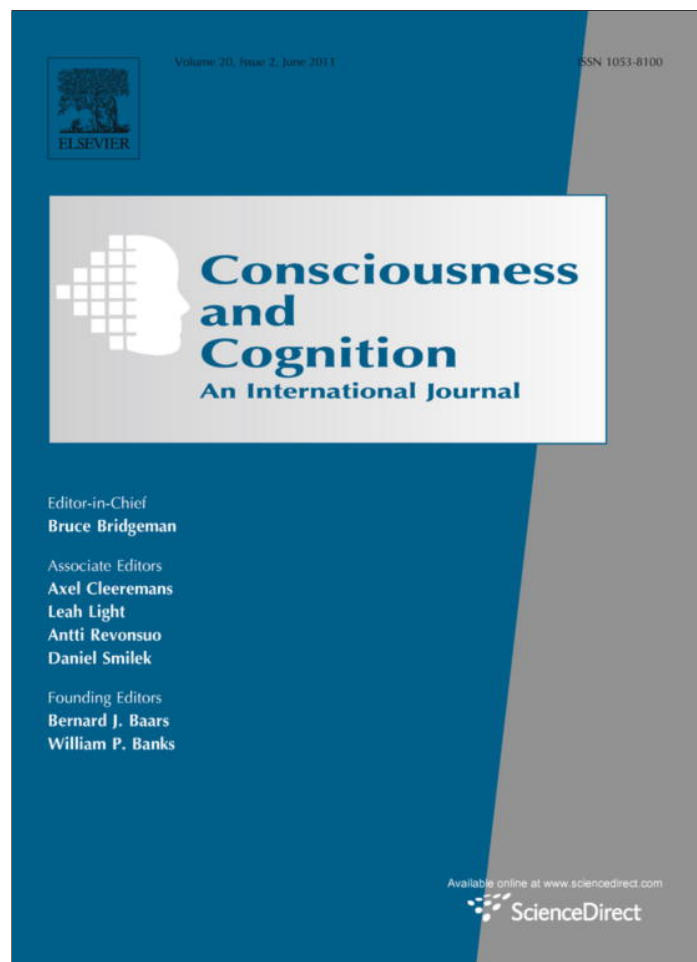


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A replication of the 5–7 day dream-lag effect with comparison of dreams to future events as control for baseline matching

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ABSTRACT

The dream-lag effect refers to there being, after the frequent incorporation of memory elements from the previous day into dreams (the day-residue), a lower incorporation of memory elements from 2 to 4 days before the dream, but then an increased incorporation of memory elements from 5 to 7 days before the dream. Participants ($n = 8$, all female) kept a daily diary and a dream diary for 14 days and then rated the level of matching between every dream report and every daily diary record. Baseline matching was assessed by comparing all dream reports to all diary records for days that occurred after the dream. A significant dream-lag effect for the 5–7 day period, compared to baseline and compared to the 2–4 day period, was found. This may indicate a memory processing function for sleep, which the dream content may reflect. Participants' and three independent judges' mean ratings also confirmed a significant day-residue effect.

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1. Introduction

Although dreams only very rarely incorporate exact copies of waking life events (Fosse, Fosse, Hobson, & Stickgold, 2003), dream content can be matched to memory elements from the dreamer's recent waking life (Kramer, 2007). The prominence of memory elements from the day before the dream as sources for dream content is termed the day-residue effect (Freud, 1900/1953). Recent work has confirmed the day-residue effect, but extended it by proposing a dream-lag effect, in which events or memory elements from approximately 5 to 7 days before the dream are incorporated into dreams at a greater rate than are events or memory elements from 2 to 4 days before the dream (Nielsen, Kuiken, Alain, Stenstrom, & Powell, 2004).

Jouvet (1993/1999) documented a delayed incorporation effect based on his records of his own dreams. He noticed that when he was away from home, his dreams did not incorporate the new environment until up to 8 days after arriving, and continued to incorporate this environment for some time following his return home. He suggested that spatial memories take longer to be incorporated into dreams than memories that do not reflect the environment.

Nielsen and Powell (1988, 1989) investigated this experimentally, finding peaks of incorporation into dreams of memory elements from experiences 1 and 6 days previously. However, only a minimal dream-lag effect was found by Nielsen and Powell (1992), who also note methodological problems with the earlier studies. The effect was much more prominent in Nielsen et al. (2004), who used a between-subjects design in which each participant kept a dream diary for 1 week. Each of the 470 subjects then selected one dream from a potential seven. They were then given by random allocation a specific day during the 7 days prior to the dream and asked to recall events of that day and to give a score of confidence for those memories. Whereas in the three earlier studies ratings were conducted by independent judges, in this study participants rated the degree of match between the events of the day and the dream report. The resulting graph shows a *u*-shaped curve

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for the high-confidence memory days, with high matching scores for dreams when compared to day 1 (the day immediately prior to the dream), lower matching when the comparison is with days 2–4, and higher matching again when dreams are compared to days 5–7 before the dream.

The term 'time-lag' is used by [Bulkeley and Kahan \(2008\)](#) in describing how there was a 'scattered occurrence' of dream content related to 9/11 throughout a 3 month journal period after 9/11, and they refer to [Nielsen et al. \(2004\)](#) for this. However, in the current study our interest is only in the specific 5–7 day lag as described by [Nielsen et al. \(2004\)](#), [Nielsen and Powell \(1992\)](#) and [Powell, Nielsen, Cheung, and Cervenka \(1995\)](#), and reviewed in [Nielsen and Stenstrom \(2005\)](#). Being specific about the predicted days of the dream-lag is important so as to diminish the possibility of type I errors.

In addition to specifying in advance the dream-lag period (5–7 days) in this study, and the day-residue period (1 day), a control period of baseline matching of days to dreams is also required, to which the 1 day and 5–7 day periods for diary to dream matching would be compared. To control for the background level of matching between diary records and dream reports the current study assesses matches between dream reports and diary records for days that occur after the dream. 'Baseline' thus refers to general commonalities that are present in the participant's life and their dream content. Some matches in the baseline period may be simple coincidences and others may be reflective of the general life circumstances of the dreamer. Anticipation of the following day or days may also be incorporated into these dreams, but the inclusion in the baseline of such increased matching due to anticipation works against the hypothesis of the baseline being significantly below the 1 day period and 5–7 day period matchings.

To our knowledge this method of control has not previously been used in research on the dream-lag effect, although it has been used in [Propper, Stickgold, Keeley, and Christman's \(2007\)](#) study on the effects on dreams of watching television during the day of 9/11. In that study, as a control, relationships were assessed between hypothesised variables concerned with media experience on 9/11 and the content of dreams from before 9/11, with the result that 16% of pre-9/11 dreams were scored as containing at least one content feature related to the 9/11 attacks. This design of pre-9/11 dreams being used as a baseline for post-9/11 dreams was also used by [Hartmann and Basile \(2003\)](#) and [Hartmann and Brezler \(2008\)](#). We use a similar control here, so as to assess the baseline of matching that occurs due to the dreams and waking life events and memory elements coming from the same person.

[Nielsen et al. \(2004\)](#) suggest that a circaseptan (i.e., about 7 days) rhythm of socio-emotional adaptation and memory consolidation may underlie the dream-lag effect. However, a possible confounding factor is that there may be recurrent routine events that occur on a weekly basis which result in a person dreaming about an event from the day before, but, with the event recurring each week, giving a spurious match of that dream with the same day of the week, but a week earlier. [Nielsen et al. \(2004\)](#) took account of this possibility by removing periodic events from consideration in their process of matching diary days and dream reports. A removal of periodic events was also effected by [Jouvet \(1993/1999\)](#), in that his findings relate to non-routine activities, such as visiting a foreign country.

It should, however, be noted that [Nielsen et al.'s \(2004\)](#) finding of a 5–7 day dream-lag effect is referring to days which are 4–6 days before the day-residue day, the day-residue day being the day before the dream, termed Day 1 by [Nielsen et al. \(2004\)](#). Weekly periodic events, therefore, which are occurring on Day 1, Day 8, Day 15, etc., seem not to account for the 5–7 day dream-lag effect. However, as there have been criticisms that the dream-lag effect may be due to this weekly periodic confound, we do assess this possible confound in the current study, using the periods between diary day and dream of +8 days (i.e., matching a diary record with a dream report from 8 days later) and –7 days (i.e., matching a diary record with a dream report from 7 days earlier). The days referred to here, which are used for the +8 and –7 days matchings, are the same days of the week as the day-residue day, which is the day before the dream. Whereas the +8 day matching assesses the proposed weekly periodic confound directly, the rationale for the use of the –7 day period is as follows: if dream-lag effects are due to spurious matches between the dream report and the day of the week 7 days earlier than the day-residue day, caused by an incorporation of weekly periodic concerns from the previous day (the day-residue day), then these spurious matches will also occur for dream reports that are compared to a day that is 7 days *after* the day-residue day.

There are three hypotheses for the study. Hypothesis 1 tests the day-residue effect: matching of dream reports to the diary record of the immediately preceding day (i.e., number of days from diary day to dream = 1) will be significantly greater than baseline. Hypothesis 2 tests the dream-lag effect: matching of dream reports to diary records from 5 to 7 days before the dream will be significantly greater than baseline. Hypothesis 3 tests the possible weekly periodic events confound: matching of dream reports to diary records of the same day of the week as the day-residue day, i.e., diary day to dream periods of +8 and –7 days, will be significantly greater than baseline calculated from the negative diary day to dream periods but without the inclusion of the –7 day diary to dream period.

The terminology used in this study is that positive diary day to dream periods indicate that the dream occurred after the diary day, and negative diary day to dream periods indicate that the dream occurred before the diary day (see [Fig. 1](#)). Number of days between diary day and dream = 1 refers to a dream report being matched to the diary record of the day before the dream; number of days = 2 refers to there being a period of 2 days between the diary day and the dream, and so on up to number of days = 14, where the dream occurs 14 days after the diary day that the dream is being compared to. Number of days = –1 refers to the dream report being compared to the diary record of the day that starts with and includes the morning that the dream occurred; number of days = –2 refers to the dream report being compared to the diary record of the day 2 days after the dream. Where number of days = –7 and +8, the day

to which the dream is matched is the same day of the week as the day-residue day (where number of days between diary day and dream = 1). In order to provide a baseline for the matching of dream reports to diary records, the present study uses the mean of all the matches of dream reports to diary records of days that follow the dream (i.e., the mean of matches from periods -1 , -2 , etc.).

2. Methods

2.1. Participants

Twenty-one participants were recruited to the study. Of these, eight (mean age = 23.13, SD = 7.88, range = 18–41, eight female) completed the daily diaries and the dream diaries for the whole study period and provided scores for the matching of all their diary records to all their dream reports. Data presented here refer to these eight participants only. Participants were students at Swansea University: five were psychology undergraduates, one was a psychology graduate student, and two were from other subjects. Recruitment was elicited by email advertisement. The study was carried out in the participants' own home environments and many of the participants travelled away from Swansea during the study period.

2.2. Procedure

Ethics approval for the study was obtained. Advertisements were placed for a study on dreaming. Applicants were screened so as to meet criteria for being frequent dream recallers (defined as dreams being recalled on 'most nights'), having English as their first language, and not having excessive alcohol intake (i.e., no higher than the UK Government recommended consumption of 21 units per week for males and 14 for females). Heavy drinkers were excluded due to the possibility of alcohol affecting memory of dreams and diminishing the amount of REM sleep.

Participants gave written informed consent to take part and were then given a 14 day daily diary and a 14 day dream diary to complete. After completion of the diaries participants rated the level of matching between every diary record and every dream report on a matrix.

2.3. Materials

2.3.1. Daily diary

Participants were asked to complete a diary during the evening of each day, regarding significant or unusual events; what they had watched on TV or listened to on the radio; whether they had travelled, and with whom; whether anything important or specific had been on their mind during the day, and which people they had spent some of the day with. A memory confidence judgement was not included because, unlike for Nielsen et al. (2004), the diary record was written on a daily basis, rather than retrospectively. Participants were not asked to rate the periodic routineness of the events of each day either in the sense of how ordinary/extraordinary the events of the days were, nor in the sense of whether the events were following a periodically recurring routine. The diary was open ended and although participants were asked to describe significant and unusual events, they could and did report mundane and ordinary events, such as eating crackers.

2.3.2. Dream diary

Participants were asked to write down a report of any dreams they had in the night. They were asked to describe the events of the dream, what the scenes were and whether the scenes were familiar, who the other people in the dream were, and whether they had any emotions during the dream.

2.4. Recording ratings of the diary day to dream report matches

2.4.1. Participants' ratings

All of the ratings were done as one task after all the diary record and dream reports were completed. At the end of the recording period, each participant gave their diaries and dream reports to the experimenter who then randomised the order of dream reports in preparation for the matching task. The eight participants were then given their diary records in date order and their dream reports in randomised order. Each participant was given a matrix to complete so as to compare all their diary records with all their dream reports. The days formed the rows of the matrix and the dreams the columns. The matrix was completed in the participants' own homes without supervision. Participants were told not to think about whether the dream occurred before or after the diary day, but to concentrate on matching the content of each dream report with each diary record. The matchings were done by comparing the diary record of one date with each of the dreams in turn, then moving onto the next date. Participants were instructed to match each journal entry with each dream report using the following six point scale:

0. no matches at all between dreams and events;
1. general matches but these may be recurring themes;
2. some vague resonances, it is possible that dream and day are related;
3. weak relationships between dreams and events;
4. several matches or one strong match; and
5. multiple strong matches between dreams and events.

No definition of dream report and diary record being related, or of “match” or “strong match” was given to the participants.

2.4.2. Matching of dream reports to diary records by independent judges

After the participants had provided the ratings for the matching of dream reports to diary records, three independent judges (two females, ages 24 and 44; one male, age 29; all psychology graduate students) then repeated the ratings procedure. Judges were given packs with diary records and dream reports (the latter randomised) and a separate matrix to complete for each participant. For each of the eight matrices there was a question and scale as follows:

What level of matching is there between the contents of the dream report and the waking day events recorded in the diary?

0. none at all;
1. very weak;
2. weak;
3. moderate;
4. strong;
5. very strong; and
6. extremely strong.

For the judges the rating scale was amended from that used for the participants so as to simplify the descriptions of the scale points, and, although points 4 and 5 were seldom used by the participants on their 0–5 scale, an extra high point was added so as to make the judges' scale symmetrical about the central, moderate point. The judges were given the following instructions about assessing levels of matching:

“You are being asked to quantify to what extent the contents of each dream match the events in the daily diaries. Such matches, or incorporations of waking life into dreams, can be direct or indirect, or even metaphorical. For example, the same person may appear in the diary and in the dream, but be doing something different, or they could do the same thing in waking life and in the dream, or an event can occur in waking life involving certain people and then the same event can occur in a dream, but with different people. Or an event can occur in waking life that leads to a certain emotion, and a completely different event can occur in the dream but which causes the same emotion. In addition to these different levels of matches, from weak to strong, there is also the possibility that more than one match can occur between any one dream and any one diary entry. You will have to bear all these factors in mind as you decide how to score the level of match between each dream and each diary entry! Many thanks for doing this as accurately as you can!”

2.5. Statistics

Means of matching scores for each of the diary day to dream periods (–14 to +14) were computed for each of the eight participants. As the period length increased there were fewer possible diary record to dream report combinations that could be used to calculate the mean for that period for each participant, with 13 combinations contributing to the diary to dream period = +1 day mean for each participant, and one combination producing the period = –14 days score and one combination the period = +14 days score. This low number of possible combinations for matching dreams reports to diary records about 2 weeks apart resulted in some participants not having a score for the end points. These were periods –14, –13, +13 or +14 (i.e., periods where the dream was 13 or 14 days before the diary day, and periods where the diary day was 13 or 14 days before the dream). These periods are thus excluded from the analyses.

In order to test hypotheses 1 and 2 the data from the separate periods were grouped to perform statistical tests. The grouped diary to dream periods used were as follows: mean of –12 to –1 days (baseline); 1 day; mean of 2–4 days; mean of 5–7 days, and mean of 8–12 days. As individuals may differ in their use and interpretation of the matching scale a Friedman test was used so as to compare the rank order in which the five grouped periods were placed by each participant. Wilcoxon tests were then used to compare matching scores for the baseline (means of –12 to –1 days) to the diary to dream period = 1 day score, and to compare the baseline to the mean of diary to dream period = 5–7 days. As the direction of the two hypotheses was clearly predicted a 1-tail test was used. Wilcoxon tests were then used to compare matching scores of the baseline (using the mean of –12 to –1 days, but excluding the score for the –7 day period) to the –7 day matching and the +8 day matching scores, so as to test hypothesis 3.

For the ratings by the three independent judges a mean score for each diary day to dream period was calculated so as to combine the three judges' scores for each participant. These means for each participant were then combined into the base-

line, 1 day, 2–4 days, 5–7 days and 8–12 days categories, and the statistical analyses as stated above for the participant ratings were then repeated.

3. Results

Ninety-six dreams were collected from the eight participants (minimum from a participant = 10, maximum = 14). This yielded a total number of dream report to diary record matches of 1334. The high number of matches did result in a high workload: participants reported a mean of 12.6 h (SD = 8.9) for undertaking the diary keeping and rating; the independent judges reported spending a mean of 13.0 h (SD = 1.7).

Excerpts from a diary record and dream report, the comparison of which was rated as five by the participant (“multiple strong matches between dreams and events”), are as follows:

Diary record: “... discussing being at work, in Next clothes shop, stressed with the pre-Christmas rush and in the evening watching Shrek and other programmes.”

Dream report: “... was working in Next, but it wasn't the Next store that I work in...” and later “... was in the car... spotted a big Shrek model... it was a type of Disneyland but it only had Shrek and Wall-e things in.”

Excerpts from a diary record and dream report, the comparison of which was rated as two by the participant (“some vague resonances, it is possible that dream and day are related”), are as follows:

Diary record: “... spent evening with boyfriend and argued before going to bed...”

Dream report: “... on holiday with boyfriend...”

Fig. 1 shows the mean matching scores (and SDs) for the eight participants at baseline and at each of the diary day to dream report periods. Wilcoxon test results of comparison of the 1 day period with surrounding periods were all significant (comparison of day = 1 with days = -2, -1, 2 and 3; all $z_s > 2.2$, all $p_s \leq .01$: -2 days period, mean matching = .74 (SD = .59); -1 day period, mean matching = .83 (SD = .65)).

Fig. 2 presents the means (and SDs) for five categories of periods for participants' diary record to dream report matchings: these diary day to dream periods are -12 to -1 days (baseline); 1 day; mean of 2–4 days; mean of 5–7 days, and mean of

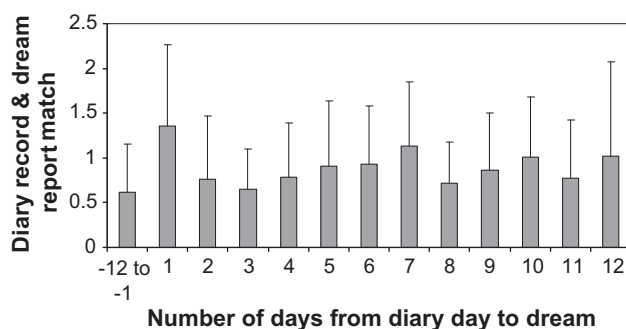


Fig. 1. Means (and SDs) of self-rated matching of dream reports to diary records as a function of time period between diary day and dream. Notes: diary record to dream report matching scores range from 0 (no matches at all) to 5 (multiple strong matches). Positive x axis numbers indicate that the dream occurred after the diary day. Negative x axis numbers (i.e., days = -12 to -1) indicate that the dream occurred before the diary day. Number of days = 1 refers to the dream being matched to the day occurring immediately before the dream, i.e., the day-residue day. Where number of days from diary day to dream = +8, the day to which the dream is matched is the same day of the week as the day-residue day.

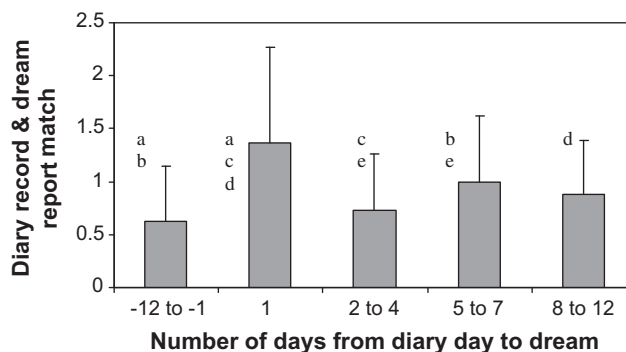


Fig. 2. Means (and SDs) of self-rated matching of dream reports to diary records as a function of time period categories between diary day and dream. Notes: diary record to dream report matching scores range from 0 (no matches at all) to 5 (multiple strong matches). Comparisons a with a and b with b and c with c, $p < .01$. Comparison d with d, $p = .01$. Comparison e with e, $p = .025$.

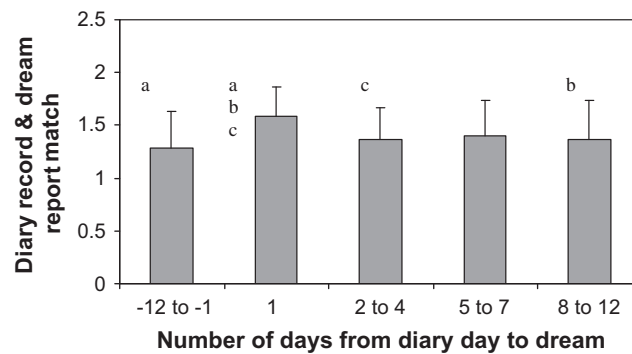


Fig. 3. Means (and SDs) of independent judges' ratings of matching of dream reports to diary records as a function of time period categories between diary day and dream. Notes: diary record to dream report matching scores range from 0 (none at all) to 6 (extremely strong). Comparisons a with a and b with b, $p = .01$. Comparison c with c, $p = .025$.

8–12 days. A Friedman test showed that there was a significant ordering effect for the five categories ($\chi^2(4) = 14.20$, $p < .01$). Testing hypothesis 1 (day-residue effect), a Wilcoxon test showed that matching of dream reports to the diary records of the immediately preceding day was significantly higher than baseline ($z = 2.38$, $p < .01$). The 1 day period was also significantly higher on dream report to diary record matching than the 2–4 day period ($z = 2.52$, $p < .01$) and the 8–12 day period ($z = 2.24$, $p = .01$). Testing hypothesis 2 (dream-lag effect), a Wilcoxon test showed that matching of dream reports to the diary records from 5 to 7 days previously was significantly higher than baseline ($z = 2.38$, $p < .01$). The 5–7 day period was also significantly higher on matching than the 2–4 day period ($z = 1.96$, $p = .025$) but not significantly higher than the 8–12 day period ($z = .70$). Non-significant differences were found comparing the 2–4 days period with baseline ($z = 1.12$) and comparing the 8–12 days period with baseline ($z = 1.54$).

The percentage of dream report to diary record matchings that were scored as at least three (i.e., at least a weak relationship) were: baseline, 9.9%; 1 day, 25.0%; 2–4 days, 9.6%; 5–7 days, 17.0%; 8–12 days, 13.1%. Odds ratios of scoring ≥ 3 for the day-residue and dream-lag periods compared to baseline were thus 3.0 and 1.9 respectively. The percentage of dream report to diary record matchings that were scored as at least four (i.e., at least one strong match or several matches) were: baseline, 3.1%; 1 day, 14.6%; 2–4 days, 4%; 5–7 days, 5.5%; 8–12 days, 5.0%. Odds ratios of scoring ≥ 4 for the day-residue and dream-lag periods compared to baseline were thus 5.3 and 1.8 respectively.

To test hypothesis 3 the mean for the matching scores of periods –1 to –12 days, but excluding the –7 days period, was computed (mean = .64, SD = .53). This was then compared to the means for the periods that used a diary day that was the same day of the week as the day-residue day (latter is the +1 day period), i.e., diary day to dream periods of +8 days and –7 days. Wilcoxon tests showed that this baseline mean was not significantly different from the +8 days diary day to dream period rating ($z = .84$), but was significantly higher than the score for the –7 days period ($z = 2.24$, $p < .05$; –7 days period, mean matching = .44 (SD = .54)). There was thus no evidence for the weekly periodicity confound.

The 1334 dream report to diary record matches were then rated by the three independent judges. Inter-rater reliabilities ranged from .37 to .48 (Spearman's rho). Fig. 3 presents the means of the independent judges' ratings of dream report to diary record matches for the five categories of period between diary day and dream. There was a significant ordering effect for the five categories (Friedman test ($df = 4$), $\chi^2 = 10.50$, $p < .05$). Wilcoxon tests showed that matching for the 1 day period was significantly higher than baseline ($z = 2.24$, $p = .01$) and significantly higher than the 2–4 days and 8–12 days periods ($z = 1.96$ and 2.24 respectively, $ps = .025$ and $p = .01$ respectively). However, the 5–7 days period did not differ significantly from baseline, nor from 2 to 4 days nor 8–12 days periods ($z = .98$, $.28$ and $.56$ respectively).

4. Discussion

This study has replicated Nielsen et al.'s (2004) 5–7 day dream-lag effect using participant ratings, but not with ratings by independent judges. For participant ratings the level of matching of dream reports to diary records at 5–7 days was significantly higher than baseline and significantly higher than at the 2–4 day period. This resurgence of incorporation of memories into dreams supports the view that sleep is involved in memory consolidation (Stickgold, 2005; Walker, 2005), with dream content reflective of that consolidation. Evidence that NREM dreams may reflect memory consolidation during sleep is provided by Wamsley, Perry, Djonlagic, Babkes Reaven, and Stickgold (2010), where 30% of all NREM dream reports of participants learning a skiing arcade game were related to the task. Furthermore, improved performance at retest on a maze virtual navigation task is strongly associated with task-related NREM dream imagery during an intervening afternoon nap, but not with task-related thoughts during wakefulness (Wamsley, Tucker, Payne, Benavides, & Stickgold, 2010). Regarding the time-course of this sleep-related consolidation, Nielsen and Stenstrom (2005) argue that the relocation of memories from the hippocampus to the neocortex occurs over time, in some cases over years, but they review several animal studies which suggest that a major transition from hippocampus to neocortex takes place over approximately 1 week, thus providing a theoretical basis for the dream-lag phenomenon. Furthermore, Schredl's (2003) model of dream and waking life

continuity allows for this continuity being modulated by the time interval between the day of the waking experience and the occurrence of the dream.

Although a possible weekly periodic confound has been proposed as a cause of or as contributing to the dream-lag effect, no evidence was found for this. However, even though there was not a significant peak at the precise +8 and –7 days time-points examined, the primary finding of a peak in incorporation of memory elements from 5 to 7 days previously clearly represents an increase in incorporations occurring after about a week. There thus remains a possibility that the anticipation of weekly recurring events contributes to the 5–7 days peak.

4.1. Shortcomings of the design

We accept that the baseline measure, in addition to being confounded by the incorporation into dreams of expectations for what will occur on the next or later days, may be also confounded at the point of rating by the knowledge that the participant has that the dream occurred before the diary day to which it is being matched. The latter confound could occur despite the rating task utilising a randomised order of dream reports, and despite the instruction to disregard whether the dream occurred before or after the diary day. The latter confound would have the effect of reducing the baseline mean.

A second limitation of this study is that whereas a rating of degree of matching between diary records and dream reports was elicited, the basis for the matching was not recorded, due to the heavy workload that the study already placed on participants. Unlike Nielsen et al. (2004) this study cannot therefore distinguish between types of memory sources that may be contributing to the matches, and does not allow conclusions as to whether there are qualitative differences between the types of incorporation occurring in dreams 1 day after events, versus 5–7 days after events.

A third limitation is that the rating method allowed for a single score, without record of the number of features in the dream report or the diary record that were being compared. It might be possible to be more exact about the number of comparisons that are being rated if, for example, only one event per day was recorded, but in this case there may still be multiple comparisons being considered by the participant or judge between items of the dream and that single waking event.

Fourthly, a methodological problem that is insurmountable in a contemporaneous diary study is that asking participants to record events prior to dreaming may inadvertently bias their dreams towards incorporations. Saredi, Baylor, Meier, and Strauch (1997) and Nikles, Brecht, Klinger, and Bursell (1998) found an effect on later dream content of reflecting on current concerns, which thus cautions that using the daily diary method might affect subsequent dream content. The methodology used in this study was designed to elicit more reliable waking event details by recording the diary on a daily basis rather than relying on retrospective reports of the events of a previous day, and the benefit of this was considered to outweigh the problem of the keeping of a diary affecting dream content.

A final limitation of the study is that it is not known for each dream whether it was from REM or NREM sleep. This is important because it may be that different memory processes occur for dreams from different sleep stages (Baylor & Cavallero, 2001) or for dreams from early versus late in the night (Paller & Voss, 2004; Payne & Nadel, 2004).

4.2. Possible reasons for the failure to find evidence for the dream-lag effect with independent judges

The independent judges were able to replicate the day-residue but not the dream-lag effect that was found with participants' ratings. Similarly, in Nielsen and Powell (1992), ratings from two independent judges supported the day-residue but not the dream-lag effect. The latter paper proposed that the failure of judges to find the dream-lag effect may be due to qualitatively different features of day-time events being incorporated into dreams at the two different times, and Nielsen et al. (2004) extended this by detailing differences in delayed and day-residue incorporations, including the greater prevalence of problem resolution and positive emotions in delayed incorporations. It may be that judges are less able to identify these dream-lag specific incorporations, just as judges underestimate positive emotions in their ratings of dream reports in comparison to participants' own ratings (Schredl & Doll, 1998). There may also be a more general transformation or abstraction from the original experience in dreams 5–7 days after an event, just as increased abstraction occurs with increased duration of sleep (Wamsley et al., 2010), and a progressive decrease in direct references to waking life experiences occurs across a sequence of nights as well as across each night (Dement, Kahn, & Roffwarg, 1965). It may be that the participants' greater knowledge of their own lives allows them to better identify the more transformed and inferred references that may be present at the 5–7 day period.

4.3. Future research

The following lines of investigation can be suggested. Firstly, the sleep stages at dream recall should be assessed so that the 5–7 day dream-lag effect can be tested for in REM and NREM dreams separately. Secondly, the contribution of emotions to delayed dream incorporations should be investigated, although, as the diminishing of the emotional tone of memories by sleep over time is proposed by Walker (2009), it may be that emotions in dreams have diminished at the dream-lag time and thus might not be present in delayed dream incorporations. Finally, although not testable with such a small sample as here, there may be psychobiological or other characteristics of individuals who show more intensely the dream-lag effect. Of note is that Nielsen et al. (2004) only found a significant dream-lag effect for females, and all the sample in the current study were

female. Further research on larger samples than in this study should test for whether gender, or specific psychobiological variables, such as levels of cortisol during sleep (Payne & Nadel, 2004), interact with the dream-lag effect.

5. Conclusions

This small scale study has successfully replicated Nielsen et al.'s (2004) dream-lag effect using participants' own ratings in a solely female sample. The study did not find evidence for a confound of weekly recurring events. That ratings from independent judges identified a day-residue but not a dream-lag effect may indicate that dream-lag incorporations are more indirect and abstract than day-residue incorporations. The study supports proposals for sleep-dependent consolidation of memories and for dreams to be reflective of such processes.

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