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BRIEF REPORT

The Relationship Between Dreams and Subsequent Morning Mood Using Self-Reports and Text Analysis

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Abstract
While material from waking life is often represented in dreams, it is less clear whether and how dreams impact waking life. Here, we assessed whether dream mood and content from home diaries predict subsequent waking mood using both subjective self-reports and an objective automated word detection approach. Subjective ratings of dream and morning mood were highly correlated within participants for both negative and positive valence, suggesting that dream mood persists into waking. Text analyses revealed similar relationships between affect words in dreams and morning mood. Moreover, dreams referencing death or the body were related to worse morning mood, as was first-person singular pronoun usage (e.g., "I"). Dreams referencing leisure or ingestion, or including first-person plural pronouns (e.g., "we"), were related to better morning mood. Together, these results suggest that subjective experiences during sleep, while often overlooked, may be an important contributor to waking mood.

Keywords Sleep · Dreaming · Emotion regulation · LIWC

Introduction

While many studies have emphasized a strong bidirectional relationship between sleep and mood (Vandekerckhove & Cluydts, 2010), relatively few have addressed how subjective experiences during sleep influence subsequent waking affect. When retrospectively surveyed about the perception of how dreams influence their waking life, nearly 40% of participants report that their dreams impact their waking mood more than once a month (Schredl, 2000, 2009). In a diary study where participants reported the perceived influence of dreams on waking mood daily, both positive and negative dream moods influenced daily mood, especially when intense (Schredl & Reinhard, 2010). This appears to be true for a variety of emotions, such as exhilaration and contempt (Yu, 2007), as well as cognitive features of dreams such as mindfulness and self-reflection (Lee & Kuiken, 2015). On mornings after nightmares, participants report higher anxiety, sadness, and even physical pain (Köthe & Pietrowsky, 2001), and having frequent nightmares is associated with higher waking distress and lower well-being (Blagrove et al., 2004).

Previous work has primarily relied on self-report measures of dream emotion to assess relationships with morning mood. Text analytic approaches can also be applied to dream reports to extract more objective affect ratings and other content scores (Bulkeley & Graves, 2018; Hawkins II & Boyd, 2017). In the current study, we combined these approaches to investigate how dream affect and other aspects of dream content influence morning mood. Towards this aim of replication and extension, we quantified similarities and differences between emotion in sleep and wake, and explored different aspects of dream content that are associated with morning mood.

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Methods

Participants

Participants were recruited through the use of a university-wide email advertisement. In addition to general recruitment, we targeted individuals who recall weekly bad dreams (defined as *a mild negative dream*) or nightmares (defined as *an intense negative dream that wakes you suddenly*). Potential candidates completed a screening questionnaire in which they self-reported their typical recall frequencies per month of three categories of dreams: neutral or positive dreams, bad dreams, and nightmares, using a 6-point scale (1 = *never*, 2 = *once per month*, 3 = *two to three times per month*, 4 = *once per week*, 5 = *two to four times per week*, or 6 = *most days*). Candidates were also screened and excluded for severe depressive or posttraumatic stress symptoms. More detail is available in the parent study, which assessed brain activity (see Carr, Summers, et al., 2020). Fifty-five eligible participants were enrolled in the study and signed Informed Consent. The final sample consisted of 54 participants (1 excluded for failure to complete dream diaries). The mean age of the sample was 23.9 years ($SD = 4.2$; 35 females, 19 males). Ethics were approved by the Swansea University Department of Psychology Research Ethics Committee.

Procedure

Each morning, participants filled in a brief dream diary via PsyToolkit (Stoet, 2017) that contained questions about their sleep and dream quality of the previous night. Participants completed up to 8 weeks of dream diaries during the study. For each diary entry, participants were first asked about sleep parameters including time to bed, minutes to fall asleep, minutes awake during the night, and time of waking. These questions were followed by a dream report and six scaled Likert questions (1–9 scale, with 1 being a very low level, 5 being a moderate level, and 9 being an intense level of the designated attribute; additional *no recall* option) regarding the intensity of negative and positive dream emotions, the amount of negative and positive dream body sensations, and the extent to which one was distressed or in a good mood upon awakening from the dream, all with respect to the last dream recalled from the night.

Analysis

Preprocessing and Report Exclusion Dream reports were stripped of all non-dream content via manual inspection. Two examiners were directed to remove all contextual material, commentary, instances of waking explanations, explicit references to the dream (e.g., "In the dream…"), and hesitations, stutters, or word repetitions. To remove morning reports with little to no dream content, reports with fewer than 30 words were removed (68% of entries). Because we were primarily interested in dream and wake emotion, any reports without ratings for all four of dream positive emotion, dream negative emotion, wake positive emotion, and wake negative emotion were removed (leaving 92% of reports that survived word restriction). After such exclusions, we removed any participants without 2 or more reports left ($N = 4$). The final dataset consisted of 671 dream reports from 46 participants. After exclusions, participants reported on average 14.6 dream reports ($SD = 9.4$), with a median of 12 and a range from 2 to 38 reports.

Correlation and Emotion Difference Analysis To quantify the relationship between self-reported dream emotions and wake emotions, we correlated dream and wake emotion separately for positive and negative valence. We used a repeated measures correlation, which takes advantage of sample dependence within participants and attempts to find a regression slope that is common across all participants (Bakdash & Marusich, 2017). To quantify change in emotion from dreaming to waking, we subtracted reported dream emotion intensity from reported wake emotion intensity, separately for each valence. Thus, a positive value results from *increased* emotion intensity from dreaming to waking, and a negative value results from *decreased* emotion intensity from dreaming to waking. Change in emotion intensity was averaged within each participant across mornings and compared against zero using a two-tailed one-sample t test. A paired t test was used to compare the change in emotion intensity between positive and negative valence. These statistics were implemented using the *Pingouin* statistical Python package (Vallat, 2018).

LIWC and Regression Analysis Dream reports were submitted to Linguistic Inquiry and Word Count 2015 (LIWC), a text analysis software that takes a dictionary-based approach by returning word frequencies of a variety of validated categories (Pennebaker et al., 2015). Categorical word frequencies offered by LIWC include common linguistic features (e.g., articles and pronouns), psychological processes (e.g., positive emotion and certainty words), content words (e.g., family and body words), and punctuation (e.g., question marks and semicolons). We selected a subset of LIWC categories related to common aspects of dreaming and emotion in order to evaluate the relationship between dream content and waking emotion. LIWC categories were binned into superordinate groups for visualization and interpretation purposes (affect, personal concerns, characters, drives, and sensory). The affect group consisted of LIWC categories

anxiety, anger, sadness, and positive emotion. The personal concerns group consisted of LIWC categories death, religion, home, work, money, and leisure. The characters group consisted of male, female, friend, family, first-person singular pronouns (abbreviated "i"), and first-person plural pronouns (abbreviated "we"). The drives group consisted of risk, power, reward, affiliation, and achievement. The sensory group consisted of body, feel, hear, health, see, sexual, and ingestion. See Pennebaker et al. (2015) for example words from each category.

For each relevant LIWC category, word frequencies were derived for each dream report and submitted to a linear mixed effects model with waking negative emotion as the outcome variable, word frequency as predictor, and participant ID as random effect. Additional analyses were run including sleep efficiency as an additional predictor, where sleep efficiency was calculated as total time asleep (time in bed minus sleep latency and WASO) divided by total time in bed (risetime minus bedtime), multiplied by 100. Though both negative and positive waking emotion were reported each morning, we chose only one as the outcome predictor because the two responses were correlated ($r = -.35$, $p < .001$). We chose negative over positive emotion because of its clinical relevance, and because negative waking mood responses had wider response variation in the current dataset. Results were qualitatively similar when using positive waking mood as the outcome variable. All predictors and the outcome variable were z-scored to allow for the reporting of standardized regression coefficients. Reported p values were corrected for multiple comparisons across all word categories (28 tests) by adjusting for the false discovery rate (FDR) using the Benjamini–Hochberg step-up procedure. This analysis was performed using the *statsmodels* statistical Python package.

Results

Across our final sample ($N = 46$), average self-reported dream recall frequencies on the 6-point scale were 4.4 ($SD = 1.2$) for neutral or positive dreams (i.e., between one and four neutral/positive dreams per week), 3.6 ($SD = 1.5$) for bad dreams (i.e., between two and four bad dreams per month), and 2.4 ($SD = 1.3$) for nightmares (i.e., between one and three nightmares per month). For all further descriptive summary statistics, including average number of dream reports, dream word counts, dream and wake emotion ratings, sleep efficiency, and LIWC variables, see Supplementary Information.

Across participants, dream and waking mood were highly correlated for both negative ($r = .65$, $p < .001$) and positive valence ($r = .55$, $p < .001$; Fig. 1A). For negative valence, the change in emotion intensity from dream to wake was below zero ($t_{45} = 8.7$, $p < .001$, Cohen's $d = 1.29$), suggesting a dissipation of negative emotion from dream to wake (Fig. 1B). There was no change in emotion intensity for positive emotion ($t_{45} = 1.5$, $p = .134$, Cohen's $d = 0.22$). The change in emotion intensity significantly differed between negative and positive valence ($t_{45} = 6.1$, $p < .001$, Cohen's $d = 1.53$).

Language predictors are presented according to our custom superordinate groups, which are largely consistent with standard LIWC categories (Fig. 2). Unsurprisingly, affect word categories had the most predictive power on morning mood, with anxiety words predicting increased negative morning mood ($\beta = 0.14$, $p_{fdr} < .001$) and positive emotion words predicting decreased negative morning mood ($\beta = -0.16$, $p_{fdr} < .001$), while other affect words were not predictive (anger and sadness, p_{fdr}'s $> .25$). Word categories regarding personal concerns were predictive of morning mood. In particular, death words were predictive of increased negative morning mood ($\beta = 0.09$, $p_{fdr} = .030$), and leisure words were predictive of decreased negative morning mood ($\beta = -0.10$, $p_{fdr} = .012$). Money words trended in the direction of predicting less negative morning mood ($\beta = -0.07$, $p_{fdr} = 0.078$), and others were not predictive (p_{fdr}'s > 0.62). Character word categories were at times predictive of morning mood, primarily from pronoun usage. First-person singular pronouns were highly predictive of increased negative morning mood ($\beta = 0.12$, $p = .005$), while first-person plural pronouns were predictive of less negative morning mood ($\beta = -0.09$, $p = 0.030$). Beyond pronouns, male words trended as predictive of more negative morning mood ($\beta = 0.07$, $p_{fdr} = .078$), and no other categories were predictive (p_{fdr}'s $> .62$). Word categories regarding drives were not strongly predictive of morning mood, with only risk words trending ($\beta = 0.07$, $p_{fdr} = .125$) as predictive of increased negative morning mood (all other p_{fdr}'s $> .14$). Of sensory word categories, words relating to the body were predictive of increased negative morning mood ($\beta = 0.09$, $p_{fdr} = .030$), words relating to ingestion were predictive of decreased negative morning mood ($\beta = -0.09$, $p_{fdr} = .030$), and other sensory categories were not predictive (p_{fdr}'s $> .31$). Results were qualitatively similar when controlling for sleep efficiency, which itself was not a significant predictor of morning mood in any of the models (see Supplementary Information).

Discussion

Overall, results suggest that dreaming and subsequent waking mood are tightly bound. First, self-reported dream emotion was strongly predictive of waking mood, though on average negative dream emotion dissipated prior to or during waking. Second, text analysis applied to dream reports

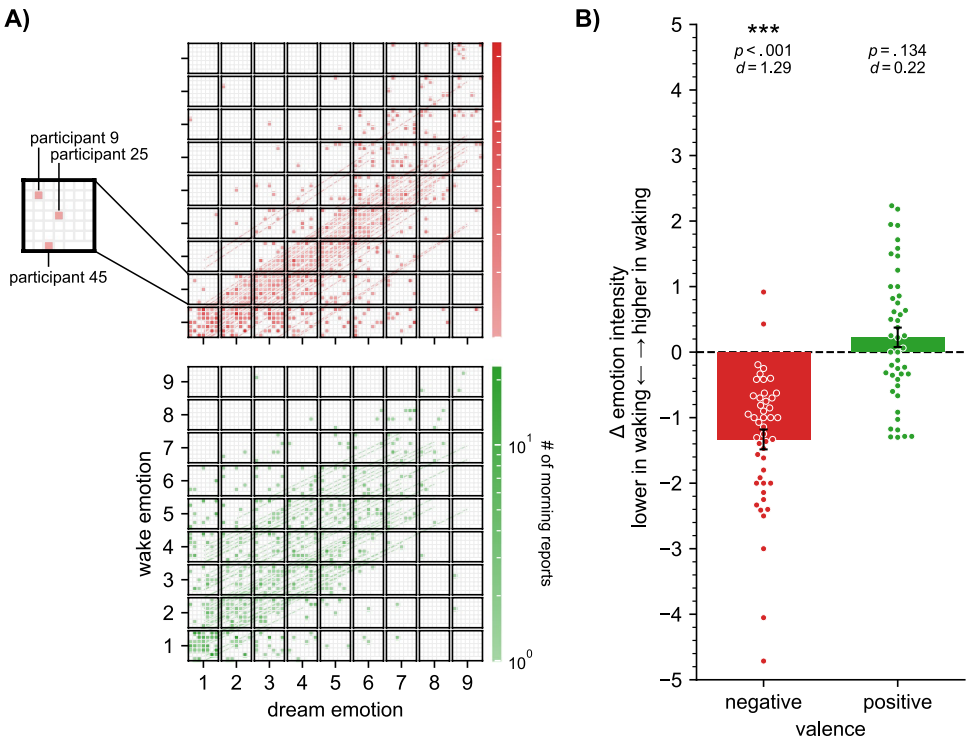

Fig. 1 Subjective dream emotion and waking emotion are tied, though not inextricably. (**A**) Both negative (top) and positive (bottom) self-reported emotion ratings were highly correlated across dreaming and waking. As a whole, both graphs illustrate results of the repeated measures correlation analysis with regression lines drawn for each participant. Within each graph, constituent grids at each Likert pairing reveal heatmaps, in which each individual square represents a single participant, and the shading of each square indicates the number of reports that participant contributes to the given Likert pairing. Ordering of participants is consistent across heatmaps. (**B**) Negative emotion, on average, decreased in intensity after awakening. Positive emotion was unchanged between dreaming and waking, though trended as increasing in waking. Each datapoint represents the average difference between reported waking and dreaming emotion intensity for a single participant.

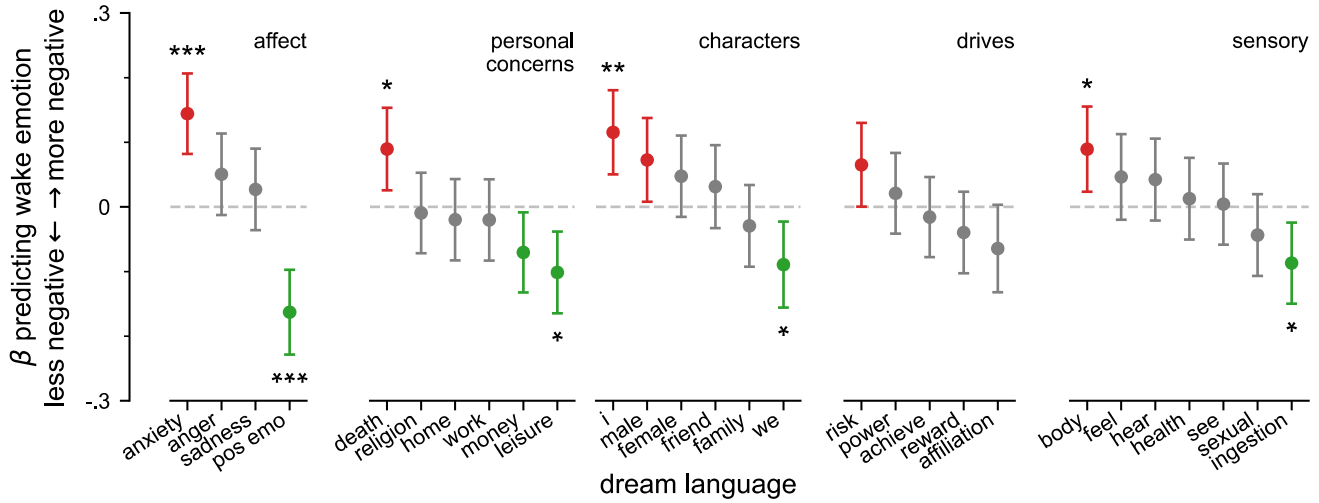

Fig. 2 Automated measures of dream content predict negative morning mood. Anxiety, death, body, and "i" words were strong predictors of high negative morning mood. Positive emotion, leisure, ingestion, and "we" words were strong predictors of low negative morning mood. Abbreviations are used for positive emotion ("pos emo") and achievement ("achieve"). Error bars represent 95% confidence intervals. Points are colored if significant at uncorrected level of $p < .05$ (red for positive betas predicting increased negative mood, green for negative betas predicting decreased negative mood). FDR-corrected p values indicated with asterisks at levels of $^{*}p_{fdr} < .05$, $^{**}p_{fdr} < .01$, $^{***}p_{fdr} < .001$

verified the close relationship between dreaming and morning mood, and revealed other content categories related to morning mood. Dreams of anxiety, death, the body, and first-person singular references related to more negative morning mood. Dreams of positive emotion, leisure, ingestion, and plural first-person references related to less negative morning mood. These effects occurred despite controlling for sleep quality (see also Barnes et al., 2020). Nevertheless, these findings are still limited only to dreams which can be remembered upon waking.

The spillover of dreaming into waking mood is reminiscent of sleep inertia, where impaired cognitive performance persists for a short period upon awakening. Dream emotion may lead to a similar type of "dream inertia" that persists on waking and dissipates over time. Our insight that, when morning mood does diverge from dream emotion it is typically less negative, is consistent with a putative function of REM sleep in processing emotional events and reducing the emotional tone of memories (Walker & van der Helm, 2009). Future work collecting mood reports across the day for several days would better elucidate both the directionality and time-course of this potential dream inertia.

Previous research on nightmares is also broadly consistent with the content that we found predictive of negative morning mood. Nightmares contain low rates of positive, and high rates of negative, emotion words (Bulkeley & Graves, 2018). Death is a common theme of nightmares (Bulkeley & Graves, 2018; Fireman et al., 2014; Schredl & Göritz, 2018), and body/somatosensory content is frequent in dysphoric dreaming, including threats of physical harm, falling, and paralysis (Robert & Zadra, 2014; Schredl & Göritz, 2018). Most aggressors in nightmares are, incidentally, male perpetrators (Schredl & Göritz, 2018). Post-trauma nightmares, compared with typical dreams, have reduced leisure word counts and increased risk words, as well as higher rates of singular first-person pronouns (Paquet et al., 2020). Notably, "finding money" and "eating delicious foods" are both positive typical dream themes (Nielsen et al., 2003). All of these patterns are consistent with word categories that we found predictive of morning mood, though it is important to consider the limitation that our sample was biased towards those that suffer from dysphoric dreaming.

Together, these findings begin to disentangle relationships between subjective sleep experience and waking mood and reveal specific affect and content categories in dream reports relevant to this relationship. With the ability to engineer and manipulate dream content on the horizon (Carr, Haar, et al., 2020), the identification of specific dream content that boosts waking mood could inform interventions that aim to improve well-being or reduce waking distress, such as lucid dreaming (Konkoly & Burke, 2019; Stocks et al., 2020). In sum, while oft observed that daily experience influences our nightly dreams, the present results suggest that dreams recalled upon awakening also influence subjective experience the following day.

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Additional Information

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Conflict of Interest The authors declare no competing interests.

Data Availability Data and materials are available in an OSF repository: https://osf.io/2xy5p/

Code Availability Analysis code is available in an OSF repository: https://osf.io/2xy5p/.

Ethical Approval Ethical approval was granted by the Swansea University Department of Psychology Research Ethics Committee.

Consent to Participate Informed consent was obtained from all participants included in the study.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s42761-021-00080-8.

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