REM sleep and dreams impact closeness to significant other: Daily associations between sleep, dreams, and attachment measures

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Summary. Objectives: Examine quantitative associations between REM sleep and dream content with measures of attachment; Test the hypothesis that REM sleep percentage (REM%) and dream content would predict daily changes in "closeness-to-significant-other" ratings. Methods: N=124 community volunteers participated in a two-week intensive-longitudinal assessment of mood, stress, social conflict, dream content measures, and sleep architecture, monitored with the DREEM3 Headband (DH) device. Multi-level modeling analyses were conducted with main and interaction effects to test the effect of daily and dream events on attachment.Results: Shifts in overnight closeness-to-significant other (SO) ratings were consistently predicted by lower levels of state attachment security. Social conflict also predicted positive overnight shifts in closeness-to-SO, with moderating effects of state attachment avoidance on social insecurity and closeness. Within-person dream content ratings had no influence on closeness-to-SO, but between-person dreamer agency had a negative impact and dream affect had a positive impact on interaction with state attachment security and avoidance. We also found that participants with higher between-person nightly levels of REM% had more positive overnight shifts in their morning closeness-to-SO ratings, indicating that intensity or amount of REM sleep mediates overnight shifts. Conclusions: REM intensity (duration/percentage) and state attachment mediate overnight shifts in subjective-ratings of closeness-to-SO.

Keywords: Attachment, REM sleep, dreams, DREEM Headband

1. Introduction

Bowlby (1969) and Ainsworth (1978) developed attachment theory. Bowlby regarded the attachment system as a biobehavioral regulatory process that adjusted physical and emotional closeness between caregiver and child. The attachment system expects the optimal bonding style called "secure attachment" wherein the infant is consistently cared for by the caregiver and therefore develops comfort with physical and emotional closeness and comfort with leaving the caretaker's immediate physical presence to explore.

Attachment orientations formed in childhood carry on into adulthood and were conceived by Bowlby (1969) as cognitive working models capturing perspectival relations between the self and the attachment object. That is, each of us cognitively represent attachment relations as representation of relations between the self and attachment object or significant other (SO). These models should be stable enough to be consistent across different life stages as well as applicable in novel contexts (Zimmerman, 1999). There are several different approaches for measuring attachment, which vary depending on the theoretical paradigm of the researcher and study design (Thompson et al., 2022). One key issue is whether or not attachment style should be best understood as a categorical (with the four traditional categories laid out by Ainsworth et al., 1978) or a dimensional construct. While the categorical approach has traditionally been favored by researchers, new analyses have found that a dimensional approach may be superior when dealing with multiple levels of analysis (Fraley et al., 2015). Another critical issue is the extent to which attachment psychological processes are dynamic across both short- and long-term timescales. Studies on short-term attachment dynamics have found that attachment can fluctuate in relation to different situations, both naturally occurring (Gillath et al., 2024) and experimentally induced through priming (Gillath et al., 2022), and these fluctuations are mediated by attachment-related traits, particularly anxiety. In addition, longitudinal studies have found that individuals can undergo substantial shifts in attachment over the course of their lifetime (Chopik et al., 2019). What these different issues reveal is that attachment is possibly best conceived as an interplay between long-term representations (often conventionally called Internal Working Models) and contextual factors, some of which can cause significant shifts in attachment traits. In this study, we focused on a particular vector of attachment change: Shifts in emotional closeness mediated by sleep and dreaming.

There is already a significant body of work documenting links between sleep and dream variables and attachment. Previous research (Scharfe & Eldredge, 2001; Sloan et al.,

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2007; Troxel et al., 2007; Veredecias et al., 2009; McNamara et al., 2001) has demonstrated that persons classified with 'anxious' attachment styles enter sleep faster, sleep longer, and recall more emotional dreams and nightmares than persons classified as avoidant or secure. Several teams have reported higher dream recall rates and dream intensity in insecurely attached individuals (McNamara et al., 2001; Selterman & Drigotas, 2009) as well as more frequent and more intense nightmares in insecure individuals (Csóka et al., 2011).

McNamara et al. (2001) found associations between attachment orientation, dream recall rates, and image intensity in dreams. McNamara et al. (2011) found that people classified as anxiously attached evidenced reduced REM latencies and were more likely to have dreams containing themes of aggression and self-denigration compared to people with other attachment styles. Further, Mikulincer et al. (2009; 2011) reported similar findings regarding associations between insecure attachment and negative self-concept in dreams, and also found that both attachment-related avoidance and anxiety correlated with less dream content denoting secure attachment such as less support seeking, less support availability, and less distress relief in dreams. Selterman and Drigotas (2009) found associations between attachment insecurity (avoidance and anxiety) and conflict in dreams that contained romantic partners. Selterman et al. (2012; 2014) later reported that participants classified as secure in their current relationships tended to report dreams that contained more secure base content, and that attachment-related dream content influenced daytime attachment behaviors. Specifically, they found that the frequency with which participants reported dreams about their romantic partners was positively associated with the extent to which they interacted with their partners and felt more love/closeness on days subsequent to dreaming about them. When people high in attachment avoidance had greater negative affect in dreams of their partners, they reported interacting less with their partners on subsequent days. For those high in interdependence, having a dream containing sexual behavior with one's partner was associated with increased love/closeness on subsequent days.

Both McNamara et al. (2018) and Nordin & Bjälkebring (2021) have found that agency-loss in the dreamer corresponds with increased levels of felt agency from other characters in the dream. In particular, McNamara et al (2015) also found that loss of agency corresponded with the emergence of unpleasant and powerful characters who drive the dream narrative. Cassidy (2021) argued that the Internal Working Models that underlie attachment representations are primarily tuned to guide the individual in situations involving threats in order to seek safety. Contexts of threat thus activate these representations and trigger attachment responses, which will vary depending on the individual's overall levels of security, anxiety, and avoidance. We suggest that reductions in dreamer agency thus likely activates attachment representations and hypothesize that low agency dreams should impact feelings of partner closeness in ways that are highly mediated by underlying attachment representations.

Although the above set of studies suggests that reliable associations exist between measures of REM sleep, dream content and attachment orientations and dynamics, all except the Selterman studies were cross-sectional and, thus, were not able to assess the extent to which sleep variables and dream content causally influenced daytime attachment measures, such as emotional closeness (to SO) ratings. Intensive in-the-home longitudinal designs on attachment, sleep and dreams are necessary to: 1) identify which factors predict short-term changes in closeness-to-SO ratings and subsequent reactive behaviors; 2) minimize retrospective bias concerning relationship closeness, distress and phenomenology while enhancing real-world validity; 3) observe sleep architecture over an extended period of time in a natural setting; and 4) increase statistical power via aggregation across repeated measurements thus ameliorating effects of within-person variability and improving reliability by estimating average functioning.

Given the above literature review, we sought to test the hypothesis that trait and state attachment would predict shifts in a key element of attachment orientation-emotional closeness ratings to a SO. In addition, given that previous work reviewed above linked dream intensity (length, vividness) and REM intensity (duration, percentage of total sleep) to attachment variables, we further hypothesized that REM sleep, as measured by the portable DREEM 3 headband (DH) device, and selected dream content indices would mediate any associations between attachment orientation and overnight emotional closeness to SO ratings.

H1: Both trait and state attachment anxiety and avoidance would predict lower levels of changes in closeness to SO ratings overnight.
H2: Dream content indices of affect, word length, and agency would mediate the impacts of state attachment on overnight rating changes.
H3: Daily experiences of social conflict, insecurity, and closeness would drive overnight shifts in closeness to SO and these effects would be mediated by attachment.
H4: REM sleep percentage (REM%) would mediate the impacts of attachment on overnight rating changes.

2. Methods

We recruited volunteers from the community who answered online adverts for a study on sleep, dreams, and nightmares. To be eligible, participants were required to: be at least 18 years old, reside in the US, speak and read English, have reliable Wi-Fi, not have a current psychiatric or neurological diagnosis, and not have a current diagnosis of a sensitive skin condition (this final criteria was added during data collection after a few participants reported a negative, although non-severe, skin irritation from wearing the DH). Volunteers (N=124) were invited to participate in a two-week study in the home during which time they completed surveys every night and every morning. We aimed to have participants contribute a maximum of 14 and a minimum of 10 days and nights of observations of daily measures described below. Surveys were distributed online using Qualtrics, with unique identifying numeric codes assigned upon completion of our baseline measures, enabling researchers to track participants during the longitudinal portion of the study. Participants received the first longitudinal survey link manually, then the system automatically sent subsequent links upon survey completion. Participants were instructed to complete the night surveys right before going to bed and the morning surveys right when they woke up and were permitted to complete the surveys on either their phone or computer. Researchers monitored survey submissions and reached out with survey links and reminders if participants did not submit at their usual times (participants were instructed to follow their normal sleeping schedule, so these times varied).

All participants were instructed to complete all survey measures. In addition, approximately half of these participants (N = 61, randomly assigned) were sent the DH, designed to derive sleep architecture measures. Participants were sent the DH along with Velcro extensions, an elastic sweatband, and a DH charger via USPS to their home, then met with a researcher over Zoom for a tutorial on how to properly wear it to achieve the best signal quality. They were taught how to start the recording when they were ready to start falling asleep and how to stop the recording when they were ready to wake up in the morning as well as the procedure for charging and ensuring the data successfully uploaded to the DH servers where researchers could monitor data quality. After the training, they were instructed to wear the DH that night for habituation and to be sure they were wearing it in the best position for a quality recording. If the channel quality was extremely poor on multiple sensors, participants were asked to adjust the fit for another trial night. Those who continued to experience difficulties met with a researcher over Zoom again to troubleshoot before continuing. Once an acceptable record quality was achieved, participants began the intensive longitudinal portion of the study, wearing the DH for 14 consecutive nights.

IRB/ethics: The study was overseen by the National University Institutional Review Board, study number 2022-184-OTH, dated May 17th, 2022, and informed consent was received prior to participation. Due to the remote nature of the study, participants were provided with a PDF of the consent form via email and met on Zoom with a researcher who read the consent letter aloud and answered any participant questions.

Sample characteristics: Our total number of participants was 124. The completion rate of daily/nightly assessments was 97.5% overall (98% morning surveys completed, 97% night surveys completed). Participants were on average 45.71 years old (SD = 14.93), predominantly female (69.4%), and White (66.9%). Most participants had completed a Bachelor's degree or higher (67.7%), and over half (65.3%) had a household income of over $50,000 a year.

2.1. Daily/Nightly measures (See supplementary materials for full questionnaires)

Sleep architecture: To collect sleep data from participants in their homes we used the DH (Beacon). The DH has been successfully utilized in well over 30 studies across very diverse populations including people during COVID lockdown (Pépin et al., 2021, 2022), deaf people (Carr et al., 2023), people with ADHD (Vojnits et al., 2023, 2024), Parkinson's (Anjum et al., 2024; González et al., 2024), Alzheimer's (Muurling et al., 2021), PTSD (Saguin et al., 2021; Youngren, 2022), nightmares (Schwartz et al., 2022), chronic pain (Zambelli et al., 2022), sleep apnea (Waeber et al., 2020, 2021), narcolepsy (Asp et al., 2022), insomnia (Arnal et al., 2020), and of course healthy volunteers.

Most importantly, DH has been previously validated against gold-standard polysomnography (PSG) and sleep staging scoring experts in at least 6 peer reviewed publications utilizing healthy volunteer adults: Debellemaniere et al., (2018) N=24; Chinoy et al., (2022) N=21; Thorey et al., (2019) N=25; Thorey et al., (2020) N=42; Birch, (2021) N=10; and Arnal et al., (2020) N=25. In 5 of these 6 studies the DH achieved an accuracy of at least 80% for all sleep stages (N1, N2, N3 and REM) studied (Debellemaniere et al. (2108), however, focused only on N3), while one only reached 75% accuracy (Birch, 2021). In short, the DH has consistently demonstrated very high reliability in identification and estimates of sleep staging metrics against PSG and AASM Board certified sleep stage scoring experts.

The DH is made of foam and fabric with an elastic strap and comes with optional Velcro extensions to ensure a secure fit for different head sizes. The DH contains embedded sensors including frontal (F7 and F8) and occipital (O1 and O2) yielding derivations F7-O1, F8-O2, F8-F7, and F8-O1 (bandpass Butterworth order 2 between 0.4Hz and 25Hz. Three additional notch filters are added to remove 50Hz and 60Hz electrical noises, and 62.5Hz). To find cycles per minute, an accelerometer tracks movements on the x, y, and z axes for 3 channels to calculate breathing rate, which go through a band pass filter (0.1Hz, 0.5Hz), followed by Principal Componential Analysis to identify the component of greatest variability, and zero crossing detection. A bone-conduction speaker delivers audio messages to the wearer when recordings are started and stopped, as well as a notification that a session is in progress if the button is pressed after the DH has successfully begun recording. The DH is used in conjunction with the 'Alfin' application, freely available on Android and Apple iOS, which allows the transfer of stored data via Bluetooth. Participants were provided with app log-in details to ensure full data confidentiality and anonymity. Users can view metrics regarding their night's sleep on the app and researchers can access the DH servers to see data that the algorithm has automatically scored.

These capacities, together with the price, ease of use, precision and reliability, and the collection of raw EEG and other relevant physiological data, make the DH an ideal candidate for high-quality large-scale longitudinal sleep studies in the home. Via the DH, we measured several sleep architecture variables. These are computed for each night based on the 30-s resolution data provided by the DH: Total Sleep Time (TST, mins), Sleep Efficiency (SE, %), Sleep Onset Latency (SOL, mins), Wake After Sleep Onset (WASO, mins), Rapid-Eye-Movement (REM) Sleep (%), N3 Deep Sleep (%), and N2 Light Sleep (%).

We sent 80 participants the DH to use during the intensive longitudinal study. We had some participants (n=13) discontinue usage of the DH for various reasons. There were also 3 participants who experienced skin irritation from wearing the DH and took a short break from wearing it during the study. Once we organized the data from participants who used the DH during the intensive longitudinal phase (896 recordings from 67 participants), we excluded data from nights where "proportion on head and scorable" was below 65% and/or channel quality for F7-F8 was below 50% (n=149 recordings). Then, all data from participants with less than 7 nights of good quality was removed (6 participants, 28 recordings). Additionally, 12 DH recordings were excluded either because participants alerted their research contact that they started the recording part way through the night, or they did not have corresponding morning surveys. This left us with at least 7 nights of quality DH data from 61 participants for a total of 707 usable recordings. These remaining DH recordings had an average of 89.18% (SD=9.18) "proportion on head and scorable" and an average F7-F8 channel quality of 87.76% (SD=9.87).

Questionnaires: All 124 participants completed all surveys whether they were wearing the DH or not. See Supplementary Materials for full Questionnaires.

Daily assessments of closeness to SO: At both morning and night, we asked participants to rate their closeness to their SO from -10 to 10. To measure overnight shifts, we subtracted the night values from the following morning (closeness to $SO_{morning}$ - closeness to SO_{night} = closeness to SO_{delta}).

Mood: At both morning and night, we asked participants to complete the Scale of Positive and Negative Emotions (SPANE), a well-validated 12-item scale that measures different dimensions of positive and negative affect (Diener et al., 2010). To measure overnight shifts, we subtracted the night scores from the morning scores, and then took the mean of the positive and negative subsets to create SPANE-P_{delta} (Cronbach's α = .83) and SPANE-N_{delta} (Cronbach's α = .70) respectively.

Daily Social Events: Each night the participants are asked to list 3 social interactions with a brief description. These interactions are then rated based on feelings of closeness as well as several other dimensions (prompted by "How much did "Social Interaction" involve the following activities"), with each score ranging from 1-7. These dimensions were adapted from Reis et al. (2000), who found a correspondence between social events and the satisfaction of relatedness needs. For this study, we utilized the ratings of social closeness (Soc. Close): "I felt close and connected with whom I was with." In addition, we utilized the scores which asked participants to rate the extent to which the social interaction involved insecurity (Soc. Insecure: "feeling self-conscious, judged, or insecure") and conflict (Soc. Conflict: "arguing or having conflict"). All items were averaged across the three social events to get a global estimate of social dynamics for that day.

State Attachment Measures: Recent studies of attachment have indicated that attachment dynamics may undergo day-to-day fluctuation in addition to being a discrete trait of individuals. Every night participants completed the Stable Attachment Adult Attachment Measure (SAAM) developed by Gillath et al. (2009), a 21-item questionnaire that reframes attachment questions in terms of how participants are feeling at that moment. Subsequent studies to Gillath et al. (2009) by Trentini et al. (2015) and Bosmans et al. (2014) have confirmed the construct validity and three-factor structure of the SAAM for measuring attachment to romantic partners, although Bosmans et al. (2014) advocate caution when using the scale to measure parental relationships. In our use of SAAM, we found good agreement for the three subscales (Cronbach's α's: State Attachment-Secure = .94, State Attachment-Avoid = .90, State Attachment-Anxiety = .95).

2.2. Dream content measures

Dream collection. Each morning participants were asked in the morning survey to report any dreams and then rate the content of their dreams in terms of mood and general themes. Dream affect and logic was measured with the structured Dreamland Questionnaire (DL-Q) (Holfzinger, 2020). The DL-Q asks participants to rate dream content along a variety of adjectival scales, such as "strange vs familiar," ranging from -10 to +10, with scores in the negative indicating the "strange" end of the scale with lower scores being more extreme.

Additionally, we collected free responses of dream content. The first question on the morning survey asked participants to report any dream content they could recall from the entire night. A later prompt asked participants to focus on the most impressive dream from the night and write it out in detail; They are then asked one final time for any additional content they recalled while completing DL-Q ratings. In order to analyze dream content, these reports were cleaned for typos, abbreviations were expanded, and reports were separated into individual dreams. For dreams that had content reported multiple times, the reports were combined to include all relevant information. Any text not directly related to the dream experience was removed (for example "I had a dream that…" or "I think I remember that…" or "but in real life it's actually…") in order to avoid these words being included in automated text analysis as part of the dream experience.

Dream Affect and Dream Logic: Dream Affect was measured by taking the average of 5 of the DL-Q adjectival pairs (pessimistic/optimistic, aggressive/gentle, scary/relaxing, unpleasant/pleasant, serious/happy) for each dream report. Dream logic was measured by taking the average of two adjectival pairs (strange/familiar, bizarre/logical) for each report.

Dream Length: Dream length was calculated based on the number of tokens in all reports for a night automatically extracted using spaCy, a high-performing natural text processing library in Python (Honnibal & Montani, 2017). We assumed that dream length would act as an indirect measure of dream intensity-a measure previously lined with attachment variables (see Introduction).

Dream Agency: Dream reports were scored for dreamer agency following methods in scoring agency in life history interviews laid out by McAdams (2001). A scale from 0-4 was used by three independent raters - two researchers and a research assistant. A score of 0 was assigned when the dreamer was trapped and unable to assert any agency within the dream and a score of 4 was assigned when the dreamer had complete control over the dream. A dream was scored as 2 if there was no discernible agency displayed. Raters coded a selection of dreams individually, then came together to compare and discuss codes before individually coding another set of dreams for comparison. In total, 1,598 dreams were scored, and we achieved a reliability of Cronbach's Alpha .802 between our three raters. The rationale for scoring "agency" content was that dreamer agency would capture the dream self or self-model of the dreamer—an essential element of attachment Internal Working Models.

2.3. Questionnaires at Baseline

To measure trait attachment, we used the Revised Adult Attachment Scale for Close Relationships (Collins & Read 1990), an 18-item questionnaire that asks participants to rate their own similarity to a series of statements about relationships. These items were then combined into a two-factor solution comprising the dimensions of attachment and avoidance (see Supplemental Materials).

2.4. Statistical Analyses

The intensive diary longitudinal design of the study allowed for use of multilevel regression analyses (i.e., mixed-effects regression, random-coefficients modeling, hierarchical linear modeling) to test the primary study hypotheses that state attachment, daily social interactions, dream content measures, and REM% would predict overnight changes in closeness to SO ratings. Multilevel regression techniques were developed to analyze nested, or hierarchical, data structures. The daily diary data, mood assessments, and sleep architecture assessments served as repeated measures that are nested within individuals. Strengths of the multilevel-regression analytic procedures include: (a) capability of handling missing data and unbalanced designs (i.e., the number of assessment points and the timing of assessments can vary across participants); (b) addressing analytic issues that arises from aggregating over a large number of assessment occasions or not accounting for the nested structure of the data; (c) very efficient and powerful estimation procedures that utilize all data points available; and (d) modeling flexibility allowing for the inclusion of continuous or categorical, time invariant or time varying, predictors and covariates. In our models, we included individual participant variability as a random effect, which adjusts the intercepts based on participant variability. All continuous longitudinal measures were centered around the participant mean, which was then added to the model as a Level 2 predictor. This is following the suggestion outlined in Hamaker and Muthén (2020), who stress that inclusion of both the within- and between-person predictors is critical for getting more accurate estimates, even when one of the pair is not statistically significant. To ascertain significance of model effects, we used Wald Confidence Intervals and Restricted Maximum Likelihood. Due to the large number of predictors in the bigger models, random-intercepts was chosen over a random-slopes approach to allow better interpretability of estimates between models. All analyses were run in Python using the pymer4 library, an extension of the lme4 R library for Python (Jolly, 2018).

When testing both daily events and dream content, we chose to only consider interactions between the state attachment variables and the predictors of interest. This decision was theory-driven, since the goal of our analysis was to primarily impact the influence of attachment on closeness to SO shifts rather than a more maximal model that would be difficult to interpret. For this same reason, we chose to model one type of daily social interaction variable at a time in interaction with attachment, in order to gain a more concrete understanding of how each type of experience was influenced by the attachment system. In the case of dream content, however, we included all dream measures in the model to control for variability between external and internal ratings of content, including our two primary predictors of affect and agency with their interactions. .

3. Results

Correlations and descriptives of all predictive variables are reported below at both the within- and between-persons level (Table 1 and Table 2).

3.1. Overnight Closeness Shifts and State Attachment

We tested the relationship between trait and state attachment and overnight shifts in closeness to SO (Table 3). In the first model, only trait attachment (TA) variables were included. The model revealed a significant negative intercept (β = -0.356, SE = 0.105, p < .001), indicating a general overnight decrease in closeness to the SO across the sample. However, neither TA-Anxiety nor TA-Avoidance were significant predictors of overnight changes in closeness to SO.

The second model incorporated both trait and state attachment (SA) variables. To control for the possibility that shifts in closeness are driven primarily by mood, we included SPANE-P_{delta} and SPANE-N_{delta} which measure mood shifts overnight. Within-person (Level-1) state security (SA-$Secure_w$) was significantly and negatively associated with overnight changes in closeness to SO (β = -0.320, SE = 0.074, p < .0001), suggesting that feeling secure on a given night was associated with a decrease in closeness to SO by the following morning. This could also be explained in the opposite direction, however, with higher levels of insecurity corresponding to increases in closeness to SO overnight. Neither within-person SA-Avoidance nor within-person SA-Anxiety significantly predicted overnight changes.

At the between-persons level (Level-2), none of the state or trait attachment variables were significant predictors. Between-persons SA-Security, SA-Avoidance, and SA-Anxiety did not significantly predict overnight changes in closeness

Table 1. Descriptives and Pearson Bivariate Correlations for Predictors at the Within-Person Level.

	Mean	SD	2	3	4	5	6	7	8	9	10	11	12
1. SA-$Secure_w$	0	0.32	-0.32***	-0.26***	-0.05	-0.07*	0.21***	0.03	0.01	-0.04	0.01	-0.21***	0.22***
2. SA-$Avoid_w$	0	0.35		0.21***	0.07	0.03	-0.10**	-0.03	0	-0.05	-0.01	0.08*	-0.11**
3. SA-$Anxiety_w$	0	0.38			0.08*	0.06	-0.06	0	0.08*	0	-0.02	0.12**	-0.16***
4. Soc. $Insecure_w$	0	0.76				0.41***	-0.18***	-0.04	0.01	-0.03	-0.01	-0.03	-0.08*
5. Soc. $Conflict_w$	0	0.77					-0.17***	-0.06	-0.05	-0.04	-0.05	0.07	-0.16***
6. Soc. $Close_w$	0	0.91						0.06	-0.02	0.05	0	-0.10**	0.12***
7. Dream $Affect_w$	0	4							0.48***	0.38***	-0.15***	0.07	-0.05
8. Dream $Logic_w$	0	4.56								0.19***	-0.16***	0.06	-0.02
9. Dream $Agency_w$	0	0.63									-0.10**	0.04	-0.02
10. Dream Word $Length_w$	0	242.61										-0.03	0.01
11. SPANE-$P_{delta-w}$	0	0.6											-0.50***
12. SPANE-$N_{delta-w}$	0	0.53											

Note: SD = Standard Deviation. Values above the diagonal present bivariate Pearson correlations between variables.
* = p < .05, ** = p < .01, *** = p < .001

Table 2. Descriptives and Pearson Bivariate Correlations for Predictors at the Between-Persons Level.

	Mean	SD	2	3	4	5	6	7	8	9	10	11	12	13	14
1. SA-Secure$_w$	4.01	0.67	-0.44***	-0.30***	0.03	0.15***	0.52***	0.09***	0.16***	0.10***	0.03	0.07**	0.16***	-0.30***	-0.41***
2. SA-Avoid$_w$	2.16	0.73		0.27***	0	-0.12***	-0.23***	-0.18***	-0.20***	-0.19***	-0.20***	0.13***	0.12***	0.55***	0.34***
3. SA-Anxiety$_w$	3.15	0.92			0.09***	-0.07**	-0.11***	0.08**	0.01	-0.03	-0.09***	0.03	-0.09***	0.19***	0.46***
4. Soc. Insecure$_w$	1.76	0.78				0.67***	-0.09***	-0.12***	-0.01	-0.17***	0.05*	-0.03	-0.10***	-0.04	0.12***
5. Soc. Conflict$_w$	1.64	0.77					0.05*	0	0.07**	-0.10***	0.04	0.07**	-0.08**	-0.13***	-0.08***
6. Soc. Close$_w$	5.01	1.04						0.23***	0.11***	0.17***	0.01	0.26***	0.19***	-0.25***	-0.29***
7. Dream Affect$_w$	0.8	2.9							0.63***	0.60***	-0.12***	0.25***	0.04	-0.10***	0.04
8. Dream Logic$_w$	0.15	3.25								0.41***	-0.07**	0.07**	0.08**	-0.12***	-0.03
9. Dream Agency$_w$	1.78	0.36									-0.12***	0.07**	0.07**	-0.07**	0.10***
10. Dream Word Length$_w$	179.04	220.4										-0.26***	-0.10***	-0.17***	-0.07**
11. SPANE-P$_{delta\text{-}w}$	-0.13	0.28											0.25***	-0.02	-0.07**
12. SPANE-N$_{delta\text{-}w}$	-0.09	0.2												0.12***	-0.08**
13. TA-Avoidance	-0.07	0.86													0.60***
14. TA-Anxiety	-0.02	0.93													

Note: SD = Standard Deviation. Values above the diagonal present bivariate Pearson correlations between variables.
* = p < .05, ** = p < .01, *** = p < .001

to SO. Additionally, TA-Anxiety and TA-Dependence were also non-significant as predictors in this model.

3.2. Daily Events and Closeness Shifts Mediated by Attachment

We then tested our hypothesis that daily experiences of social conflict, insecurity, and closeness would drive overnight shifts in closeness to SO when mediated by attachment. In order to get a clear understanding of the dynamics of SA and daily events, we tested both main effect and interaction models (Table 4).

In the main effects model, we found that within-person daily social conflict had a positive and significant relationship with closeness to SO$_{delta}$. In the interaction model, the interaction between within-person social conflict and SA-

Table 3. Linear Mixed Effects Regression Models Predicting Overnight Shifts in Closeness to SO from Attachment.

Outcome	Predictor		β	Z	t	95% CI Low	95% CI High
Closeness to SO$_{delta}$							
	Level-1						
		Intercept	-0.356	0.105	-3.383***	-0.562	-0.15
	Level-2						
		TA-Avoidance	-0.048	0.134	-0.358	-0.311	0.215
		TA-Anxiety	0.123	0.134	0.913	-0.141	0.386
Closeness to SO$_{delta}$							
	Level-1						
		Intercept	-0.352	0.104	-3.366**	-0.556	-0.147
		SA-Secure$_w$	**-0.182**	**0.074**	**-2.468***	**-0.326**	**-0.037**
		SA-Avoid$_w$	0.073	0.072	1.018	-0.068	0.215
		SA-Anxiety$_w$	-0.054	0.071	-0.766	-0.193	0.084
		SPANE-P$_{delta\text{-}w}$	0.562	0.079	7.088***	0.407	0.718
		SPANE-N$_{delta\text{-}w}$	-0.318	0.079	-4.011***	-0.473	-0.162
	Level-2						
		SA-Secure$_b$	-0.123	0.126	-0.975	-0.369	0.124
		SA-Avoid$_b$	-0.11	0.126	-0.874	-0.357	0.137
		SA-Anxiety$_b$	0.216	0.124	1.752	-0.026	0.459
		SPANE-P$_{delta\text{-}b}$	0.213	0.11	1.934	-0.003	0.429
		SPANE-N$_{delta\text{-}b}$	-0.1	0.111	-0.9	-0.319	0.118
		TA-Avoidance	-0.194	0.155	-1.253	-0.498	0.11
		TA-Anxiety	0.179	0.148	1.208	-0.112	0.47

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

Table 4. Linear Mixed Effects Regression Models Predicting Overnight Shifts in Closeness to SO from Attachment.

Outcome	Predictor	β	Z	t	95% CI Low	95% CI High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.348	0.436	-0.799	-1.202	0.506
	SA-Secure$_w$	**-0.193**	**0.08**	**-2.4***	**-0.35**	**-0.035**
	SA-Avoid$_w$	0.095	0.079	1.211	-0.059	0.25
	SA-Anxiety$_w$	-0.068	0.077	-0.882	-0.219	0.083
	Soc. Conflict$_w$	**0.214**	**0.076**	**2.83****	**0.066**	**0.362**
	SPANE-P$_{delta-w}$	0.549	0.086	6.397***	0.381	0.717
	SPANE-Nd$_{elta-w}$	-0.283	0.086	-3.287**	-0.452	-0.114
	Level-2					
	Gender-Male	0.324	0.277	1.171	-0.218	0.867
	Gender-NB	0.117	0.624	0.188	-1.106	1.341
	Age	-0.002	0.009	-0.246	-0.021	0.016
	SA-Secure$_b$	-0.198	0.143	-1.388	-0.478	0.082
	SA-Avoid$_b$	-0.104	0.141	-0.737	-0.379	0.172
	SA-Anxiety$_b$	0.186	0.132	1.407	-0.073	0.446
	Soc. Conflict$_b$	0.167	0.112	1.483	-0.054	0.387
	SPANE-P$_{delta-b}$	0.303	0.124	2.44*	0.06	0.546
	SPANE-N$_{delta-b}$	-0.029	0.142	-0.206	-0.309	0.25
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.393	0.442	-0.887	-1.259	0.474
	SA-Secure$_w$	**-0.173**	**0.081**	**-2.15***	**-0.331**	-0.015
	SA-Avoid$_w$	0.1	0.079	1.276	-0.054	0.254
	SA-Anxiety$_w$	-0.064	0.077	-0.832	-0.215	0.087
	Soc. Conflict$_w$	**0.18**	**0.077**	**2.333***	**0.029**	0.331
	SPANE-P$_{delta-w}$	0.548	0.086	6.394***	0.38	0.716
	SPANE-N$_{delta-w}$	-0.283	0.086	-3.279**	-0.451	-0.114
	Soc. Conflict$_w$ X SA-Secure$_w$	**-0.137**	**0.056**	**-2.447***	**-0.247**	-0.027
	Soc. Conflict$_w$ X SA-Avoid$_w$	**0.164**	**0.08**	**2.059***	**0.008**	0.32
	Soc. Conflict$_w$ X SA-Anxiety$_w$	-0.049	0.068	-0.723	-0.181	0.084
	Level-2					
	Gender-Male	0.321	0.279	1.151	-0.226	0.867
	Gender-NB	0.077	0.635	0.121	-1.168	1.321
	Age	-0.001	0.01	-0.141	-0.02	0.017
	SA-Secure$_b$	-0.21	0.144	-1.451	-0.493	0.073
	SA-Avoid$_b$	-0.092	0.141	-0.65	-0.369	0.185
	SA-Anxiety$_b$	0.179	0.133	1.348	-0.081	0.44
	Soc. Conflict$_b$	0.164	0.128	1.278	-0.087	0.415
	SPANE-P$_{delta-b}$	0.314	0.124	2.525*	0.07	0.557
	SPANE-N$_{delta-b}$	-0.06	0.152	-0.394	-0.358	0.238
	Soc. Conflict$_b$ X SA-Secure$_b$	-0.06	0.164	-0.366	-0.38	0.261
	Soc. Conflict$_b$ X SA-Avoid$_b$	0.071	0.139	0.512	-0.201	0.342
	Soc. Conflict$_b$ X SA-Anxiety$_b$	-0.087	0.1	-0.868	-0.284	0.11

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = $p < .05$, ** = $p < .01$, *** = $p < .001$). CI = Wald confidence intervals.

Secure was significant and negative, while the interaction between within-person social conflict and SA-Avoidance was significant and positive. Daily social closeness was not significant in the main effects model, but there was a significant and negative interaction between daily social closeness and SA-Avoidance at the within-person level, and a significant and positive interaction between daily social closeness and SA-Secure at the between-persons level. For daily insecurity experiences, only the interaction between insecurity and avoidance at the within-person level was significant, with a positive interaction.

Table 4. (continued).

Outcome	Predictor	β	Z	t	95% CI Low	High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.537	0.423	-1.27	-1.367	0.292
	$SA\text{-}Secure_w$	**-0.185**	**0.076**	**-2.447***	**-0.333**	**-0.037**
	$SA\text{-}Avoid_w$	0.041	0.073	0.568	-0.101	0.183
	$SA\text{-}Anxiety_w$	-0.057	0.071	-0.798	-0.197	0.083
	Soc. $Close_w$	-0.138	0.071	-1.96.	-0.277	0
	$SPANE\text{-}P_{delta\text{-}w}$	0.501	0.08	6.271***	0.344	0.657
	$SPANE\text{-}N_{delta\text{-}w}$	-0.303	0.08	-3.798***	-0.46	-0.147
	Level-2					
	Gender-Male	0.262	0.261	1.005	-0.249	0.774
	Gender-NB	-0.268	0.585	-0.459	-1.414	0.878
	Age	0.002	0.009	0.274	-0.015	0.02
	$SA\text{-}Secure_b$	-0.016	0.147	-0.112	-0.304	0.271
	SA-Avoidb	-0.072	0.126	-0.569	-0.319	0.176
	$SA\text{-}Anxiety_b$	0.219	0.122	1.791.	-0.021	0.459
	Soc. $Close_b$	-0.179	0.137	-1.303	-0.447	0.09
	$SPANE\text{-}P_{delta\text{-}b}$	0.275	0.122	2.252*	0.036	0.514
	$SPANE\text{-}N_{delta\text{-}b}$	-0.105	0.128	-0.82	-0.357	0.146
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.606	0.423	-1.434	-1.435	0.222
	$SA\text{-}Secure_w$	-0.189	0.077	-2.462*	-0.339	-0.038
	$SA\text{-}Avoid_w$	0.038	0.073	0.521	-0.105	0.181
	$SA\text{-}Anxiety_w$	-0.069	0.072	-0.966	-0.21	0.071
	Soc. $Close_w$	-0.133	0.071	-1.875.	-0.271	0.006
	$SPANE\text{-}P_{delta\text{-}w}$	0.499	0.08	6.241***	0.342	0.656
	$SPANE\text{-}N_{delta\text{-}w}$	-0.304	0.08	-3.81***	-0.461	-0.148
	Soc. $Close_w$ X $SA\text{-}Secure_w$	-0.061	0.069	-0.891	-0.197	0.074
	Soc. Closew X $SA\text{-}Avoid_w$	**-0.143**	**0.071**	**-2.008***	**-0.282**	**-0.003**
	Soc. $Close_w$ X $SA\text{-}Anxiety_w$	0.011	0.07	0.157	-0.127	0.149
	Level-2					
	Gender-Male	0.33	0.261	1.266	-0.181	0.842
	Gender-NB	-0.194	0.59	-0.329	-1.35	0.962
	Age	0.002	0.009	0.197	-0.016	0.02
	$SA\text{-}Secure_b$	0.02	0.148	0.132	-0.271	0.31
	$SA\text{-}Avoid_b$	-0.037	0.128	-0.291	-0.288	0.214
	$SA\text{-}Anxiety_b$	0.168	0.126	1.333	-0.079	0.416
	Soc. $Close_b$	-0.083	0.148	-0.563	-0.372	0.206
	$SPANE\text{-}P_{delta\text{-}b}$	0.261	0.122	2.134*	0.021	0.501
	$SPANE\text{-}N_{delta\text{-}b}$	-0.105	0.128	-0.824	-0.356	0.145
	Soc. Closeb X $SA\text{-}Secure_b$	**0.261**	**0.123**	**2.12***	**0.02**	**0.503**
	Soc. $Close_b$ X $SA\text{-}Avoid_b$	0.213	0.136	1.572	-0.053	0.479
	Soc. $Close_b$ X $SA\text{-}Anxiety_b$	0.09	0.111	0.814	-0.127	0.308

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

3.3. Dream Content and Closeness Shifts

We hypothesized that dreaming/dream content would mediate the way state attachment influenced closeness shifts during sleep. Our primary dream content predictor variables were participant ratings of dream affect and external ratings of dream agency. Our control variables were overnight shifts in mood as well as dream word length and participant ratings of dream logic from the DL-Q. We constructed both a main effects model without interactions and an interaction model to test for the interaction between state attachment and our dream (Table 5).

Similar to above, within-person SA-Security was a significant predictor of overnight decreases in closeness to SO with a negative estimate (β = -0.410, SE = 0.084, $p < .0001$).

Table 4. (continued).

Outcome	Predictor	β	Z	t	95% CI Low	High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.564	0.42	-1.342	-1.387	0.26
	SA-$Secure_w$	**-0.209**	**0.078**	**-2.695****	**-0.362**	**-0.057**
	SA-$Avoid_w$	0.126	0.076	1.655.	-0.023	0.274
	SA-Anxietyw	-0.111	0.075	-1.476	-0.258	0.036
	Soc. $Insecure_w$	0.01	0.072	0.142	-0.132	0.152
	SPANE-$P_{delta-w}$	0.512	0.084	6.096***	0.348	0.677
	SPANE-$N_{delta-w}$	-0.331	0.084	-3.942***	-0.496	-0.167
	Level-2					
	Gender-Male	0.384	0.265	1.452	-0.134	0.903
	Gender-NB	0.068	0.579	0.117	-1.067	1.203
	Age	0.003	0.009	0.315	-0.015	0.021
	SA-$Secure_b$	-0.039	0.134	-0.287	-0.301	0.224
	SA-$Avoid_b$	0.057	0.131	0.435	-0.2	0.315
	SA-$Anxiety_b$	0.209	0.126	1.652	-0.039	0.456
	Soc. $Insecure_b$	0.062	0.112	0.554	-0.157	0.28
	SPANE-$P_{delta-b}$	0.348	0.121	2.873**	0.11	0.585
	SPANE-$N_{delta-b}$	-0.127	0.131	-0.97	-0.385	0.13
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.636	0.431	-1.477	-1.48	0.208
	SA-$Secure_w$	**-0.203**	**0.078**	**-2.586****	**-0.356**	-0.049
	SA-Avoidw	0.112	0.076	1.461	-0.038	0.261
	SA-$Anxiety_w$	-0.113	0.076	-1.487	-0.262	0.036
	Soc. $Insecure_w$	0.011	0.072	0.147	-0.131	0.153
	SPANE-$P_{delta-w}$	0.512	0.084	6.089***	0.347	0.676
	SPANE-$N_{delta-w}$	-0.343	0.084	-4.073***	-0.508	-0.178
	Soc. $Insecure_w$ X SA-$Secure_w$	-0.002	0.066	-0.033	-0.131	0.126
	Soc. $Insecure_w$ X SA-$Avoid_w$	**0.127**	**0.061**	**2.062***	**0.006**	**0.247**
	Soc. $Insecure_w$ X SA-$Anxiety_w$	-0.049	0.059	-0.829	-0.165	0.067
	Level-2					
	Gender-Male	0.345	0.272	1.267	-0.189	0.879
	Gender-NB	0.018	0.593	0.03	-1.145	1.18
	Age	0.005	0.009	0.505	-0.013	0.023
	SA-$Secure_b$	-0.053	0.138	-0.383	-0.323	0.217
	SA-$Avoid_b$	0.06	0.135	0.449	-0.204	0.325
	SA-$Anxiety_b$	0.195	0.129	1.509	-0.058	0.448
	Soc. $Insecure_b$	0.101	0.127	0.794	-0.148	0.349
	SPANE-$P_{delta-b}$	0.35	0.123	2.845**	0.109	0.591
	SPANE-$N_{delta-b}$	-0.137	0.135	-1.014	-0.401	0.128
	Soc. $Insecure_b$ X SA-$Secure_b$	-0.09	0.174	-0.516	-0.431	0.252
	Soc. $Insecure_b$ X SA-$Avoid_b$	0.113	0.116	0.975	-0.115	0.342
	Soc. $Insecure_b$ X SA-$Anxiety_b$	-0.071	0.108	-0.657	-0.283	0.141

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

Within-person dream content variables of participant ratings of dream affect and logic, external ratings of dream agency, and dream word length were not significant predictors. At the between-persons level, only the content variable of external ratings of dream agency was significant (β = -0.411, SE = 0.165, p = .015). In the interaction analysis, none of the dream content variables were significant at the within-person level. At the between-persons level, however, there was a positive and significant interaction between Dream Affect and SA-Secure and Dream Affect and SA-Avoidance. In addition, there was a positive and significant interaction at the between-persons level between Dream Agency and SA-Anxiety.

Table 5. Linear Mixed Effects Regression Models Predicting Overnight Shifts in Closeness to SO from the Interaction of Attachment with Dream Content Predictors.

					95% CI	
Outcome	Predictor	β	Z	t	Low	High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.598	0.454	-1.32	-1.487	0.29
	$SA\text{-}Secure_{w}$	**-0.238**	**0.092**	**-2.584****	**-0.419**	**-0.058**
	$SA\text{-}Avoid_{w}$	0.161	0.09	1.794.	-0.015	0.337
	$SA\text{-}Anxiety_{w}$	-0.123	0.088	-1.401	-0.295	0.049
	Dream $Affect_{w}$	0.057	0.101	0.562	-0.141	0.254
	Dream $Agency_{w}$	-0.04	0.091	-0.436	-0.217	0.138
	Dream $Logic_{w}$	-0.02	0.095	-0.208	-0.205	0.166
	Dream Word $Length_{w}$	**-0.054**	**0.084**	**-0.647**	**-0.22**	**0.111**
	$SPANE\text{-}P_{delta\text{-}w}$	0.331	0.098	3.377***	0.139	0.524
	$SPANE\text{-}N_{delta\text{-}w}$	-0.361	0.098	-3.678***	-0.553	-0.169
	Level-2					
	Gender-Male	0.66	0.323	2.046*	0.028	1.292
	Gender-NB	-0.234	0.683	-0.343	-1.573	1.104
	Age	0.003	0.009	0.302	-0.016	0.021
	$SA\text{-}Secure_{b}$	-0.146	0.153	-0.95	-0.446	0.155
	$SA\text{-}Avoid_{b}$	-0.126	0.157	-0.8	-0.434	0.183
	$SA\text{-}Anxiety_{b}$	0.222	0.141	1.576	-0.054	0.498
	Dream $Affect_{b}$	0.213	0.189	1.13	-0.157	0.583
	Dream $Agency_{b}$	-0.392	0.172	-2.279*	-0.728	-0.055
	Dream $Logic_{b}$	0.074	0.159	0.467	-0.238	0.387
	Dream Word $Length_{b}$	0.126	0.137	0.917	-0.143	0.395
	$SPANE\text{-}P_{delta\text{-}b}$	0.313	0.147	2.133*	0.025	0.601
	$SPANE\text{-}N_{delta\text{-}b}$	-0.237	0.138	-1.717.	-0.509	0.034

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

3.4. State Attachment and REM% Influence on Closeness to SO Shifts

We then tested the relationship between REM% and SA on overnight shifts in closeness to SO (Table 6). This model also found that within-person SA-Security was a significant predictor of overnight changes in closeness (β = -0.360, SE = 0.102, p < .0001), as well as between-persons SA-Anxiety. While within-person differences in REM% did not significantly predict changes in closeness, between-persons REM% was a significant predictor (β = 0.344, SE = 0.115, p = .011) indicating that participants with higher average REM% tended to experience more positive overnight changes in closeness. In our interaction analysis, we then tested for the impact of between-persons REM% level on SA in predicting overnight shifts in closeness to SO. We found only one significant and negative interaction, between between-persons REM% and within-person SA-Secure, which indicates that the relationship between nightly ratings of attachment security and overnight shifts is mediated by overall levels of REM sleep..

4. Discussion

Our results show that sleep and dreaming, particularly REM sleep, play a regulatory role in felt closeness to a significant other, apparently acting in a counterbalancing manner in response to episodes of conflict or insecurity. This conclusion is supported by the fact that within-person state attachment security was significantly and negatively associated with overnight shifts in closeness to a significant other across all tested models. We further found that episodes of conflict and insecurity at night lead to more positive shifts in closeness ratings overnight and vice versa. Further evidence for the counterbalancing effect of sleep can be seen in the daily social events models. In this analysis, we found that higher within-person levels of social conflict that day had a positive association with overnight shifts in closeness to a significant other. Notably, this was the only one of our three social interaction variables to have a main effect outside of interaction with state attachment, which provides further support for our contention that the counterbalancing function of REM sleep is primarily driven by episodes of disruption. Our model of dream content variables found that only dreamer agency at the between-persons level was a significant predictor of overnight shifts in closeness to a significant other, indicating that individuals with overall higher levels of dreamer agency, as expressed in their dreams, experience less increases in closeness to their significant other overnight. We speculate that enhancing the subjective sense of agency (via dreamwork mechanisms) provides some emotional distance from the partner the next day when that is perceived as necessary. Finally, our analysis of overall REM% during the night found both overall increased

Table 5. (continued).

Outcome	Predictor	β	Z	t	95% CI Low	High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.452	0.453	-0.997	-1.341	0.437
	$SA\text{-}Secure_w$	**-0.252**	**0.093**	**-2.717****	**-0.434**	**-0.07**
	$SA\text{-}Avoid_w$	0.173	0.091	1.903.	-0.005	0.351
	$SA\text{-}Anxiety_w$	-0.13	0.088	-1.468	-0.303	0.043
	Dream $Affect_w$	0.055	0.102	0.541	-0.144	0.254
	Dream Agencyw	-0.036	0.091	-0.398	-0.215	0.142
	Dream $Logic_w$	-0.011	0.095	-0.114	-0.198	0.176
	Dream Word $Length_w$	-0.051	0.085	-0.603	-0.217	0.115
	$SPANE\text{-}P_{delta\text{-}w}$	0.326	0.098	3.318***	0.133	0.519
	$SPANE\text{-}N_{delta\text{-}w}$	-0.354	0.099	-3.592***	-0.548	-0.161
	Dream $Affect_w$ X $SA\text{-}Secure_w$	-0.142	0.098	-1.455	-0.334	0.049
	Dream $Affect_w$ X $SA\text{-}Avoid_w$	-0.031	0.101	-0.313	-0.229	0.166
	Dream $Affect_w$ X $SA\text{-}Anxiety_w$	0.012	0.094	0.126	-0.172	0.196
	Dream $Agency_w$ X $SA\text{-}Secure_w$	0.042	0.1	0.424	-0.153	0.238
	Dream $Agency_w$ X $SA\text{-}Avoid_w$	-0.103	0.106	-0.967	-0.311	0.106
	Dream $Agency_w$ X $SA\text{-}Anxiety_w$	-0.034	0.097	-0.355	-0.224	0.156
	Level-2					
	Gender-Male	0.654	0.319	2.048*	0.028	1.279
	Gender-NB	-0.54	0.676	-0.798	-1.864	0.785
	Age	0	0.009	0.018	-0.018	0.018
	$SA\text{-}Secure_b$	-0.221	0.157	-1.409	-0.528	0.086
	$SA\text{-}Avoid_b$	-0.166	0.156	-1.066	-0.471	0.139
	$SA\text{-}Anxiety_b$	0.149	0.145	1.027	-0.136	0.434
	Dream $Affect_b$	0.073	0.202	0.361	-0.322	0.468
	Dream $Agency_b$	-0.327	0.184	-1.777.	-0.688	0.034
	Dream $Logic_b$	0.078	0.161	0.483	-0.238	0.394
	Dream Word $Length_b$	0.091	0.136	0.671	-0.176	0.359
	$SPANE\text{-}P_{delta\text{-}b}$	0.373	0.145	2.575*	0.089	0.657
	$SPANE\text{-}N_{delta\text{-}b}$	-0.187	0.137	-1.37	-0.455	0.081
	Dream $Affect_b$ X $SA\text{-}Secure_b$	**0.689**	**0.251**	**2.742****	**0.197**	**1.182**
	Dream $Affect_b$ X $SA\text{-}Avoid_b$	**0.44**	**0.205**	**2.143***	**0.038**	**0.842**
	Dream $Affect_b$ X $SA\text{-}Anxiety_b$	-0.32	0.165	-1.942.	-0.643	0.003
	Dream $Agency_b$ X $SA\text{-}Secure_b$	-0.343	0.2	-1.714.	-0.735	0.049
	Dream $Agency_b$ X $SA\text{-}Avoid_b$	-0.318	0.215	-1.48	-0.739	0.103
	Dream $Agency_b$ X $SA\text{-}Anxiety_b$	**0.428**	**0.173**	**2.476***	**0.089**	**0.766**

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

positive shifts in closeness to a significant other for higher REM% at the between-persons level as well as a significant interaction between within-person state attachment security and between-persons REM%. This provides further support for our contention that REM sleep functions as a type of emotional processing system that operates to promote increased relationship closeness, but that this function primarily works through restoring equilibrium following a disturbance caused by attachment insecurity.

Our analysis of the interaction between state attachment and daily interactions provides further nuance to how this process unfolds. In the case of conflict, the interaction with security (β = -.137) only slightly moderates the primary effect of security (β = -.173) but shifts the direction of the primary effect of conflict (β = .18), which indicates that the effect of insecurity is the roughly same whether conflict is present or not. State attachment security also positively interacts with social closeness at the between-persons level, indicating that overall high levels of security and close interactions correspond with more positive overnight shifts towards partners. In the case of avoidance, however, there are no primary effects but there are significant interactions at the within-person level with conflict (β = .164), social closeness (β = -.143), and social insecurity (β = .127). These observations, combined with the lack of significant effects for anxiety throughout, indicate that security is likely playing a primary role in driving the regulation of the attachment system overnight in general, with an important but secondary

Table 6. Linear Mixed Effects Regression Models Predicting Overnight Shifts in Closeness to SO from the Interaction of Attachment with Dream Content Predictors.

					95% CI	
Outcome	Predictor	β	Z	t	Low	High
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.82	0.565	-1.453	-1.927	0.286
	SA-Securew	**-0.301**	**0.11**	**-2.745****	**-0.516**	**-0.086**
	SA-Avoidw	0.224	0.107	2.089*	0.014	0.433
	SA-Anxietyw	0.17	0.105	1.608	-0.037	0.376
	REM%w	-0.002	0.102	-0.023	-0.203	0.198
	Level-2					
	Gender-Male	0.146	0.282	0.517	-0.407	0.7
	Gender-NB	**-0.09**	**0.782**	**-0.116**	**-1.623**	**1.442**
	Age	0.012	0.011	1.096	-0.01	0.034
	SA-Secureb	0.076	0.155	0.49	-0.228	0.381
	SA-Avoidb	0.151	0.15	1.008	-0.143	0.444
	SA-Anxietyb	0.357	0.151	2.372*	0.062	0.652
	REM%b	0.435	0.138	3.152**	0.165	0.706
Closeness to SO_{delta}						
	Level-1					
	Intercept	-0.817	0.565	-1.446	-1.925	0.291
	SA-Securew	-0.292	0.109	-2.677**	-0.505	-0.078
	SA-Avoidw	0.169	0.115	1.472	-0.056	0.394
	SA-Anxietyw	0.124	0.106	1.173	-0.083	0.331
	REM%w	-0.017	0.101	-0.166	-0.215	0.181
	REM%b X SA-Securew	-0.481	0.125	-3.861***	-0.725	-0.237
	REM%b X SA-Avoidw	0.101	0.143	0.708	-0.179	0.381
	REM%b X SA-Anxietyw	-0.182	0.121	-1.507	-0.42	0.055
	Level-2					
	Gender-Male	0.654	0.319	2.048*	0.028	1.279
	Gender-NB	-0.54	0.676	-0.798	-1.864	0.785
	Age	0	0.009	0.018	-0.018	0.018
	SA-Secureb	**-0.221**	**0.157**	**-1.409**	**-0.528**	**0.086**
	SA-Avoidb	-0.166	0.156	-1.066	-0.471	0.139
	SA-Anxietyb	0.149	0.145	1.027	-0.136	0.434
	REM%b	0.073	0.202	0.361	-0.322	0.468

Note: β = estimated coefficient. Z = Standard Error. t = t statistic reporting likelihood that the estimate significantly varies from 0 (* = p < .05, ** = p < .01, *** = p < .001). CI = Wald confidence intervals.

role for avoidance in response to daily events. In particular, we think it is notable that the interaction between avoidance and social closeness has a negative and significant effect, indicating that avoidance may be functioning to reduce closeness to when it is subjectively perceived as too high.

Notably, of the dream content indices, only between-persons dream agency had a significant main effect on overnight closeness to a significant other shifts. Dream agency refers to the extent to which the dreamer drives events in the dream narrative. The other dream content variables, dream affect and length, did not affect daily closeness to a significant other ratings. This null result for participant ratings of dream affect challenges previous findings that emotional dream content affects overnight shifts in relationship closeness. Previous research may have been confounded by cross-sectional study design, in which remembering dreams with more positive content may lead to more positive appraisal of one's partner. It should be noted, however, that some previous results also depended on more fine-grained dream content measures involving individuals dreaming about their partner, while we looked more at dream affect and agency as a whole. Our interaction analysis of the dream variables indicates that dreaming may play a role in regulating attachment at more global levels. The positive interaction of dream affect at the between-persons level with both between-persons state attachment security and avoidance suggests that positive dreaming contributes to higher morning ratings of closeness to a significant other for avoidant and secure individuals. In the case of between-persons state attachment anxiety, however, the only significant interaction was dream agency, indicating that higher

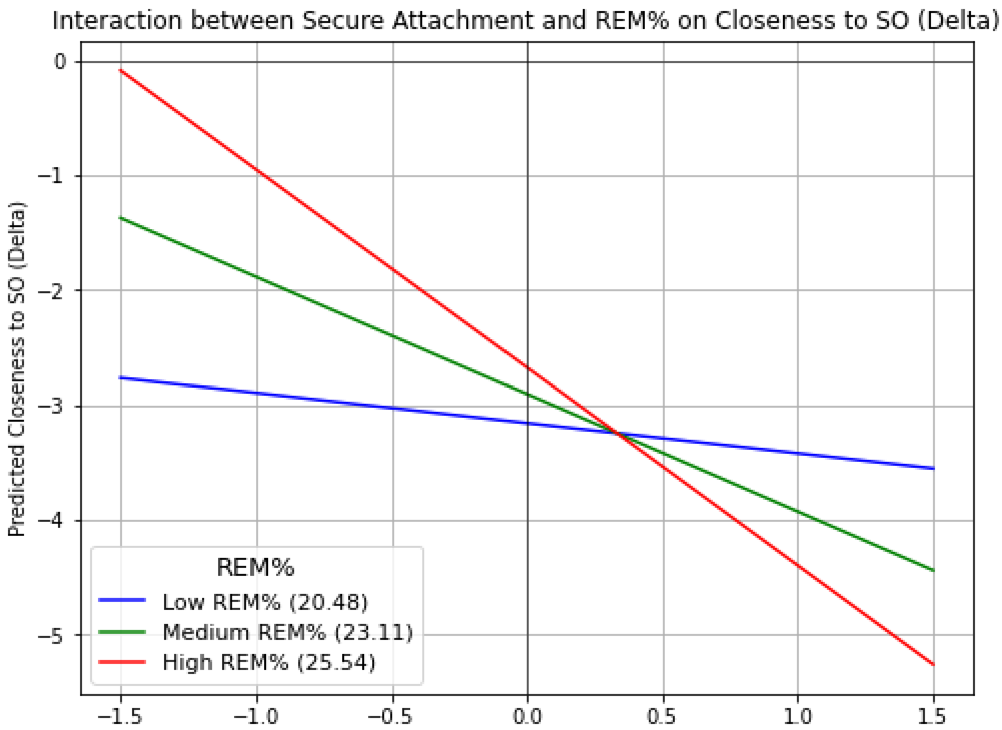

Figure 1. Interaction between secure attachment and REM% on closeness to SO (Delta). This figure summarizes the results of the interaction between REM% and SA-Security in Table 6. REM% levels are binned into three groups for the purpose of visual demonstration, and should not be interpreted as statistically significant groups..

levels of agency for anxiously attached individuals positively contribute to closeness to a significant other deltas.

The overall mechanism through which these shifts are facilitated is suggested by our final analysis. The finding of an association between overall levels of REM% and positive shifts in closeness to a significant other overnight indicates that the habitual processing of relational dynamics during REM sleep significantly influences daily emotional closeness. The mediating effect between within-person state attachment security and between-persons REM% that strengthens the effect of security on overnight shifts suggests that these individuals habitually rely on REM intensity (duration, percentage of total sleep) to emotionally process intimate relationships.

Why might individuals use the REM sleep system to help regulate intimacy levels/attachment dynamics? One possibility is that REM sleep involves activation of the neurobiological substrate for attachment and bond formation between infant and caretaker or between two romantic partners while dreams handle cognitive aspects of attachment formation. McNamara (1996) and Zborowski and McNamara (1998) postulated neurobiological associations between REM sleep processes and attachment regulatory processes (see also McNamara, 2004). The theory suggests that REM sleep neurobiological processes and dream content elements can be used to facilitate both daily and long-term attachment patterns. The data presented in this study are consistent with this theoretical framework. REM sleep is also known to facilitate the consolidation of emotional memories that are related to attachment processes (e.g., Walker & van der Helm, 2009). If, for example, REM sleep functions to modulate closeness levels to keep them at an optimal level, then some individuals will use the system to do so when they subjectively feel that they need to distance themselves or move close to a significant other. Our data suggest that social conflict is one daily factor that influences this monitoring and compensatory/counterbalancing system.

In terms of future studies that can build upon this work and the literature reviewed in the introduction, we recommend further identification of factors that influence daily dynamics in relationships. We also recommend that effect sizes of the impact of REM% on daily closeness to a significant other ratings be compared to effect sizes of other factors known to influence daily shifts in closeness. In addition, use of more developed cognitive measures of dream content that would likely relate to attachment variables such as measures of Internal Working Models could potentially be identified in dream content and then related to daily changes in closeness.

Another obvious next step to take in this research is to assess REM sleep, dreams, and attachment developments in children. Although there is great variability across children, dreams in the form of nightly experiences involving extended narratives probably do not come online until the second or third year of life or even later, although attachment orientation typically forms between the first and second year. REM sleep might support facilitation of attachment orientation in infancy and the toddler in two ways: by activation of behavioral displays during the sleep state that elicit care from caretakers (e.g., babbling, suckling, smiling, night-wakings and so on), and by facilitation of consolidation of emotional memories concerning interactions with the caretaker. As the child gets older, REM sleep would likely function to adjust attachment processes as needed, but of course little or nothing is known of these processes as it would require longitudinal studies of sleep, dreams and attachment across decades to accurately quantitate these relationships. When dreams come online in young children they too may facilitate formation, maintenance, and change of Internal Working Models of attachment orientation. Dreamer agency appears to be important in mediating the process of editing of representations of self and other representations—specifically differentiation of self and other and 'closeness' of self to the attachment object. This gap has been mediated by a recent pilot study by Bédard et al. (2021), but more longitudinal study in this area is critical for a deeper understanding of the developmental trajectories of attachment and dreaming.

Another area for future research is to investigate the specificity of the association documented here between REM and closeness to SO ratings. REM is known to help regulate emotional reactivity so it may be that after a night of sleep, REM adjusts emotional tone overnight and then the individual awakes feeling better in general. His or her general feeling of well-being after Rem does it overnight therapeutic work leads to a general feeling of greater closeness to SO. One way to test the specificity of the REM effect on closeness ratings is to compare it to N3's effect on closeness ratings for example.

5. Limitations of the Study

One potential limitation of our study is the large number of variables modelled in our study and thus the increase in risk for Type I error, particularly when modeling interaction effects. However we note that interactions were only tested between the state attachment variables and the longitudinal variables (see our hypotheses 1-4). Interactions were only assessed between the three state attachment variables and the relevant predictors in that section (i.e. social events, dream content, and REM%). This was based on our theoretical examination of whether or not attachment plays a distinct mediating role in the translation of social events and dream content in overnight shifts in closeness. This is why, for example, we do not test interactions between dream content and REM% on closeness. Our mixed-effects regressions and our multi-level modeling also ameliorates some of these concerns. We limited the number of interactions tested precisely because sleep/dream impact on attachment dynamics is the primary topic of the paper, No other interactions were tested. Our future work will include pre-registration to further mitigate such concerns

Black-box algorithms for sleep architectural scoring have inherent limitations. For example, the DH automatic sleep scoring algorithm only reaches about 55% accuracy when detecting N1, which could affect accuracy of the sleep stage classifications and distributions (Beacon). Since participants were responsible for the placement of the DH, the signal quality varied throughout their two-week participation in the study. Participants were instructed to start the recording when they were ready to start trying to fall asleep and end the recording when they woke up, but it is possible that some did not follow this instruction exactly, resulting in extra wake time being recorded, which would affect related metrics. Some participants also reported that the DH disrupted their sleep on occasion, which could have impacted their sleep architecture outputs. It should also be noted that since the DH requires a smartphone or tablet along with strong, reliable Wi-Fi, those without full access to these resources were not able to participate, potentially biasing the sample.

Other potential issues with this study arise from the inherent problems with self-reporting. It is possible that there may be variability in ratings of significant others in the evening and morning that are not accounted for within our measures. In addition, we asked participants who are single to rate whoever they felt closest to that day, without requiring them to specify one relationship at the beginning of the study that they then consistently rated throughout. We therefore exercise caution in interpreting our findings, which are limited to understanding global measures of state attachment without extending to specific relationships or types of relationships (i.e., romantic vs. parental, etc.).

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Data Availability Statement

The data underlying this article will eventually be made available at the Open Science Framework site for Cognitive Neuroscience of Religious Cognition. Readers should forward inquiries to the corresponding author (JB) in the meantime.

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