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## The 'Dream-Lag' Effect: A 6-day Temporal Delay in Dream Content Incorporation†

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*The temporal relationship between daily events and their incorporation into dreams was studied. In two experiments, a 6-day delay between event occurrence and dream incorporation was found. Moreover, variations in incorporation across a 7-day-period were found to follow a sinusoidal pattern. These results implicate dream incorporation in the learning consolidation functions of REM sleep.*

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Theories of dream function are frequently based upon observations about the correspondence between events of the day and dreams of the subsequent night. According to many such theories, the recurrence of important daily events in nighttime dreams is evidence for a continued processing of those daily events. Such recurrences are said to be 'incorporated' into dream content, and have been studied experimentally with a variety of instruments.<sup>1</sup> Accordingly, a typical dream incorporation study involves presentation of an experimental pre-sleep stimulus and subsequent assessment of references to that stimulus in dreams collected from the next available REM periods (e.g., 2, 3). Thus, most incorporation research is guided by an assumption of temporal contiguity between daytime events and nighttime mentation, i.e., that daytime events will recur in dreams after a 1-day or, at most, a 2-day delay.

This assumption of temporal contiguity was held by Freud,<sup>4</sup> who used the post hoc method of free association to demonstrate that clients could associate dreams from a given night to waking events from the previous day — events he termed day residues. Experimental studies have generally confirmed the occurrence of day residues. For example, residues of events recorded in day journals were found to occur more than twice as often in dreams recalled 1 day after the entry than dreams recalled 2 to 3 days after the entry.<sup>5</sup>

Other research findings suggest that greater delays in dream incorporation can occur, however. Cartwright<sup>6</sup> used

erotic films as a pre-sleep stimulus and found that incorporations of a film were more likely to appear in dreams occurring on the second, rather than the first, night after exposure. Verdone<sup>7</sup> asked participants to estimate the time period with which dream elements (scenes, characters, etc.) were associated. Estimates ranged from "earlier this evening" to "greater than 5 years ago," but most frequently was "the past week" and not "yesterday." Finally, McGregor<sup>8</sup> found evidence of an affective and motivational correspondence between a lab night dream and events which occurred over the 10-day period preceding the dream. These studies together are consistent with the notion that temporal contiguity is not an invariable aspect of dream functioning, i.e., that substantial incorporations may occur after delays which are longer than 1 day. We tested the hypothesis that dreaming may involve temporal delays in incorporation of daytime events which are longer than 1 or 2 days. In two experiments, we examined whether dream incorporations of an important daytime event would occur after temporal delays of up to 7 days.

### EXPERIMENT 1

#### Method

Experiment 1 was a prospective pilot study of the dream-lag effect. One hundred and twenty-nine students from introductory psychology classes were asked to keep written records of their dreams at home for a one-week period. After this period, they returned their records to the laboratory. They were then asked to take ten minutes to list and date the most significant events that had happened to them during that week. Descriptions for each event were thus typically brief — one or two sentences in length (e.g., Thursday, Oct 1, 'I had a fight with my boyfriend. I felt really bad.').

From each participant's list of events, and without reference to their dreams, one target event was selected which met the following two criteria: (a) the event was relatively specific and (b) the event occurred relatively early in the week. The date of each target event and of each individual dream was masked, and the target event was clipped to that participant's dream diary. To help obscure the temporal relationship between the target event and the dreams and to compensate for the fact that the order of the dreams was not scrambled, a judge was given false information that the target event could have occurred any time during

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atory study, and were well-rehearsed in all aspects of the procedures used. The event to be scored for incorporation into the diary dreams thus consisted of any aspect of the lab procedures or physical environs recognizable as such by the judges (e.g., presence of electrodes, lab equipment, experimenters, self-reflection instructions, etc.). Unlike in Experiment 1, dreams were not rated separately for affect incorporation in this experiment. In summary, the design of Experiment 2 was an improvement over that of Experiment 1 in several respects: 1) dream records were collected long before any hypothesis about the dream lag effect was conceived, minimizing opportunities for experimenter bias and demand characteristics; 2) temporal order of the dream records was randomized, eliminating possible time-of-week biases in the ratings; 3) high dream recallers were used, increasing the number of dreams recorded later in the week; 4) the pre-sleep stimulus was a relatively constant event with which judges were completely familiar, permitting more precise ratings of incorporation; 5) dreams were independently rated by two judges, allowing determination of inter-rater correspondence.

## Results

Unlike Experiment 1, the number of dreams reported throughout the week for Experiment 2 was relatively constant; totals for Days 1 to 7 were 24, 20, 27, 22, 17, 21, and 22, respectively. Data for all Days was therefore included in the analyses.

Incorporation ratings by Judge 1 were consistently higher than those by Judge 2. Nevertheless, rating profiles for the two judges were very similar; the correlation of incorporation ratings between judges was highly significant ( $r=.56$ ,  $p<.001$ ,  $df=155$ ), even when dream records for which both judges scored incorporation as 0 were excluded ( $r=.40$ ,  $p<.001$ ,  $df=102$ ). The percent of variance accounted for by the two judges was not large, however ( $R^2=.36$  for all records).

Ratings were analyzed separately for Judges 1 and 2 using the same statistical procedures as in Experiment 1. The pattern of results for the two judges was generally similar. The main effect for Days was found to be non-significant for Judge 1 and marginally significant for Judge 2 ( $F(1,39.5)=2.58$ ,  $p=.08$ ). However, for both judges, Day 6 emerged as a peak incorporation day (see Figure 2). For Judge 1, planned comparisons revealed that the Day 6 incorporation mean (2.00) was greater than the means for Day 2 (.70;  $F(1,32.1)=5.93$ ,  $p=.02$ ) and Day 3 (1.11;  $F(1,32.1)=3.20$ ,  $p=.08$ ), but not Days 1 (1.50), 4 (1.23), 5 (1.71), and 7 (1.23).

For Judge 2, planned comparisons revealed that the mean for Day 6 (1.24) was greater than the means for Day 2 (.30;  $F(1,39.5)=9.69$ ,  $p=.004$ ), Day 3 (.48;  $F(1,39.5)=7.28$ ,  $p=.01$ ), and Day 4 (.36;  $F(1,39.5)=8.83$ ,  $p=.005$ ), but not greater than the means for Days 1 (.79), 5 (.94), and 7 (.36). Also for this Judge, mean incorporation for Day 5

was marginally greater than the mean for Day 4 ( $F(1,39.5)=3.43$ ,  $p=.07$ ).

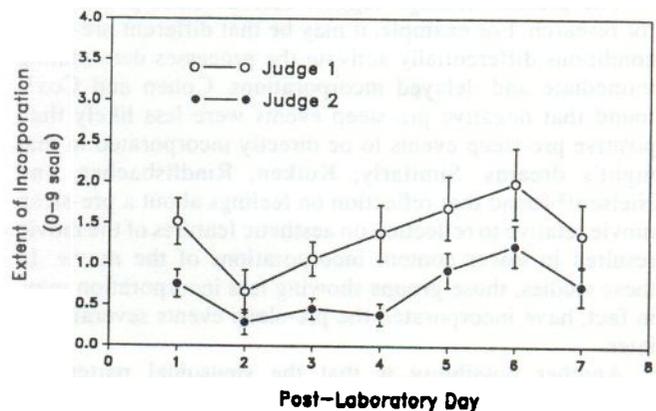
A marginally significant linear trend was found for Judge 2 ( $F(1,32.1)=3.87$ ,  $p=.06$ ), indicating a tendency for incorporations to increase across Days 1 to 7. The linear trend accounted for 75% of the variance ( $R^2=.75$ ). Significant cubic trends were observed both for Judge 1 ( $F(1,32.1)=4.56$ ,  $p=.04$ ) and Judge 2 ( $F(1,39.5)=6.84$ ,  $p=.01$ ). In both cases, these trends accounted for more variance ( $R^2=.78$  and  $.87$ , respectively) than the linear trends.

## DISCUSSION

The present results support the hypothesis that substantial incorporation of daytime events into dreams occurs after delays of greater than 1 or 2 days. Specifically, in two experiments dream incorporations were found to peak approximately 6 days after the occurrence of a significant daytime event. In addition, in both experiments ratings of incorporation across days showed similar patterns of fluctuation, especially when the discarded results from Day 7 of Experiment 1 were again included.

For Experiment 1, but not Experiment 2, a high level of incorporation was found for Day 1, as would be expected from previous research.<sup>(1-4)</sup> The fact that lab night dreams were not included in analyses of the data for Experiment 2 may account for the absence of this day residue effect in Experiment 2. This possibility is consistent with the finding that incorporation of lab experience often occurs in lab night dreams.<sup>(11, 12)</sup> In fact, later examination of the lab night dreams for participants in Experiment 2 suggested that laboratory incorporations were probably higher and more explicit in these dreams than in the home diary dreams collected on Day 1. If the lab night dreams had been included in the sample (lab night becomes Day 1, Day 1 becomes Day 2, etc.), incorporation ratings for Day 1 may have been higher and the 7-day profile of the ratings even more similar to that found for Experiment 1.

Figure 2. Mean laboratory incorporation ratings for Experiment 2



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