# A Sideways Look at the Neurobiology of Psi: Precognition and Circadian Rhythms

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**ABSTRACT**

Theory suggests that the chemicals made in the pineal gland follow a circadian rhythm and may be important in the processes of sleeping and dreaming, and it is speculated that these chemicals may also be important in the mediation of spontaneous mystical and visionary states, and in the mediation of psi (clairvoyance, telepathy, precognition or psychokinesis). The abundance of one such chemical, melatonin, is known to fluctuate cyclically, nevertheless very little research has been conducted to test whether peak melatonin periods (3am) are more conducive to psi than lower melatonin periods (e.g., 8am). The present study tested for precognition among ten participants across ten nights each, both during the night and first thing in the morning. Two types of test were used on each occasion: A 10-trial forced-choice precognition task and a single-trial free-recall dream precognition task, and it was predicted that dream psi performance would be better than forced-choice psi, particularly in the middle of the night when compared to performance in the morning. A number of other factors were also monitored for the possible relationship to psi performance, including belief in psi, belief in the paranormal and openness to experience. Both precognition task overall sample scores were non-significant, but dream precognition performance was significantly better at 3am than 8am, whereas the reverse was true for forced choice task, as predicted, although the interaction was not significant. None of the personality measures were found to correlate with precognition task performance, as might be expected with such a small sample size. The findings point to the importance of exploring circadian cycles in the research of psi, and offer tentative support for the psi-pineal gland hypothesis.

**Key Words:** dream precognition, melatonin, pineal, DMT, circadian rhythms

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## Introduction

Research has shown that 33-68% of spontaneous cases of extra sensory perception (ESP, i.e. telepathy, clairvoyance or precognition) are reported to occur during dreams (Van de Castle, 1977) and experimental free-response dream ESP research has tended to produce positive results overall (for a review see Sherwood & Roe, 2003). Much of the experimental dream ESP research was conducted at the laboratory of the Maimonides Medical Centre in Brooklyn during the 1960s and 1970s (Ullman, Kripnner & Vaughan, 2002), although once the dream ESP programme there ended most of the following research tended to use the more economical method of having participants dream at home and then come to the lab to take part in the judging phase of the experiment, with almost as good results (Sherwood & Roe, 2003). Typically in this later research the participant's dream would be compared to four images or video clips and the one most similar to the dream content would be selected as the predicted target, or sometimes all the images/clips would be ranked, and if the participant predicted the correct target or ranked it higher than the others then the trial would be considered a hit.

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In some studies participants would share their dreams of the previous night and take part in the target prediction process as a group (e.g., Roe, Sherwood, Luke & Farrell, 2002). Overall the participants tended to select the actual target significantly more often than chance, providing support in favour of the hypothesis that psi (an umbrella term for ESP or psychokinesis) can manifest through dreams (Sherwood & Roe, 2003).

Most of this fairly extensive dream ESP research, however, has tended to overlook neurobiological and neurochemical factors, despite speculations by Roney-Dougal (1989, 2001) that dream ESP is mediated by the pineal gland neurochemicals supposedly responsible for sleeping and dreaming: melatonin and N,N-dimethyltryptamine (DMT) (see Callaway, 1988, Luke & Friedman, 2010). Despite Persinger (1988, 1993) originally speculating that it is, researchers suggest that melatonin is *not* directly implicated in psi effects (e.g., Roney-Dougal, 2001), most likely due to its inactivity as a psychoactive substance (see Shulgin & Shulgin, 1997) and lack of visionary qualities. However, melatonin's life cycle in the brain may be linked to the production of the highly potent vision-inducing endogenous psychedelic, DMT, a substance which is considered as a more likely neurobiological paranormal mediator (e.g., Hill & Persinger, 2003; Roney-Dougal, 2001; Strassman, 2001) due to its more profound psychoactive properties. Made in the pineal gland, melatonin follows a relatively well understood circadian cycle (Stehle *et al*., 2011) and it is converted from serotonin at night, in much the same way that DMT supposedly is (see Luke & Friedman, 2010; Strassman, 2001), and so presumably DMT follows the same circadian cycle as melatonin in the brain, although the evidence for this is not as yet forthcoming (but for a discussion see Barker, McIlhiney & Strassman, 2012). Therefore if psi can be demonstrated to fluctuate with circadian rhythms, particularly melatonin levels, then this may offer indirect support for the psi-DMT hypothesis, though such evidence would be merely supportive not conclusive, of course.

Although there is a dearth of experimental research on the subject, support for the psi-DMT hypothesis comes from survey research and ethnographic accounts of paranormal experiences from those who have ingested DMT (see Luke, 2008, 2011b; Luke & Kittenis, 2005). However, some tentative experimental support for the notion that ESP performance is related to circadian pineal gland activity is evident from research that demonstrated that prepubescent children score better on forced-choice ESP tests at 3am, when the pineal gland's nocturnal chemicals (melatonin, etc) are at peak concentrations in the brain, rather than at 9pm when they are typically lower by a magnitude of 5-10 times (Satyanarayana, Rao, & Vijayalakshmi, 1993). Aside from the predominance of psi experiences that occur in dreams (Van de Castle, 1977), experiences of crisis apparitions and of a sensed presence are also more common during the period between 2am and 4am (Persinger, 1993, 2001) than at other times, as supported by folk concepts of this time (3-4am) as "the witching hour" and "the graveyard shift", and coinciding with the approximate 3am peak melatonin period, which gives good reason to explore the notion that DMT levels coincide as well.

Use of DMT in its pure form is extremely fast acting and short lived, so experiences with it are brief and intense and don't necessarily lend themselves well to the reporting of psi *per se*, nevertheless there is some promising phenomological research emerging from a plant-based DMT-containing Amazonian jungle decoction called *ayahuasca* that is receiving growing academic attention. Used widely in the Amazon basin and across much of South America, ayahuasca, which means "the vine of the spirits" in Quechua, is usually a combination of at least two plants, one of which contains β-carbolines / MAO inhibitors (e.g., harmala, harmaline – once called telepathine) – such as the ayahuasca vine (*Banisteriopsis caapi*) – and the other of which contains DMT, such as the chacruna bush (*Psychotria viridis*) (Shanon, 2002). Both β-carbolines / MAO inhibitors (e.g., pinoline) and DMT are also thought to be made in the pineal gland (Strassman, 2001) and have been considered to regulate dreams in much the same way that the melatonin made in the pineal gland regulates sleep (Callaway, 1988), indicating that ayahuasca potentially mimics the nocturnal chemistry of the pineal gland, whereas the pineal gland may make *endohuasca* – ayahuasca from within (Callaway, 1995).

In this sense, whereas the pineal supposedly mediates sleeping dream experiences (via melatonin and DMT,

respectively), ayahuasca produces a kind of waking dream experience (Luke, 2012). Beyond theoretical speculation, however, there is little evidence to support the hypothesis that dreams are mediated by DMT, other than the endogenous nature of DMT, its visionary qualities (Callaway, 1988) and its possible pineal gland genesis (Strassman, 2001). Furthermore, although both states are visionary and lend themselves well to paranormal experiences (though not necessarily genuine paranormal phenomena – see Luke 2008 for a review), dreams differ from DMT/ayahuasca experiences in distinct ways, such that dreams do not generally involve colourful geometric percepts, although hypnogogia does (Mavromatis, 1987). Furthermore, unlike in (non-lucid) dreams, rational thinking concerning supposedly impossible phenomena (e.g., discarnate beings) is actually likely under the influence of ayahuasca, although such events are also typically hyperreal (Luke, 2011b). Currently, however, a thorough comparative phenomenological analysis of the DMT and dream experience is lacking.

Given the difficulty in measuring and researching DMT directly (Barker, McIlhiney & Strassman, 2012), the current study indirectly investigates Roney-Dougal's (2001) DMT-pineal-psi aggregate hypothesis further by seeking to detect differences in dream ESP performance between 3am and 8am, when melatonin (and perhaps DMT) levels differ considerably, and it is predicted that dream precognition scores will be better at 3am rather than 8am. Free-response testing methods (whereby the targets are unknown to the participant and relatively unlimited in form, so guesses are open-ended) are thought to be more conducive than forced-choice tasks (where there are a fixed number of possible target identities, as with zener cards) to the increased mental imagery of altered states of consciousness (ASC), such as dreams, and are the method of choice in experimental psi-ASC research (Luke, 2011a). For this reason it is expected that the neurochemical factors hypothetically related to dream precognition (such as increased vividness or imagery of the dream) will not necessarily be advantageous to non-dream precognition and so a forced choice task unrelated to the participant's dream is expected to be less successful in eliciting a precognition effect than a free-response dream task at 3am. Furthermore, in line with previous precognition research (Luke, Delanoy & Sherwood, 2008; Luke & Morin, 2009: Luke, Roe & Davison, 2008) positive predictors of precognition task success are sought, in an exploratory fashion, from various individual differences measures: sheep-goat belief in psi, paranormal belief, and openness to experience.

H1 – Free-response dream precognition scores will be significantly better than chance.

H2 – Dream precognition test scores will be significantly higher at 3am than at 8am.

H3 – Forced-choice precognition scores will be significantly better than chance expectation.

H4 – There will be a significant interaction between time of day and psi task, with free-response task performance exceeding that of forced-choice task performance specifically at 3am, but not 8am.

## Methods

### *Design*

An experimental 2x2 (psi task x time of day) repeated-measures design, measuring performance on both a free-response and forced choice precognition task in the middle of the night (3am) and in the morning (8am).

### *Participants*

Selected from a pool of volunteers on the basis of reported dream recall ability, lack of difficulty sleeping again once woken, and lack of concern about being woken during the night, 12 participants took part in 10 experimental sessions (a session is both a 3am and 8am trial on the same morning) and 1 pilot session and were paid £10 per session (£110 total per participant for completion of the study). It was predetermined that only 10 participants were required but two extra were recruited to cover likely attrition, and in the end only 10 participants completed all trials, and only data from these participants were used in the analysis. All participants were students on a parapsychology course at the University of Greenwich, and of the final 10 participants completing (age, mean = 24.5, SD = 3.3) only one was male, however the imbalanced gender ratio represents the actual ratio of the psychology student body at this institution, and in any case, beyond childhood, females consistently recall more dreams than

males (Schredl & Reinhard, 2008), which is advantageous in this study.

## Materials

*Participant Information Form* – A simple demographic questionnaire with items relating to age, gender, and a sheep-goat scale (belief in psi), comprising four true/false items (score range 0-4) concerning belief in psi (Palmer, 1972), such as "I believe that I have had a psychic experience."

*Anomalous Experience Inventory* (AEI; Kumar, Pekala, & Gallagher, 1994) – Includes five subscales measuring anomalous/paranormal abilities, belief, experiences and fear, and drug use. Only the paranormal belief subscale was used in the current study and comprises 11 binary agree/disagree statements (score range 0-11) relating to the respondent's beliefs, such as "I believe that many paranormal occurrences are real." The AEI has been shown to have reasonable internal reliability (KR-20 = .77 for the Anomalous/Paranormal Beliefs subscale) and a replicable, moderate degree of concurrent validity (coefficients ranging from .33 to .77) with other paranormal belief scales (Gallagher, Kumar, & Pekala, 1994; Thalbourne, 2001).

*Openness to Experience Questionnaire* (Goldberg, 1999) – Includes ten negatively and ten positively worded statements relating to the 'Big-Five' personality trait of openness to experience and scored on a scale of 1-5 ranging from "very inaccurate" to "very accurate" (score range 20-100).

*Free-response precognition materials* – A target pool of 22x4 dynamic one-minute video clips originally developed for and used in previous dream ESP research (Roe, Sherwood, Luke & Farrell, 2002). The clips were obtained from commercial films covering a range of genres, chosen on the basis of their ability to engage the viewer, typically with relatively strong emotional content (either negative or positive). Each of the four clips comprising each one of the 20 sets were selected on the basis that they are thematically orthogonal to the other clips in the set to allow differentiation during judgement. Each of the 22 sets of 4 clips was assigned to one of the 20 experimental trials and 2 pilot trials. Each of the four clips in a set were ordered from A to D.

*Forced-choice precognition software* – Designed and programmed by the principal investigator (DL) this software was written in Visual Basic (v.6) and is an adaptation of a software programme used in previous precognition research (Luke, Delanoy & Sherwood, 2008; Luke & Morin, 2009; Luke, Roe & Davison, 2008). The programme presents 10 pools of four randomly arranged fractal images in each of the four quarters of the monitor screen (figure 1), which, once the participant has chosen one of the images as the target, the programme then independently selects a random target number (corresponding to the images) from one to four. Both processes are done by pseudo-random number generator using the RND function in the Visual Basic program, which is seeded by the timer, and both processes have been shown to be acceptably random (Luke, 2007; Luke, Delanoy & Sherwood, 2008). The entire 40 fractal images for this program were selected previously via a standardisation procedure from a pool of 72 such images, which had themselves been created randomly (using the freeware fractal generator program Fractalus v4.02). Images had been presented to five independent judges via a presentation program written in Visual Basic, and standardised using a similar rating process to that used in the creation of the 'International Affective Picture System' (IAPS; Lang & Greenwald, 1993). Images had then been grouped together into the ten best pools of four images based upon the homogeneity of their individual scores on scales of pleasantness and arousal (Luke, 2007), however the images themselves remain diverse in terms of colour and shape. The task has good validity as a one-off test of non-intentional precognition as demonstrated by a series of five independent studies (Hitchman, Roe & Sherwood, 2012; Luke, Delanoy & Sherwood, 2008; Luke & Morin, 2009; Luke, Roe & Davison, 2008) where it has been shown to be effective in eliciting above chance scoring, indicative of precognition, although in these studies participants were naïve to the task and received a contingent reward based on their performance – factors which are not utilised in the current study because of repeated testing.

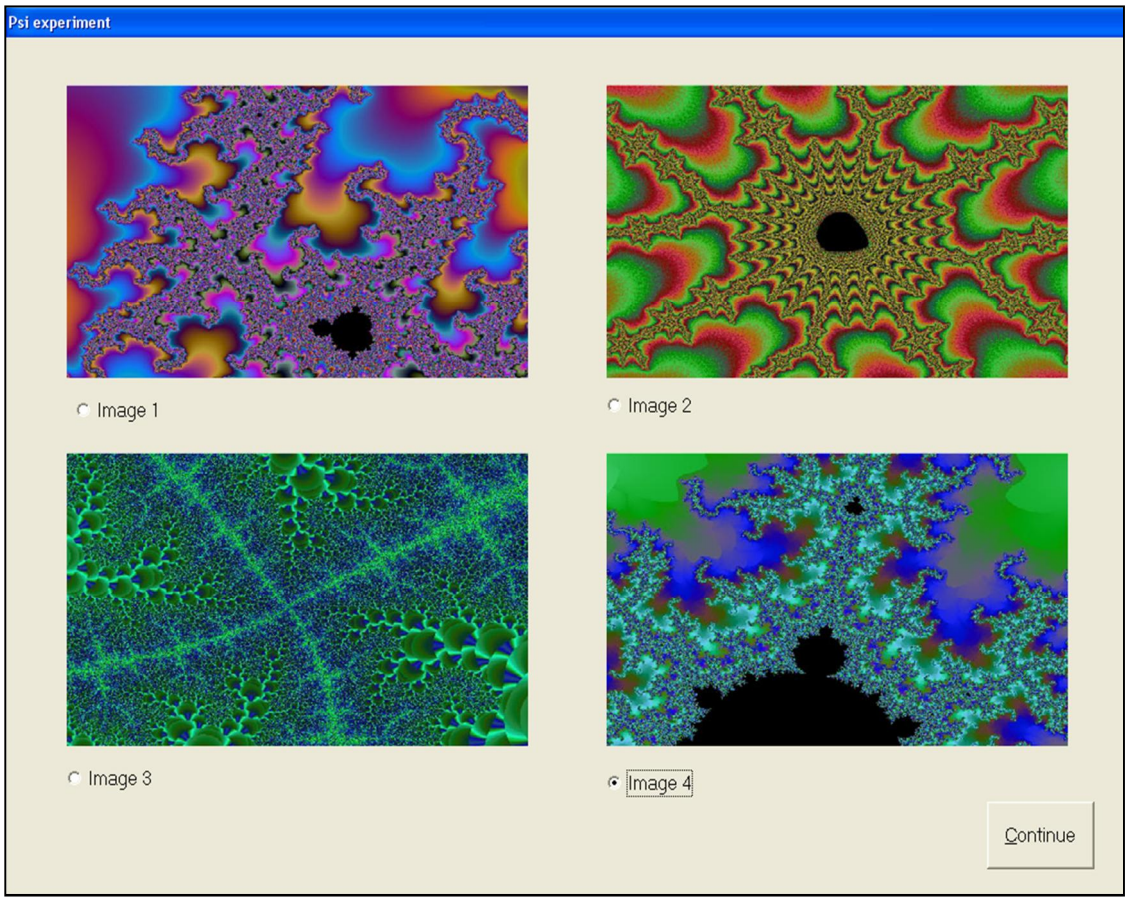


**Figure 1.** Example of fractal image selection screen for the forced choice precognition task

## Procedure

This study was given full ethical approval by the University Research Ethics Committee and adhered to the codes of practice stipulated by the British Psychological Society (2009), including informed consent. The ten experimental sessions were spread over a two-month period (June-July, 2010) depending on each participant's availability, with at least one night off in between experimental nights to avoid fatigue through any inadvertent sleep loss.

Participants were trained in dream recall techniques and the relevant experimental procedures at the university, and completed the various questionnaires. The requisite film clips were supplied in advance, although it was strongly emphasised that participants should not watch the clips until they were required to do so, and all participants reported that this was the case at debriefing (in any event participants could not anticipate the actual targets even if they had watched the clips). A pilot session was run to allow participants and experimenters the opportunity to practice the protocol under experimental conditions. The data from the pilot session was not used in the final analysis. There were four experimenters (KZ, OR, IT, JP) who between them collected the data from the other participants, and simultaneously participated in the study, although no experimenter collected their own data. On experimental nights participants slept at home and would set their alarm, and their intention to dream the target clip for the free-response dream precognition task, just prior to going to sleep (sometime before midnight). At 3am and 8am they performed the experimental tasks, waking up as necessary, either by alarm, or, rarely, the experimenter calling them by phone if they had not woken up and texted or emailed the experimenter by ten minutes past the hour.

Upon awaking, participants immediately recorded (written and then typed, or just typed directly onto word processing software) the mentation of any dreams they had just had. They then alerted the experimenter by text that they were awake. The free-recall dream precognition task was then attempted first. Participants watched

each of the four one-minute video clips for that trial in turn, and ranked each clip (1st, 2nd, 3rd, or 4th) with a unique number from 1 to 4 according to which most closely resembled their dream. This data was appended to their dream mentation document and emailed to the experimenter (at their own home) immediately upon completion. Once the participant had emailed the researcher with their selection, then the actual target was selected by the experimenter using a true random number generator (the *random.org* online true-RNG), and the participant was given feedback by email as to the target clip once they had completed the other precognition task.

The participants then attempted the forced-choice precognition task on their computer and emailed the experimenter with the output (a list of unidentifiable numbers relating to a number of variables, incomprehensible to the participant without a key). For each of the ten trials required on each occasion the task required the participant to close their eyes and try and visualise the unknown target fractal image, they were then presented with four randomly arranged fractal images, and they then had to select which one out of four possible images they thought was the target. This process was repeated for each of the ten trials. Images were fractal patterns, displayed in a random arrangement from a unique pool of four images for each of the ten trials. Once the participant had made their target selection the computer randomly selected one of the four fractal images as the (*post factum*) precognition target. Thus, randomised selection of the actual target occurred each time an image was selected. No feedback was given to the participant on target identification success until all ten predicted targets were selected by the participant and the data had been sent to the experimenter, to prevent the detection of any inadvertent patterns in the actual randomised target selection performed by the computer. In total, recording of the dream mentation and completing both experimental tasks (1 trial of free response dream precognition and 10 trials of forced choice precognition) took between 15-30 minutes to complete and send to the experimenter. Once they had completed the study participants were invited back to the university and debriefed face-to-face.

## Results

In the following analyses, where possible both direct hit and sum of rank scores are given, although hypotheses are tested in terms of um of ranks, whenever possible, as this calculation gives a more sensitive gauge of task success.

**Table 1.** frequency distribution of target ranks at 3am & 8am

| Rank | Frequency 3am | Frequency 8am | Total Frequency | Total % |
|---|---|---|---|---|
| 1 | 23 | 20 | 43 | 21.5 |
| 2 | 36 | 23 | 59 | 29.5 |
| 3 | 23 | 29 | 52 | 26.0 |
| 4 | 18 | 28 | 46 | 23.0 |
| Total *n* | **100** | **100** | **200** | |

Exploring free response dream psi scoring, Table 1 shows that although there was an overall negative direct hit rate of 21.5% (compared to MCE of 25%) the spread of the ranks is not especially negative, with the pre-specified sum of ranks analysis (participant mean of 50.1 compared to MCE = 50) giving a very slightly negative but non-significant psi score (a rank of 1 = direct hit, so the lower the rank the better the score) compared to chance expectation, $t$ (19) = 0.07, $p$ = .95 two-tailed, $r$ = -.015, thereby failing to support H1. Comparing psi scores at 3am to 8am, however, there was a significant tendency for better psi scoring at 3am (mean trial sum of ranks = 2.36) than at 8am (mean trial sum of ranks = 2.65) as hypothesised $t$ (9) = -2.54, $p$ = .031 two-tailed, $r$ = .42, thereby supporting the primary hypothesis of this study, H2.

Exploring the data further, when only those trials in which the participant actually recalled their dreams are explored a slightly different trend emerges. Table 2 shows that the number of dreams recalled was quite different between the two time points with only 65% dream recall at 3am and 78% at 8am.

Additionally, psi scores actually differ more between the two time points than when all the data (for recalled and non-recalled dreams combined) is considered, giving a 24.6% hit rate and a mean trial sum of ranks of 2.23 at 3am, and a 21.8% hit rate and a mean sum of ranks of 2.64 at 8am, with the difference between the groups on the sum of ranks being significant, $t$ (141) = -2.27, $p$ = .025 two-tailed, $r$ = .19, though non-significant for direct hits, $t$(141) = .396, $p$ = .69 two-tailed, $r$ = .03. Indeed, taken as a whole, the sum of ranks for all trials with dream recall (mean = 2.45) becomes slightly positive, though not significantly so, $t$(141) = -.50, $p$ = .62 two-tailed, $r$ = .20.

**Table 2.** frequency distribution of target ranks at 3am & 8am for those recalling dreams

| Rank | Frequency 3am | % 3am | Frequency 8am | % 8am | Total Frequency | Total % |
|---|---|---|---|---|---|---|
| 1 | 16 | 24.6 | 17 | 21.8 | 33 | 23.1 |
| 2 | 28 | 43.1 | 18 | 23.1 | 46 | 32.2 |
| 3 | 11 | 16.9 | 19 | 24.4 | 30 | 21.0 |
| 4 | 10 | 15.4 | 24 | 30.8 | 34 | 23.8 |
| Total *n* | **65** | | **78** | | **143** | |

An overall comparison of direct hits shows that participants scored far more direct hits when they could recall their dreams (mean hits 23.1%, $n$ = 143) compared to when they could not (mean hits 17.5%, $n$ = 57) although this difference was not significant, $t$ (198) = -.857, $p$ = .39 two-tailed, $r$ = .06, furthermore the difference in mean trial sum of ranks for trials with dream recall (2.45) compared to without dream recall (2.63), was also better but was not significant $t$ (198) = 1.06, $p$ = .29 two-tailed, $r$ = .07.

Of note, dream recall length (only for trials in which a dream was recalled) was significantly longer at 8am (mean = 101.4 words) compared to 3am (mean = 53.4 words), $t$ (97.8) = 3.71, $p$ = .001 two-tailed, although there was no correlation between dream recall length and rank score $r_s$ (143)= .02, $p$ = .82 two-tailed.

Furthermore, the difference between the mean number of words recalled per dream (when a dream was recalled) was slightly lower for direct hits (mean = 71.0, n = 33) compared to misses (mean = 82.2, $n$ = 110), although this was not significant $t$(141) = .65, $p$ = .51, two-tailed.

With regard to the forced-choice precognition task, contrary to H3, overall scores (mean participant score = 47.9) were below mean chance expectation (MCE = 50), although not significantly so, $t$ (9) = -1.51, $p$ = .16 two-tailed, $r$ = .45. Comparing forced-choice precognition performance (MCE = 25) at the two time points, 3am performance (mean participant score = 21.3) was found to be worse that at 8am (mean participant score = 26.6), the difference being significant, $t$ (9) = -4.08, $p$ = .003 two-tailed, $r$ = .81.

Combining tasks and time points, Figure 2 shows a clear cross over of performance on the tasks, such that free-response performance (shown as mean direct hits for all sessions) is better at 3am but then declines at 8am, whereas the opposite is apparent for the forced choice task (shown on a comparable scale of mean direct hits per session), as predicted. However a 2x2 repeated measures ANOVA gives a non significant interaction effect of time of testing by precognition task, $F$ (1, 9) = 2.95, $p$ = .12, thereby failing to support H4. Figure 2 also shows mean chance expectation for both tasks (it being the same for both with these measures) as a horizontal line.

Exploring how individual differences relate to precognition task performance (Table 3), it can be seen that none of the individual measures correlate with scores in either task. Finally, exploring possible fatigue effects, mean participant scores per session (for both 3am and 8am) were correlated with session number to see if task scores declined over time, Pearson correlations indicate that if anything there was a trend towards improved task score as time progressed across the study, although all these correlations (with a low n = 10) are non significant, for the forced choice task, $r$ = .07, $p$ = .85; and free-response task, sum of ranks, $r$ = .26, $p$ = .48; direct hits $r$ = .41, $p$ = .24.

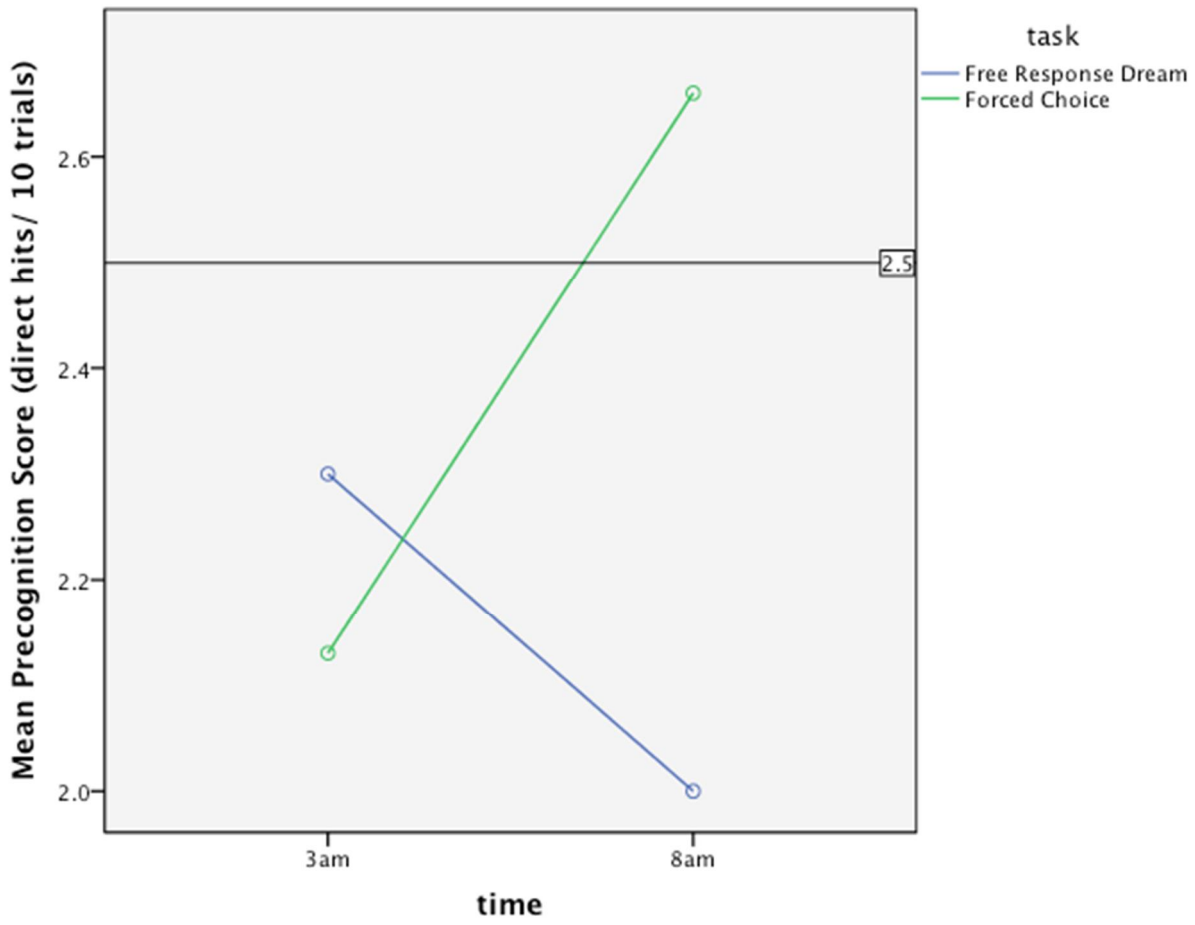


**Figure 2.** Interaction of precognition test scores across test time and precognition task

**Table 3.** Correlations between participants overall psi scores and various individual difference measures

| | Free-recall dream precognition (sum of ranks) | | Forced-choice precognition | | |
|---|---|---|---|---|---|
| Measure | Correlation coefficient ($r_s$ or $r$*) | Exact p value (2-tail) | Correlation coefficient ($r_s$ or $r$*) | Exact p value (2-tail) | N |
| Sheep-goat | .003 | .99 | .08 | .82 | 10 |
| Paranormal Belief | -.16 | .65 | -.11 | .75 | 10 |
| Openness to experience* | -.35 | .32 | .11 | .75 | 10 |

## Discussion

Three of the four main hypotheses were not supported. Overall psi scoring in both tasks were in the opposite direction to that predicted, although virtually at chance in one task, and neither of them were significant. However, the primary hypothesis was supported and psi scoring at 3am was significantly greater than at 8am lending some support to the notion that precognition performance may follow a circadian rhythm, dependent upon the type of measurement used. As predicted forced choice precognition task performance was worse than free-response performance at 3am, although the interaction between time and task was not significant. Caution is raised, however, over the direct comparison of the two tasks as, for one thing, the free response data is based on 20 trials per participant whereas the forced choice data is in units of 200 trials per participant – a possible case of comparing

apples with oranges. Indeed the free response sum of ranks data is more sensitive, and is used in preference, but does not make for a equivalent comparison to the forced choice data.

Nevertheless, the trend towards better precognition scoring at 3am with the dream task and worse precognition scoring with the forced choice task is evident, perhaps indicating that the effects of peak nocturnal neurotransmitters in altering one's state of consciousness, if indeed this is actually occurring, are not conducive to the more proscriptive forced-choice methodology. Such a relationship between state of consciousness and ESP testing methods appears to be apparent with the nascent experimental psychedelic-ESP research conducted this far (for a review see Luke, 2008), which shows practically no positive results for forced choice tasks, and some, at best, promising though not evidential findings for free-response ESP tasks. At any rate the current findings give tentative support to the pineal-psi hypothesis (Roney-Dougal, 1989, 2001), and even more tentative support to the psi-pineal-DMT hypothesis as a result, though replication of the nocturnal free-response effect is needed.

That psi scores were not significant overall may be due to a lack of a genuine psi effect. However, the most recent review (Sherwood & Roe, 2003) of experimental dream psi research indicates that while the great majority of the 21 studies since the earlier Maimonides research are positive, the three precognition studies actually fared the worst of all of them, with effect sizes ranging from $r$ = -.34 to .07 (median -.04), and the current study is well within that range ($r$ = -.015), even if the findings are non-significant. It might be that precognition, as opposed to clairvoyance or telepathy, does not lend itself well to this type of testing, or that dreaming isn't especially as conducive to precognition as it is to clairvoyance and telepathy.

Given that trials in which participants actually remembered their dreams gave a better sum of ranks score overall – compared to both non-recall trials and all the data together – and dream recall increased the psi score differences between the 3am and 8am time periods, it's tempting to suggest that had participants remembered more dreams that there would be better evidence of a precognition effect. Nevertheless few of these dream recall trends were actually significant. Furthermore, length of dream recall mentation appeared to be negatively related to precognition performance, if at all, somewhat undermining a plea to under motivated students as poor ESP experiment participants. However, longer dream recall at 8am (when dream ESP was worse) is probably due to increased sleepiness and the lack of experience in performing tasks at 3am compared to 8am, and so length of dream recall is likely to be confounded as a good precognition predictor variable. The lack of personality correlates too is somewhat disappointing, but not surprising given the small number of participants and subsequent lack of power to detect such relationships. Further research should increase the sample size to increase the power to find personality correlates, perhaps at the expense of fewer trials.

As for the forced choice precognition task, the overall number of hits on this task was found to be less than chance overall, though non-significantly. Such results point to the lack of a psi effect, at least with this method of testing. These null findings are somewhat surprising as previous research utilising similar methodology and technology has consistently found positive results, with the five previous studies combined being highly significant overall, stouffer $Z$ = 3.25, $p$ = 0.001 (Hitchman, Roe & Sherwood, 2012). What differs between those tests and this one, however, is that previous use of the fractal precognition programme was used with naïve participants, who did not know they doing a psi task, and so were tested for their *non-intentional* precognitive abilities. Furthermore, as a motivating factor, participants received a contingent reward or punishment related to their performance in those previous studies. That the current use of the fractal programme required participants to do repeated intentional tests runs counter to the original design of the task, which was engineered to test non-intentional precognition in the vein of Stanford's (e.g., 1990) *psi-mediated instrumental response* (PMIR) model of psychic activity. It might well be reasoned then that the intentional fractal target task is not a good means of eliciting precognition under controlled conditions, at least certainly not at 3am in the morning. This middle of the night challenge may also contribute to this test's failure to elicit psi, because attentional factors might be muddying

the decision-making processes required in such a task.

Finally, although there is good evidence to suggest that melatonin is generally much more abundant in the brain at 3am as compared to 8am, it would refine the research strategy to exploit individual differences and determine what each person's melatonin levels were during testing. Luckily, melatonin assays are fairly inexpensive and easily available, although assaying DMT, which is the ideal strategy, is not so simple and methods are still very much in development (Barker, McIlhiney & Strassman, 2012). As a cheaper and easier alternative, further research might look to monitor supposed melatonin-related psychological variables such as dream bizarreness (Kahan, Hays, Hirashima & Johnston, 2000).

## Conclusion

In summary, little evidence was found for psi generally, not dream precognition in particular, but support was found for the notion that dream precognition is better during peak melatonin concentration periods, rather than at other times, indirectly supporting the psi-pineal gland hypothesis. These findings also point to the importance of exploring circadian rhythms in parapsychology more generally, and they may indicate optimum periods for testing for psi and the appropriate methods for doing so.

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