Experience, which had been assumed in previous studies. We predicted that individuals with diminished latent inhibition would score higher on Goldberg's measure of Openness to Experience. It was found that although individuals with decreased latent inhibition showed higher levels of Openness to Experience, the difference between scores was not statistically significant, $t(46) = 0.97$, $p = .34$, one-tailed.

DISCUSSION

The aims of this study were to provide further evidence of a non-intentional precognition effect, as framed within Stanford's psi-mediated instrumental response theory, and to explore in greater detail the role of latent inhibition, predicted by the PMIR model to be a covariate of psi task success. Participants in this study scored an overall number of tacit precognitive hits that exceeded the mean chance expectation, although their scores just failed to reach a statistically significant level. The effect size observed in the present study (ESr = 0.23) was similar to Luke's original study using this paradigm (ESr = .24) and approached that of the four studies reported by Luke and colleagues combined (ESr = .28). With respect to statistical power, the size of the sample recruited for the present study was pre-specified as 50 participants on the basis that Luke and colleagues[16] reported significant non-intentional precognition effects using relatively small samples (25 and 32 respectively) and that this study was part of a series of progressive studies leading to a planned combined analysis. On the assumption that further participants would have performed at a similar level, the null hypothesis would have been refuted if the sample size was as large as the original Luke and colleagues study ($N = 100$). Furthermore, the effect size observed here was greater than that reported in the Hitchman el al.[18] replication attempt (ESr = .16), suggesting that the methodological developments implemented in the present study may have yielded some benefits. In particular, the use of authentic, mirrored images in a binary selection format ensured that any potential preferential biases were minimised relative to the more diverse fractal patterns or authentic images that had been employed previously. As a result,

[5] As noted by Hitchman et al.,[18] the parametric Pearson correlation test may not be valid for scales with a score range of less than 20 points (as in the case of the Emotional Reactivity measure). Whilst Pearson correlations are reported for consistency and comparison with other correlations, a Spearman nonparametric correlation was also calculated. This yielded a similar effect size which was statistically significant: $r_s = -.29$; $p = .04$.

any potential psi-mediated bias should, in theory, have had less competition in overcoming intrinsic perceptual preferences in instigating a need-serving behavioural response.

Another potentially contributory factor which also represented a development of the paradigm was the integration of a reward system which was determined by the preferences of the participant. Hitchman et al.[18] discussed the significant problem of identifying contingent outcome tasks which were appropriate for all participants. The present study made use of pre-categorised image subsets which were internally homogenous in terms of their semantic properties and IAPS pleasantness and arousal rating data, and superficially heterogeneous, with subsets ranging from very pleasant animal pictures through to very unpleasant images depicting dead, injured or mutilated human bodies. Prior to taking part in the non-intentional precognition task, participants rated a sample of two images from each of the subsets, which enabled the sets to be rank ordered according to the participants' own evaluations. Subsequent to completing the tacit psi task, their reward or punishment stimuli were then specifically tailored to the preferences they had already indicated. This removed the majority of doubt over the assumption made in previous studies that all participants should necessarily like the reward condition and dislike the punishment condition.

Turning to internal effects, the Luke and colleagues and Hitchman and colleagues studies also provided some support, albeit indirect and inconsistent, for the notion that a person's sensitivity to psi stimuli may be mediated by their tendency to exhibit latent inhibition. The present study implemented a performance based measure of latent inhibition to overcome the limitations of the questionnaire proxy which had previously been employed. However, the results of this study failed to yield evidence of the predicted relationship between latent inhibition and performance at the tacit psi task. Perhaps more surprisingly, previous studies that indicated a link between latent inhibition and Openness to Experience[23,24] were not supported; the relationship was found to be in the predicted direction but represented a relatively small effect size which was not statistically significant. This finding therefore serves to support the rationale behind using direct behavioural measures in preference to questionnaire based proxies.

Following Hitchman et al.,[19] the present study employed emotionally potent images in the negative reward condition as opposed to the boring number vigilance task utilised by Luke and colleagues in previous experiments. It was therefore deemed particularly important to have a gauge of whether individuals who were more reactive to negative emotive content would be more averse to these images, and hence avoid the negative reward condition more frequently. Curiously, however, a medium sized *negative* correlation was found between the emotional reactivity scores of participants and their performance at the non-intentional precognition task. This finding is counter to the experimental hypothesis, as well as previous research[19,28] and we are not aware of a logical explanation for why this may have occurred in the present study. To better understand this relationship, it may be worthwhile to continue to monitor this variable as a potential covariate of performance in psi tasks with emotive contingent outcome tasks.

In summary, participants in this study scored more hits at a non-intentional precognition task than the MCE, but their level of outperformance just failed to reach a statistically significant level. A meta-analysis considering this study together with the 6 aforementioned Luke and colleagues and Hitchman and colleagues studies suggests that this paradigm continues to present significant evidence of tacit psi, Stouffer $Z = 3.66$, $p = .0001$, mean $ESr = .20$. A larger effect size was found in this study than reported by Hitchman et al.,[11] suggesting that the methodological adjustments implemented here may have gone some way towards achieving their desired outcomes. In particular, the use of mirrored images for stimuli in the tacit psi task was effective in homogenising the response options, theoretically allowing a greater scope for extrasensory biases to influence behavioural choices. This did, however, come at the expense of statistical power, as a choice from four images was necessarily collapsed to a binary choice scenario. Future

studies may wish to attempt to identify images which could be rotated through 90, 180 and 270 degrees in order to yield stimulus sets which depict authentic scenes but maintain the statistical advantages associated with having 4 response options. The contingent reward system employed within the present study represents another development of the paradigm, as participants were essentially able to self-select their own outcome task, viewing more images which they had pre-rated as preferable the better they performed at the tacit precognition task.

Curiously, participants' hits rates were found to be negatively correlated with their emotional reactivity. In addition to continuing to monitoring the role of this factor in non-intentional precognition studies making use of emotive contingent outcome tasks, it may be of interest to future researchers to assess the role of participants' underlying sensitivities to rewards and punishments. Individual differences in these variables may be useful in differentiating between participants who merely seek to avoid being punished and those who strive to achieve very high hit rates. Moreover, it is possible that participants in future studies could be further incentivised to achieve higher levels of performance in the non-intentional psi task if the criteria for avoiding a negative outcome were more challenging. At present, participants avoid all negative images merely by ensuring they do not score below the MCE. The design could be easily adjusted such that participants must score higher in order to avoid being punished, which could in turn increase overall hit rates. If applied thoughtfully, these modifications may help further improve an experimental paradigm which remains encouraging and worthy of further pursuit.

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