Working the graveyard shift at the witching hour: Further exploration of dreams, psi and circadian rhythms

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Summary. Research and theory suggests that the chemicals made in the pineal gland (e.g., melatonin, pinoline, and possibly DMT) follow a circadian rhythm and are important in the processes of sleeping, and possibly dreaming too. These nocturnal chemicals may also be important in the mediation of spontaneous mystical and visionary states and in the mediation of psi (e.g., precognition or telepathy). One such pineal chemical, melatonin, is known to fluctuate in quantity considerably during the night. Nevertheless very little research has been conducted to test whether peak melatonin periods (e.g., 3am) are more conducive to psi than lower melatonin periods (e.g., 8am), although the two studies that have been conducted have found positive effects (Luke et al., 2012; Satyanarayana, Rao & Vijayalakshmi, 1993). The present study tested for dream precognition among 20 individual participants on ten separate nights each, with trials both during the night and first thing in the morning. A free-response dream precognition task was used, with participants viewing four clips after dreaming and ranking them for similarity to the dream. After ranking, the actual target was selected randomly by computer. Dream precognition scores were above chance, and scores were better at 3am compared to 8am, however these findings were nonsignificant. Dream bizarreness, supposedly mediated by melatonin, was actually higher at 8am than at 3am, though again, nonsignificant, however some individual differences were found that were tentatively interpreted as indicating the necessity for recruiting motivated participants, especially when recruiting from an undergraduate student population, because issues of maturity, belief and attentiveness appear important. Directions for future research are discussed.

Keywords: Dream precognition, Circadian cycles, Melatonin, DMT, Dream bizarreness

1. Introduction

Between 33-68% of spontaneous cases of so-called extrasensory perception (ESP), such as apparent telepathy, clairvoyance or precognition (all of which come under the rubric of 'psi'), are reported to occur during dreams (Van de Castle, 1977) and free-response dream ESP research has tended to produce positive results overall (for reviews see Sherwood & Roe, 2003, 2013). Such dream ESP research carefully controls for and eliminates sensory leakage between the participant and the target and effectively rules out obtaining information about the target via sensory cues, even subtly, or through the use of inference and deduction. As such, if the results are above chance the alternative explanation that non-ordinary information transfer (i.e., psi) has occurred is considered. Most of this research, however, has tended to overlook neurobiological and neurochemical factors despite speculations by Roney-Dougal (2001) that dream psi is mediated by the pineal gland neurochemical supposedly responsible for dreaming; N,N-dimethyltryptamine (DMT) (see Callaway, 1988, Luke, 2012b). Despite Persinger's (1988, 1993) original speculation to the contrary, researchers typically suggest that melatonin is not directly implicated in psi effects (e.g., Roney-Dougal, 2001), likely due to its inactivity as a psychoactive substance (Shulgin & Shulgin, 1997). However, melatonin's life cycle may be linked to the production of the highly potent vision inducing endogenous psychedelic, DMT, a substance speculated to be made in the pineal gland and which is considered as a more likely neurobiological mediator of psychic experiences (e.g., Hill & Persinger, 2003; Roney-Dougal, 2001; Strassman, 2001) due to its more profound psychoactive properties. Melatonin is known to be made in the pineal gland where it follows a relatively well understood circadian production cycle (Stehle et al., 2011) when it is converted from serotonin at night, in much the same way that DMT supposedly is (see Luke, 2012b; Strassman, 2001), and so presumably DMT follows the same circadian cycle as melatonin in the brain. 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.

Lacking support from direct experimental research, which is yet to be conducted, support for the psi-DMT hypothesis comes from survey research and ethnographic accounts of paranormal experiences from those who have ingested DMT (Luke, 2008, 2011; Luke & Kittenis, 2005). However, some indirect experimental support for the notion that ESP performance is related to circadian pineal gland activity is evident. Satyanarayana, Rao and Vijayalakshmi (1993) demonstrated that prepubescent children score better on forced-choice ESP tests at 3am, when the pineal gland's

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nocturnal chemicals (melatonin, etc.) are at peak concentrations in the brain, rather than at 9pm when they are typically lower by a factor of 5-10. Besides 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), 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.

Attempting to investigate Roney-Dougal's (2001) DMT-pineal-psi aggregate hypothesis further Luke et al. (2012) sought to initially research the possible differences in dream ESP performance between 3am and 8am, when melatonin levels differ considerably, advancing on the research conducted by Satyanarayana et al. (1993). Using a free-response dream precognition task using one-minute video clips (3 decoys, 1 target) in a participant judging design, 10 participants performed 10 trials at 3am and a further 10 trials at 8am on the same nights over a two month period around the summer solstice, resulting in significantly better dream psi performance at 3am than at 8am ($t = -2.54$, $df = 9$, $p = .031$), but with chance psi scoring overall. These findings are encouraging, but other than the timing itself there is nothing to say that melatonin or other nocturnal neurochemicals are responsible. Suggestions for improvements in the design included increasing the sample size to increase power in the detection of salient individual differences and the use of either a direct measure of melatonin fluctuations or a proxy measure (Luke et al., 2012).

One of the factors supposedly related to elevated melatonin levels is dream bizarreness, although the literature is not consistent on this point. Dawson and Encel (1993) suggest that melatonin should have no effect on dream content or bizarreness, although other researchers have informally observed increases in dream vividness following administration (e.g., Zhdanova, Lynch & Wurtman, 1997), and experimental research comparing melatonin dosing pre-sleep to a placebo condition has found an increase in dream bizarreness for the 'transformation of objects' subscale for females, though the opposite effect for males (Kahan, Hays, Hirashima, Johnston, 2000). However, there was no overall difference between the melatonin and placebo condition, and this melatonin-gender interaction may be artefactual because of the lack of correction for multiple analyses. In evaluation, however, the melatonin-dream bizarreness effect may be subtle, so the use in this study of small doses (6mg, compared to some studies using 250mg) a relatively small number of participants (22) and only one trial per condition, may have been too underpowered to detect a genuine effect anyway. Consequently, the relationship between melatonin and dream bizarreness remains unproven but is worth further exploration.

A further consideration, besides the circadian rhythm of melatonin fluctuation, is the supposed circannual rhythm in humans. Several studies have demonstrated that melatonin follows a cyclic increase in winter and a decrease in summer, linked to daylength, although other less-obvious circannual patterns have been observed (for a review see Morera & Abreu, 2006), though these contradictions to the simple daylight hours-melatonin reduction pattern may be due to different methodologies (sampling periods, sample fluid, medication and posture), and different environmental factors such as latitude and geomagnetic fluctuations (e.g., Bergiannaki, Paparrigopoulos & Stefanis, 1996) that are thought to affect the pineal gland's production of melatonin. Geomagnetic activity (GMA) has been demonstrated to be related to laboratory psi (e.g., Krippner & Persinger, 1996) and fairly reliably related to melatonin production (e.g., Burch, Reif & Yost, 2008) and has also been associated with dream bizarreness (Lipnicki, 2009) further supporting the melatonin-dream bizarreness link, albeit indirectly. A review of the relationship between geomagnetic activity and psi is overdue, however, as the relationship is inconsistent and seems to be more complex than a matter of simple overall magnitude of activity and local readings and frequency bands are likely to also be relevant (e.g., Ryan, 2008; Roney-Dougal, Ryan & Luke, 2013). The present review suggests that advancing on the previous circadian-dream psi research of Luke et al. (2012) dream bizarreness and, ideally, geomagnetic fluctuations should be monitored.

Other factors that may be relevant to the production of precognitive dreams is dream recall frequency, for both spontaneous self report (Schredl, 2009) and laboratory conditions (e.g., Robinson, 2009). The previous study to this (Luke et al., 2012) also found that dream recall length was significantly higher at 8am compared to 3am, although there was no correlation between psi score and recall. Dream recall is also positively related to the boundary thinness and openness to experience personality variables, and beyond age ten is more pronounced in females than males (Schredl & Reinhard, 2008). Self-report spontaneous precognitive dreams also correlate positively with boundary thinness and, to a lesser extent, openness to experience, although this appears to be mostly due to their relationship to dream recall, particularly for openness to experience (Schredl, 2009). The previous study (Luke et al., 2012) found a small positive correlation between openness to experience and psi score, but was nonsignificant, perhaps indicating a lack of power with just ten participants so this variable will be explored further. Previous research also shows a positive link between psi scoring and both 'sheep-goat' (belief in psi) scores and belief in the paranormal (e.g., Luke, Delanoy & Sherwood, 2008). One theory being that those proficient with psi are more likely to have psi experiences and related anomalous phenomena – the anomaly-prone personality (Simmonds-Moore, 2012) – and subsequently are more likely to believe in psi and related paranormal phenomena (Luke, 2007).

Aims

The current project aims to replicate and extend Luke et al.'s (2012) exploratory research into free-response dream precognition and the peak melatonin production period. This research will help discern whether dream recall from periods of peak melatonin production (and therefore also DMT production, according to theory) provides greater psi scores (precognition, in this case) compared to dream recall from a period in the morning of much lower melatonin production.

Hypotheses

H1 – Overall psi score will be significantly greater than chance

H2 – Psi test scores will be significantly higher at 3am than at 8am

H3 – Dreams will be more bizarre at 3am than at 8am

Further, there will be a number of exploratory hypotheses exploring psi scores in relation to individual differences (paranormal belief, experiences, ability and fear; drug use [AEI subscales], belief in psi, openness to experience, boundary thinness, lucid dream experience, OBEs) and other factors relating to the dream experience such as recall, length of recall, bizarreness and vividness. Geomagnetic fluctuations will be considered in a later paper.

2. Method

2.1. Design

This study utilised an experimental repeated-measures design, measuring performance on a free-response dream psi task in the middle of the night (3am) and in the morning (8am) the same night. After one pilot session (both a 3am & 8am trial) – not used in the analysis – all participants performed ten dream psi trials at 3am and ten at 8am.

2.2. Participants

Selected from a pool of volunteers on a parapsychology course at the University of Greenwich, 20 participants (18 female, 2 male; age range 20-35, mean age 23.4) were recruited. 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. Volunteers who responded to an advert for a dream-psi study were offered £160 for completion of the study, including training. The following inclusion criteria, based on self reports, were met: Average recall of at least three dreams per week, regular nocturnal sleep patterns, easily able to go back to sleep if disturbed in the night and prepared to wake up in the night to perform the experiment. Exclusion criteria were also successfully implemented for shift work and the current use of cannabis, which is known to reduce dream recall (e.g., Russo, Guy & Robson, 2009). Participants were also required to have a reliable internet connection and use of a dedicated web-enabled computer for the study's duration.

To ensure that participants were suitable for the study and that the sleep disruption would not adversely affect them, all participants were screened for sleep quality using the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988), a 19-item self-report measure. A PSQI global score >5 is considered to be suggestive of significant sleep disturbance (Buysse et al., 1988). Only one volunteer had a significantly high PSQI score (11 out of possible range of 0 to 21) and was interviewed. It was agreed that she could take part but that she would be closely monitored throughout and any deterioration in her sleep quality would lead to her discontinuation of the study, however no sleep disturbance was evident and she completed the study without complaint. For the remaining participants the mean PSQI score = 4.0 (SD = 1.6).

2.3. Apparatus and Materials

Participant Information Form – A simple demographic questionnaire with items relating to age and gender; a 'sheep-goat' scale recording belief in psi consisting of four true/false items (Palmer, 1972) and questions related to the participants personal experience and estimated lifetime occurrence of precognitive dreams, sleep paralysis, lucid dreaming and out of body experiences (OBEs).

Free-Response precognition materials. A target pool of 20x4 dynamic one-minute video clips (plus a further 2x4 for the pilot sessions) used in previous dream ESP research (e.g., Roe, Sherwood, Luke & Farrell, 2002). Pools of four clips are selected so as to be maximally different to each other, and free from disturbing material. Target selection is made post-judging by a computerised randomisation procedure.

Dream Bizarreness Questionnaire. An adaptation of the Kahan, Hays, Hirashima and Johnston (2000) self-report dream bizarreness questionnaire based on Hunt et al.'s (1982) dream bizarreness dimensions for independent judges. A 14-item self rated measure of dream bizarreness measuring major aspects of dream bizarreness such as plot discontinuity, hallucinations of content, hallucinations of exotic setting, bizarre personification and transformations of form. Dream bizarreness was scored on a scale of 1-7 and the questionnaire was divided into five subscales looking at dream characters, objects, the location and setting, events, dream plot and dream vividness. Characters, objects and location/setting used the same scoring, i.e.,1 = stayed the same, 7 = transformed into other things, 1 = ordinary or 7 = bizarre, 1 = familiar or 7 = unfamiliar, whereas events in the dream were scored as 1 = ordinary or 7 = impossible, dream plot was scored as 1 = coherent, 7 = fragmented and dream vividness was scored as 1 = dull, 7 = colourful, 1= indistinct/bland, 7 = distinct/striking and 1 = lack of feeling, 7 = intense feeling. Of the 14 items, 11 relate to dream bizarreness and 3 to vividness, giving possible score ranges of 11-77 and 3-21 respectively.

Anomalous Experience Inventory (AEI; Kumar, Pekala, & Gallagher, 1994) – Includes five subscales measuring anomalous/paranormal belief ("I believe I have great power and energy within me waiting to be awakened"), experiences ("I have had a mystical experience"), ability ("I can control my own dreams"), fear ("I'm afraid of having an altered-state experience") and drug use ("I have tried mind-altering substances"). The AEI has 70 items and responses are recorded as either true or false. Score ranges are 0-29 (experiences), 0-11 (belief), 0-17 (ability), 0-6 (fear), and 0-7 (drug use).

Openness to Experience Questionnaire (Goldberg, 1999) – Includes ten negatively (e.g., "I am not interested in abstract ideas") and ten positively (e.g., "I enjoy hearing new ideas") 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", providing a score range of 20-100.

Short-form Hartmann Boundary Questionnaire (BQ18: Hartmann, Harrison, & Zborowski, 2001; Kunzendorf, Hartmann, Cohen, & Cutler, 1997) - Includes eighteen statements measuring individual differences in the "thinness" of mental boundaries which are presumed to separate the contents of consciousness. Responses are scored on a scale of 0 – 4 ranging from "not at all true of me" to "very true of me". Typical statements include: "In my dreams, people sometimes merge into each other or become other people" and "There is a place for everything, and everything should be in its place". Possible scores range from 0 to 72.

2.4. Procedure

Participants were trained in the relevant procedure at the university and completed the various questionnaires. The

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

Target Rank	Frequency 3am	% 3am	Frequency 8am	% 8am	Total Frequency	Total %
1	54	27.0	53	26.5	107	26.8
2	45	22.5	51	25.5	96	24.0
3	59	29.5	48	24.0	107	26.8
4	42	21.0	48	24.0	90	22.5
Total n	200		200		400	

relevant preformatted response documents were supplied for each trial in advance along with the requisite film clips, 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. On experimental nights participants slept at home and would set their intention to dream the target clip and would send this intention by email, in a uniquely worded way each time, to the researcher before each trial, thereby also alerting the allocated researcher that the participant had not forgotten they were experimenting this night. At 3am and the following 8am they performed the experimental tasks, waking up as necessary, either by alarm, or, rarely, the experimenter calling them by phone.

Upon awaking, participants immediately recorded (written down and/or word processed) the mentation of any dreams they had just had. They then watched the selection of four one minute video clips for that session, rated each clip with a unique number from 1 to 4 according to which most closely resembled their dream (1 = most alike) and answered all the bizarreness and vividness questions relating to their dream. Each pool of 4 clips was unique for each trial (20 unique pools in all) and so no clips were repeated across trials for any participant. All data was word processed into one preformatted document and emailed to the experimenter upon completion.

Once the participant had emailed the researcher with their selection, then the actual target was selected by random number generator by the experimenter – ensuring the prevention of sensory leakage concerning the target prior to participant ranking – and the participant was given feedback by email as to the target clip. In total, recording of the dream mentation and completing the experimental tasks took between 10-25 minutes to complete per trial. Trials were conducted at 3am and 8am on the same night over ten experimental nights (plus one pilot). Experimental sessions were spread over a two-month period around the winter solstice and there was always at least one night off in between experimental nights so that participants would not suffer adversely from fatigue or minor sleep loss. Any participants experiencing significant sleep loss and tiredness were to be withdrawn, though none occurred. Participants were invited back to the university and debriefed face-to-face once they had completed the study.

3. Results

Exploring psi scoring Table 1 shows that although there was an overall positive direct target hit rate of 26.8% (compared to mean chance expectation of 25%) the spread of the ranks is not particularly positive, with the pre-specified sum of ranks analysis (participant mean of 49 compared to MCE = 50) giving a positive but non-significant psi score (a rank of 1 = direct hit, so the lower the rank the better the score) compared to chance expectation, $Z = .89$, $p = .37$ two-tailed, $r = .04$, thereby failing to support H1. Comparing psi scores at 3am to 8am, psi scoring was higher at 3am (sum of ranks = 24.1) than at 8am (sum of ranks = 24.75) as hypothesised, although the difference between the groups is non-significant $t(19) = -.57$, $p = .58$ two-tailed, thereby failing to support 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 although the number of dreams recalled was about the same overall (mean 67%) for the two time points, psi scores actually differ, with a 21.8% hit rate and a mean sum of ranks of 2.49 at 3am, and a 29.6% hit rate and a mean sum of ranks of 2.40 at 8am, nevertheless the difference between the groups on the sum of ranks is non-significant, $t(266) = -.66$, $p = .51$ two-tailed, and similarly for direct hits, $t(266) = -1.46$, $p = .14$ two-tailed.

Exploring the interaction (Table 3) between time period (3am & 8am) and dream recall (yes or no) a 2x2 ANOVA further reveals no main effect of dream recall, $F(1, 396) = .027$, $p = .87$, and although suggestive of an enhanced dream psi from 8am to 3am compared to the opposite enhanced

Table 2. Frequency distribution of target ranks for those recalling dreams

Target Rank	Frequency 3am	% 3am	Frequency 8am	% 8am	Total Frequency	Total %
1	29	21.8	40	29.6	69	25.7
2	37	27.8	32	23.7	69	25.7
3	40	30.1	32	23.7	72	26.9
4	27	20.3	31	23.0	58	21.6
Total n	133		135		268	

Table 3. Comparison of mean target ranks across time and dream recall

Time	*Dream recall*	*Mean ± SD*	*n*
3am	No dream	2.36 ± 1.29	67
	Dream	2.49 ± 1.05	133
	Total	2.44 ± 1.10	200
8am	No dream	2.57 ± 1.09	65
	Dream	2.40 ± 1.14	135
	Total	2.46 ± 1.12	200
All	No dream	2.46 ± 1.15	132
	Dream	2.44 ± 1.09	268
	Total	2.45 ± 1.11	400

non-dream psi from 3am to 8am, the interaction is also non-significant, F (1, 396) = .027, p = .21.

A comparison of direct hits shows that participants scored more direct hits when they could not recall their dreams (mean hits 28.8%, n = 132) compared to when they could (mean hits 25.7%, n = 268) although this difference was not significant, t (398) = -.645, p = .52 two-tailed.

Investigating H3, dreams are slightly more bizarre at 8am than they are at 3am, contradicting the hypothesis, however the difference is not significant (Table 4). Nevertheless, dreams are more vivid and significantly more wordy (multiple analyses notwithstanding) at 8am compared to 3am, possibly due to neurobiological, motivational and/or other factors.

Exploring the relationship of the various dream-related variables to psi target ranking (Table 5) an (uncorrected) significant correlation is found between word length of dream and target rank, indicating that the wordier the dream the greater likelihood of the participant matching it to the target.

Exploring how individual differences relate to target rank scoring (Table 6), it can be seen that, excepting for age (because no direction was expected) the majority (8/13) of the remaining measures are in the expected direction, and the strongest and most statistically unlikely correlations are also in the expected direction. However, without correcting for multiple analyses, only age and sheep-goat score correlate significantly with target rank, indicating that older participants and sheep tend to do better on the dream psi task. Furthermore, in line with the observations regarding correlates of the frequency of self-reported precognitive dreams (Schredl, 2009), boundary thinness has a similar effect size (r = .26) and is more salient to dream precognition scores than openness to experience, however, using Fisher's r', the difference between these two correlations in this study is not significant, z = .68, p = .25 one-tailed.

Table 5. Correlations between target rank & dream variables

Measure	Correlation (r)	p value (2-tailed)	N
Words per dream	-.13	.038*	268
Vividness score per dream	-.07	.26	267
Bizarreness score per dream	.04	.54	267

* significant at alpha = .05 not correcting for multiple analyses

Table 4. Comparison of means at 3am & 8am for dream variables

	Time	*n*	*Mean ± SD*	*t*	*p*
Bizarreness per dream	3am	132	33.0 ± 14.4	-.581	.56
	8am	135	34.1 ± 15.6		
Vividness per dream	3am	132	10.9 ± 4.2	-1.72	.086
	8am	135	11.8 ± 4.5		
Words per dream	3am	132	44.6 ± 34.8	-3.94	.001*
	8am	135	68.1 ± 59.6		

* Exact p value (2-tailed), significant at alpha = .001 not correcting for multiple analyses

4. Discussion

The three main hypotheses were not supported. Overall psi scoring, although positive, was not significant. Psi scoring at 3am was greater than at 8am, but not significantly, and recalled dreams were actually more bizarre at 8am than at 3am, though not significantly so. 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, 2013) of experimental dream psi research indicates that

Table 6. Correlations between participants overall target rank score various individual difference measures (N = 20)

Measure	Correlation (r)	p value (2-tailed)
Age	-.49*	.028**
Sheep-goat (belief in psi)	-.46	.042**
Sleep Paralysis***	-.32	.17
Number of dreams recalled	-.27	.24
Precognitive dreams***	-.25	.29
Boundary Thinness (BQ18)	-.23*	.34
Lucid Dreams***	-.16	.49
Paranormal Ability	.12	.60
OBEs***	-.10	.67
Drug Use	.06	..81
Paranormal Belief	.04	.88
Paranormal Experience (AEI)	-.03	.91
Fear of the Paranormal	-.01	.97
Openness to experience	.002*	.99

* Spearman's rho
** significant at alpha = .05 not correcting for multiple analyses
*** participant's estimated lifetime prevalence

while the great majority of the 28 studies reviewed since the Maimonides research are positive, the six precognition studies (excluding Luke et al., 2012) fared the worst with effect sizes ranging from r = -.34 to .07 (median -.06), so the current study has surpassed most of those in terms of effect size (r = .04), even if the findings are non-significant.

Nevertheless a speculative raking over of the findings may indicate that motivational factors played a part in the non-significant results. Participants' scores in the first trial alone were independently near significant when considered in terms of direct hits, t(39) = 1.6, p = .057 one-tailed, of which there were ten (hit rate = 50%) at 3am and five (hit rate = 25%, at chance level) at 8am (overall 37.5% hit rate), indicating significantly greater psi task rank score performance at 3am than at 8am (t = -2.3, p=.031). Ironically, had the experiment finished after the first session it would have supported both of the first two hypotheses, yet psi scores and differences dwindled after the first session, though there was no discernable trend in scores over trials generally.

Furthermore, of the individual differences measures, only age and sheep-goat score correlated with psi target ranking, notwithstanding multiple analyses, perhaps indicating that maturity (considering this is an undergraduate student sample) as well as belief would make good predictors of psi-score. Finally, the only other measure to correlate with psi target ranking is the number of words recalled per dream, again perhaps indicating a motivation to recall details as a salient factor in psi task performance, though of course it is possible that the quantity of dream material itself relates to target ranking, or indeed some other interpretation may prevail. Nevertheless, as a cautionary tale, motivational factors could well play a part given the decline in scoring after the first session, and given that performance appears to be related to maturity, positive beliefs about psi and the amount of dream content recalled – all of which would seem to be related to motivation.

Inspecting the individual differences correlation p-values another cautionary tale, in line with that already given, might be that recruiting a greater number of participants (preferably those older and believing in psi) and testing them less would improve the significance of these tests for the same amount of data collected, and less sessions may even assist with motivation. Currently, with only twenty participants only correlations of at least medium strength are significant, so an issue of statistical power arises with so few participants. Given this fact, the correlations are generally in the right direction, especially those with any magnitude, so further research with a larger sample could prove worthwhile and the current results, with only 20 participants, are nonetheless encouraging. Nevertheless, the difficulty lies in recruiting willing participants, and to this end money is a great motivator for people to take part, but not necessarily a good one to get them to perform well, hence the possible motivational problems. In the end, however, one must accept that the results are not directly supportive of the hypotheses, for whatever reason.

Returning to the hypotheses concerning melatonin production periods, the finding, contradictory to that of Luke et al. (2012), that psi scores are not significantly better at 3am compared to 8am, seems to suggest that if nocturnal pineal gland chemicals such as melatonin are related to psi activity then they are not major players in this activity. Furthermore, the finding that dreams are not significantly more bizarre at 3am than at 8am (and actually trend in the opposite direction) seems to suggest that previous speculations about melatonin as a mediator of dream bizarreness (Kahan et al., 2000; Lipnicki, 2009) are not supported. Indeed, current speculations (e.g., Payne, 2010) about the possible role of cortisol in naturally generating bizarre dreams may warrant further consideration, given that cortisol is most active first thing in the morning (around 8am). Nevertheless, the cortisol hypothesis also appears incomplete given the lack of significant difference in dream bizarreness between 3am and 8am. Further consideration should perhaps then turn to the validity of dream bizarreness measures themselves, given that no psychometrically sound measure is currently available.

Whether dream bizarreness is related to melatonin or not, the present study lends no support to the idea that dream bizarreness is related to precognitive dreaming, at least under these conditions. So, given that melatonin does not appear to generate especially bizarre dreams, perhaps the peak melatonin period, the witching hour, is still important in the production of psi. Further research could do much to refine understanding by actually measuring melatonin levels (e.g., in saliva) and monitoring how intra- and inter-individual differences in melatonin fluctuate in relationship to psi test scoring and dream bizarreness.

One factor to consider with regards to the greater difference between findings at 3am compared to 8am in the previous study compared to this one is that the previous study was conducted around the summer solstice and the present study was conducted around the winter solstice. These findings then run somewhat counter to the supposed observation that melatonin production decreases as daylight hours increase. If melatonin or other nocturnal pineal chemicals are a factor in dream psi experiences then 3am psi scores should be better, not worse, at the winter solstice, perhaps further indicating that melatonin is not related to dream psi or possibly reflecting that the relationship between daylight hours and melatonin production is not particularly robust, as already indicated (see Morera & Abreu, 2006).

Returning to the psi-DMT hypothesis (Roney-Dougal, 2001), ideally, a DMT assay, such as that being developed by McIlhenny et al. (2009), would also be used instead of, or alongside, a melatonin assay. Currently, however, the facilities available for doing this are sparse and samples have to be frozen, stored and then typically shipped overseas for analysis making such research costly. Hopefully, however, any further research spent working the graveyard shift should look to embrace our nocturnal neurochemistry as closely as possible, keeping an eye open for any secrets it may reveal about the neurobiology of sleep, dream and psi.

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