Electrophysiological correlates of the incorporation of recent memory sources into REM and non-REM dreams and of levels of insight following REM and non-REM dream interpretation

Introduction

There have been reports and claims throughout history that the consideration of dreams can result in personal realizations and insight. For example, the claims that the inspiration for the sewing machine needle, and the books Dracula and Frankenstein, resulted from recall of dreams (Maquet & Ruby 2004). Edwards et al. (2013) addressed these claims in a non-clinical dream interpretation group that followed the dream group method of Montague Ullman (1996). Self-ratings of gains from participation in the dream group sessions, assessed by the Gains from Dream Interpretation questionnaire, showed that the Ullman technique is an effective procedure for establishing connections between dream content and recent waking life experiences. In Edwards et al. (2015) participants reported and considered a recent home dream in a dream discussion group, that following the 'Appreciating dreams' method of Montague Ullman, the study had a control condition where the participant also reported a recent event, the consideration of which followed the same technique as was followed for the dream report. Outcomes of the discussions were assessed by the participants on the Gains from Dream Interpretation scale, and on its counterpart, the Gains from Event Interpretation scale. High ratings on the GDI experiential-insight subscale were reported for the Ullman method and were significantly higher than for the control event condition.

The brain basis for insight resulting from dreams is detailed by Cai et al. (2009), who conclude that there is a greater spread of activation in REM than in NREM sleep or wake, and that REM enables the assimilation of new with past experiences by creating a rich network of associations. Edwards et al. (2013, 2015) review such psychophysiological reasons for dream insight that derive from the likelihood that many home recalled dreams will occur from REM sleep, and that REM is involved in emotional memory consolidation and processing (Nishida et al., 2009). We therefore used N2 dreams as a comparison condition as such processes have not been linked to N2. However, the possibility of insight occurring from studying dreams does not require a function to be claimed for REM sleep, and some authors do not distinguish characteristics of REM sleep dream content from non-REM dream content, except that reports of npn-TREM dreams occur less frequently from awakenings, length in words of non-REM reports is shorter than for REM reports. Therefore, following Noreika et al. (2010), a daydream, collected in the sleep lab, was also used as a control condition for dream reports, and we hence used that type of comparison text here. We hypothesised that Exploration-Insight would be higher for REM dreams than daydreams (control condition). It is unclear whether to expect differences between REM and N2 dreams in the elicitation of insight. As our previous work has shown that incorporation of recent memories into REM sleep dreams is correlated with EEG theta power from the REM sleep period we also aimed to assess number of waking life event incorporations and, in an extension of that

work, also aimed to correlate insight that results from dream discussion with EEG theta power from the sleep period that produced the dream.

Method

Participants

31 participants took part in the study (15 females, 16 males; aged 18 – 30 years, mean = 20.42, SD=3.16). All were students at Swansea University. All participants were native English speakers and were students at Swansea University. Participants were self-reported frequent dream recallers (defined as recalling dreams 4–7 days per week); sleeping a minimum of 7 hours per night; with no disorders that could affect their sleep; non-smokers; not taking recreational drugs and not having an excessive alcohol intake (defined as intake greater than 6 units of alcohol per night, or greater than 21 units per week). Participants gave written informed consent and were paid for their participation. Ethical approval for the study was obtained from the Research Ethics Committee at the Swansea University Department of Psychology.

Procedure and materials

Pre-sleep lab

Daily logs

All participants were instructed to keep a daily log for 10 consecutive days, recording their waking experiences from the day. On the tenth day of keeping the log, participants slept for a night in the sleep laboratory, where dream and 117 daydream reports were collected. The daily log consisted of the following three categories:

1. Major daily activities (MDAs): activities that took up most of the participants' time during the day (for example, going to work or university, meals, shopping).

2. Personally significant events (PSEs): important daily events that may or may not have taken up much time (for example, emotional events).

3. Major concerns (MCs): concerns or thoughts that participants had on their mind during the day that may not have taken up much time, but were still considered important to them (for example, money problems, exam stress).

Participants reported up to five events per category on each daily log. Any accompanying emotions were reported next to the event and were scored by the participant for intensity on a scale from 1 (*low*) to 3 (*high*).

Sleep lab

Participants slept in the sleep lab on a Monday night and were woken after 10 minutes of REM and 10 minutes of N2 sleep, in counterbalanced order, so as to obtain dream reports. Sleep was monitored using polysomnography (sampling rate 200Hz, high-pass filter 0.1 Hz). Electroencephalography (EEG) was recorded using a Trackit™ 18/8 system (Lifelines Ltd, UK). EEG electrodes were placed according to the standard 10–20 system at C3, C4, F3, F4, M1 and M2.

For daydream report collection, participants were informed that before going to sleep, the equipment would need to be checked. They were told to lie on the bed in the bedroom and that while the equipment was checked they would be given the opportunity to experience how the dream reports would be collected during the night. They were instructed to lie down and keep their eyes closed, but not fall asleep, and to let their minds wander (Noreika et al., 2010). The following text was read out to the participants: 'We need you to lie down while we check the connections and that the recordings are free of interference, and that the muscle recordings work. Please lie down, we need you to have your eyes closed, but it is very important that you stay awake. Just think of anything, let your mind wander, but please don't fall asleep! Once we have checked everything we will sound the buzzer and play you the messages that we will play during the night. We will ask you what was going through your mind before the buzzer went. Although you will have been awake, please answer in as much detail as you can.'

After 10 minutes, participants were signalled with a buzzer and received the following recorded audio message played from a digital recorder through an intercom: 'What was going through your mind before the buzzer?' To prompt the participants, they were next asked with a recorded message: 'Can you remember anything else?' If a daydream report was less than 20 words, another attempt to collect a report was made following another 10 minutes of lying down in bed.

During the night, participants' dream reports were collected, with the aim of achieving one from N2 sleep and two from REM sleep. Awakenings were not scheduled during the first two sleep cycles, as to not disrupt SWS. The order of the first awakening (N2 or REM sleep) was counterbalanced between participants. As a result of the awakenings, 24 participants had a daydream, REM and N2 report, five had a daydream and a REM dream, one had a daydream and N2 dream, one had a REM and N2 dream.

Dream discussion

All participants took part in discussion sessions scheduled for 1-3 days after the sleep lab night that considered each of their REM dream, N2 dream and daydream reports, each condition was timed to last up to 45 minutes. The discussion was with Mark Blagrove and Chris Edwards, who are experienced in the running of Ullman dreams groups. The order of conditions was counterbalanced across participants. Each session was digitally voice recorded and later transcribed. The length of time of each session and the length of time spent on each stage of the Ullman method was calculated from the session transcripts so as to check whether the conditions differed on these variables.

In the group sessions Mark Blagrove and Chris Edwards did not know the EEG theta data for each participant, and were blind to the REM / N2 / daydream status of the three texts, although it was difficult to conceal that a text was from a daydream rather than a dream. It is acknowledged that REM dreams may be longer than N2 dreams on average, and so implicit information on likely awakening stage may have been present. As in Edwards et al. (2015) the length of time of each session, and the length of time spent on each stage and substage of the Ullman method was calculated from the digital recording of the discussion.

After each discussion participants completed the 14 item Gains from Dream Interpretation questionnaire (GDI; Heaton et al., 1998b). The GDI has 14 items with a 9-point scale for responding to each item (1–9, where 1 = "strongly disagree" and 9 = "strongly agree"). The GDI has three subscales: Exploration-

Insight gains, Experiential gains, and Action gains. Each of the subscales has a range of scores of 1 – 9. The Action gains subscale of the GDI and GEI has five items, which refer to being able to change bad dreams (or change waking life events) and change waking life cognitions or actions, as a result of the session. The GDI Exploration-Insight subscale comprises items on the experience of being in the group session, on insight obtained during the session about oneself or one's life, and insight about memory sources for the dream. The GDI questionnaire was amended so as to refer to dreams and daydreams, with (day)dream substituted for dream throughout.

Ullman technique

The Ullman (1996) 'Dream appreciation' technique involves the following stages: 1A. Reading of the dream aloud by the dreamer. 1B. Clarification of the dream report by the group asking questions of the dreamer. 2A. Brief discussion of the dream by the group members other than the dreamer so as to imagine what feelings they would have experienced if the dream were their own, and then; 2B. Eliciting these individuals' projections about the dream in terms of their own lives so as to give symbolic or metaphorical meaning to the dream images. 3A. Response by the dreamer to stage 2. 3B.1 Description by the dreamer of his/her waking life context for the dream, in terms of the dreamer's life experiences, with particular emphasis on recent experiences and concerns. 3B.2 Reading the dream back to the dreamer, in the second person, so that any additional information about the dream or waking life can be obtained; and 3B.3 Orchestration, in which all members of the group suggest connections between information that the dreamer has given about their dream and information the dreamer has given about the dreamer's life. For a full description of the process, see Ullman (1996).

The main hypothesised difference between dream and daydream conditions was in score on the Exploration-Insight subscale, which comprises the following items:

1. I was able to explore my (day)dream thoroughly during the session.
2. I learned more about what this (day)dream meant for me personally during the session.
6. I learned more from the session about how past events influence my present behaviour.
7. I learned more about issues in my waking life from working with the (day)dream.
8. I felt like I was very involved in working with the (day)dream during the session.
12. I learned things that I would not have thought of on my own.
13. I was able to make some connections, that I had not previously considered, between images in my (day)dream and issues in my waking life.

Correspondence identification task

After the dream group participants were asked to identify correspondences between the (day)dream reports and daily diaries kept over the 10 days before entering the sleep lab. This procedure allows the identification off waking life sources of dream content, the level of which can be correlated with electrophysiological variables.

Independent scoring of (day)dream reports

Two judges assessed the transcripts for the dream and event conditions on Foulkes and Fleisher's (1975) Dreamlike Fantasy scale using the following options:

2. Conceptual content, everydayish
3. Conceptual content, bizarre or unusual topics
4. Perceptual content, nonhallucinatory, everydayish, undramatic
5. Perceptual content, nonhallucinatory, bizarre or unusual, dramatic
6. Perceptual content, hallucinatory, everydayish, undramatic
7. Perceptual content, hallucinatory, bizarre or unusual, dramatic

Results

One participant did not manage to fall asleep, resulting in a final sample of 31 participants. Number of awakenings, reports and report length are presented in Table 1. A total of 39 attempts were made to collect daydream reports. Of these, 30 reports (78.9%) were of 20 words or longer and thus included in the discussions and analyses. Of the 43 counterbalanced awakenings conducted during N2 sleep, 26 (60.5%) resulted in a dream report of 20 words or longer. For REM sleep dreams 31 counterbalanced awakenings were conducted, of which 30 reports (96.8%) resulted in a dream to be included in the discussions and analyses.

Table 1 - Number of reports attempted and collected, mean (SD), minimum and maximum word length of reports, mean Dreamlike fantasy score for reports, and number of incorporations of Major Daily Activities, Personally Significant Events, and Major Concerns from diary reports of the 10 days before the night of the dream.

	Daydreams	N2 dreams	REM dreams
Total number of attempts to collect reports (P 11 to add?)	39	43	31
Total number of reports	30	26	30
Mean (SD) report length in words	84.37 (42.28)	96.23 (39.89)	130.80 (59.64)

Minimum report length in words	26	51	44
Maximum report length in words	232	245	353
Dream fantasy scale	2.83 (1.62)	6.02 (0.79)	5.87 (0.76)
Major Daily Activities [a]	4.52 (4.06)	4.84 (3.75)	5.57 (4.30)
Personally Significant Events [a]	2.55 (3.09)	2.80 (2.16)	3.07 (2.50)
Major Concerns [a]	3.41 (4.82)	3.08 (3.35)	2.27 (2.35)

[a] Due to participant not completing correspondence scores, daydreams n=29, N2 n=25

All differences between conditions on the incorporations of MDAs, PSEs and MCs were non-significant, all ts < 1.60. However, a difference did occur in timescale of incorporations for concerns. Daydreams were more likely to incorporate Major Concerns from the two days before the sleep lab night compared to the 3rd and 4th day before the sleep lab night.

Dreamlike Fantasy was significantly lower for Daydreams than for N2 dreams ($t(24) = 8.89$, $p<.001$) and REM dreams ($t(28)=8.66$, $p<.001$), but did not differ between REM and N2 dreams ($t(24)=0.81$, $p=.425$). REM dreams were significantly longer than N2 dreams ($t(24)=2.39$, $p=.025$) and Daydreams ($t(28)=5.17$, $p<.001$), but N2 dreams and Daydreams did not differ significantly in length ($t(24)=1.35$, $p=.191$).

Table 2 shows total time and time spent on each of the stages of the Ullman method discussing the reports.

Table 2 - Time spent on each of the stages of the Ullman method discussing the reports for the REM dream, N2 dream and daydream conditions

	REM dream	N2 dream	Daydream
Length of:	n=30	n=26	n=30
Whole session	35.71 (6.23)**	34.38 (4.61)**	30.77 (4.09)
1.Dream recount	9.26 (1.97)**	9.07 (2.25)**	7.63 (2.47)
2.Group discusses (day)dream	4.86 (1.17)	4.85 (0.97)	5.00 (1.39)
3a. Dreamer responds	1.11 (0.82)	1.01 (0.83)	1.07 (2.14)
3b1.Recent waking life explored	13.15 (2.84)**	12.13 (2.36)*	10.91 (3.30)
3b.2. (Day)ream	1.50 (0.67)	1.52 (0.68)	1.55 (0.92)

playback			
3b.3. Orchestration	5.84 (2.20) *	5.80 (1.97)*	4.61 (1.39)

Note:

* p<.05 comparison with daydreaming condition

** p≤.001 comparison with daydreaming condition

So as to address the main hypothesis of the study the mean scores on the exploration-insight subscale of the GDI were calculated. These scores are: REM, mean = 7.49 (1.01); N2, mean = 7.76 (0.85); Daydream, mean = 7.13 (0.99). Exploration-insight for Daydreams was significantly lower than for REM dreams (t(28)=1.83, p=.035, 1-tail) and for N2 dreams (t(24)=2.65, p=.007, 1-tail). REM dreams and N2 dreams did not differ significantly (t(24)=1.15, p=.262). As REM and N2 dreams did not differ significantly on the exploration-insight subscale (nor on the Experiential or Action subscales), REM and N2 results are combined in the following GDI analyses.

Table 3 shows that Exploration-Insight was significantly higher for dreams than daydreams. Importantly, the dream and daydream discussions did not differ significantly on participant ratings on whether the dream or daydream was explored thoroughly during the session, or on the participants' rating of having been involved in working with the dream or daydream. Nevertheless, on other items, and on Exploration-insight overall, there were significant differences in gains between dream and daydream discussions.

Table 3: Exploration-insight scores for daydream and dream conditions, and scores for the seven items of the exploration-insight subscale (N=30)

	Dream		Daydream		
	Mean	SD	Mean	SD	P
Exploration-Insight	7.60	0.88	7.13	0.99	.002
1. I was able to explore my (day)dream thoroughly during the session	8.35	0.97	8.07	1.20	.117
8. I felt like I was very involved in working with this (day)dream during the session	7.97	1.28	7.80	1.21	.241
12*. I learned things that I would not have thought of on my own	7.53	1.22	6.63	2.13	.002
2*. I learned more about what this (day)dream meant for me personally during the session	8.00	0.86	7.07	1.48	<.001
13. I was able to make some connections, that I had not previously considered, between images in my (day)dream and	7.85	0.89	7.37	1.33	.055

issues in my waking life					
7. I learned more about issues in my waking life from working with the (day)dream	6.95	1.74	6.40	1.85	.038
6. I learned more from the session about how past events influence my present behaviour	6.57	1.79	6.57	1.70	1.00

Conclusions and Recommendations

Participants gave high ratings for their Exploration – Insight gains from participating in the dream/daydream group, with scores significantly higher for considering dreams than for considering daydreams. The high level of realisations reported from daydream discussions confirms the appropriateness of this as a control condition. The comparability of amount of insight from the three conditions (REM and N2 dreams and daydream) may be a function of their comparability in incorporating items from daily logs from the 10 days before sleeping in the sleep lab, categorised as either major daily activities, personally significant events and major concerns. Daydreams had sufficient emotional content to allow a meaningful and potentially insightful discussion to occur, just as occurred for the dream conditions. REM and N2 dreams did not differ on GDI scores, in line with 1-generator models of dream production. The dreams and daydreams had similar levels of references to recent waking life personally significant events and major concerns in the dream and daydream reports, but we will be reporting in the main (Blagrove first author) paper that daydreams had a greater incorporation of concerns from the two days prior to sleeping in the lab than concerns from the eight days before this. These ratings of incorporation of waking life memories into dreams and daydreams are currently being correlated with EEG theta power for inclusion in the main paper for the study.

To answer the question why is there a higher exploration-insight score for dreams than daydreams, we propose that dreams and daydreams both refer to recent personal events and major concerns, discussion of which can result in insight. However, firstly, daydreams were found to be more tied to very recent concerns, and secondly, dreams might be utilising more metaphorical images and associations than do daydreams. The insight that results might not be astounding, but the dream content may act as a reminder, a reference to what might be being ignored, and it may do so in a metaphorical way. As with metaphors in general, it may be that any new metaphor will provide some restructuring of waking life cognition, even if the waking life issues are quite well known and already well-considered and explored. So, dreams refer to emotional areas of waking life, and may be related to novel or metaphorical connections between new and old memories. Dreams might enable this by making connections between previously unrelated information ("hyperassociativity": Hartmann, 1995, 1996), and because censorship and control of thinking decreases in dreams ("dream rebound"). The metaphor might raise awareness, in that it may be that the dreamer knew of the issue already, but the new word / image gives a different way of looking at the issue.

Although dream discussions were rated highly on learning what the report means for the dreamer in terms of waking life issues (and significantly higher than for daydreams), these results occurred even though participants did not select the dream as it was the one they were woken from (home dreams are usually

selected before being told to others, based partly on salience and how interesting they appear). Furthermore, the dreams were shorter than those obtained from spontaneous recall, due to mostly occurring in the middle of the night, and participants mostly did not have major life concerns. Nevertheless, benefits from discussing the dreams did occur. Indeed, it may be that full benefits from dream discussions are underestimated here due to the brief timescale of discussion and assessment used in the current study, and that further gains might occur with increased discussion time. Furthermore, these lay group results might also underestimate gains that could occur with more experienced researchers running the groups, or researchers with clinical experience, or participants with greater experience of considering their own dreams. It may also be that, as suggested by Heaton et al. (1998a), particular types of dreams, such as troubling or recurrent ones, are more important to explore, whereas the current studies used lab dreams of each participant irrespective of content or type.

The hypothesis that consideration of dream content might result in personal insight was supported by the premise that dreaming reflects emotional memory consolidation, functional reorganization and neural processes of insight occurring during sleep. However, it is not necessary to posit that dreams are related to a function of sleep for there to be a hypothesis of benefits in the consideration of dream content. It is possible that the sleeping brain state, for non-necessarily functional reasons, allows dream content to represent waking life matters about which we are more normally defended or even unaware when awake, because active inhibition of attending to these is suppressed during sleep.

Whereas all EEG records were suitable for differentiation of REM and N2 dreams and daydreams in the present study extra computations are being conducted to ensure that all are suitable for quantitative analysis of EEG power. Once that is done EEG power correlates of insight and of incorporation of waking life memories in into dreams and daydreams can be computed. I apologise that this is a slow process and we will include these results in the final main paper.

Regarding the timescale of incorporation of memory sources into dreams, we only provided partial replication of the REM sleep dream-lag effect (Blagrove et al., 2011), and so, although many papers have found this effect, we do recommend further replications. We recommend that future studies assess the aptness of metaphors present in dreams using methods from the scientific study of metaphor generation and metaphor comprehension. We recommend that individuals with significant waking life concerns, such as divorce, are studied, so as to identify whether such concerns are alleviated by the group discussion of dream content. We also recommend the study of the discussion of nightmares so as to compare insight obtained with that obtained from more ordinary dreams, and to also assess the EEG theta correlates of waking life memory sources in nightmares, and the EEG theta correlates of insight obtained from discussing nightmares.

References

1. Blagrove, M., Fouquet, N.C., Henley-Einion, J.A., Pace-Schott, E.F., Davies, A.C., Neuschaffer, J.L., & Turnbull, O.H. (2011a). Assessing the dream-lag effect for REM and NREM stage 2 dreams. PLoS ONE, 6(10), e26708. doi:10.1371/journal.pone.0026708.

2. Edwards, C., Malinowski, J., McGee, S., Bennett, P., Ruby, P. & Blagrove, M. (2015). Comparing personal insight gains due to consideration of a recent dream and consideration of a recent event using the Ullman and Schredl dream group methods. Frontiers in Psychology 6, 831
3. Edwards, C.L., Ruby, P.M., Malinowski, J.E., Bennett, P.D., & Blagrove, M.T. (2013). Dreaming and insight. Frontiers in Psychology, 4:979. doi: 10.3389/fpsyg.2013.00979
4. Cai, D. J., Mednick, S. A., Harrison, E. M., Kanady, J. C., and Mednick, S. C. (2009). REM, not incubation improves creativity by priming associative networks. *Proc. Nat. Acad. Sci. U.S.A*. 106, 10130–10134. doi: 10.1073/pnas.0900271106
5. Foulkes, D., & Fleisher, S. (1975). Mental activity in relaxed wakefulness. *Journal of Abnormal Psychology, 84*(1), 66-75. doi: 10.1037/h0076164
6. Hartmann, E. (1995). Making connections in a safe place: is dreaming psychotherapy? *Dreaming 5*, 213–228. doi: 10.1037/h0094437
7. Hartmann, E. (1996). Outline for a theory on the nature and functions of dreaming. *Dreaming* 6, 147–170. doi: 10.1037/h0094452
8. Heaton, K.J., Hill, C.E., Hess, S.A., Leotta, C., and Hoffman, M.A. (1998a). Assimilation in therapy involving interpretation of recurrent and nonrecurrent dreams *Psychother.* 35, *147-162.* doi.org/10.1037/h0087784
9. Heaton, K. J., Hill, C. E., Petersen, D. A., Rochlen, A. B., and Zack, J. S. (1998b). A comparison of therapist-facilitated and self-guided dream interpretation sessions. *J. Couns. Psychol*. 45, 115–122. doi: 10.1037/0022-0167.45.1.115
10. Maquet, P., and Ruby, P. (2004). Psychology: Insight and the sleep committee**.** *Nature* 427, 304-305. doi:10.1038/427304a
11. Nishida, M., Pearsall, J., Buckner, R.L., and Walker, M.P. (2009). REM sleep, prefrontal theta, and the consolidation of human emotional memory. *Cereb. Cortex,* 19, 1158-66. doi: 10.1093/cercor/bhn155
12. Noreika, V., Valli, K., Markkula, J., Seppälä, K., and Revonsuo, A. (2010). Dream bizarreness and waking thought in schizophrenia. *Psychiat. Res.* 178, 562–564. doi: 10.1016/j.psychres.2010.04.034
13. Ullman, M. (1996). *Appreciating Dreams: A Group Approach*. Thousand Oaks, CA: Sage.