Published in final edited form as:

Attach Hum Dev. 2011 March ; 13(2): 141–154. doi:10.1080/14616734.2011.553999.

Sleep architecture and sleep-related mentation in securely and insecurely attached people

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Abstract

Based on REM sleep's brain activation patterns and its participation in consolidation of emotional memories, we tested the hypothesis that measures of REM sleep architecture and REM sleep-related mentation would be associated with attachment orientation. After a habituation night in a sleep lab, a convenience sample of 64 healthy volunteers were awakened 10 minutes into a REM sleep episode and 10 minutes into a control NREM sleep episode in counterbalanced order, then asked to report a dream and to rate themselves and a significant other on a list of trait adjectives. Relative to participants classified as having secure attachment orientations, participants classified as anxious took less time to enter REM sleep and had a higher frequency of REM dreams with aggression and self-denigrating themes. There were no significant differences across attachment groups in other measures of sleep architecture or in post REM-sleep awakening ratings on PANAS subscales reflecting mood and alertness. Selected aspects of REM sleep architecture and mentation appeared to be associated with attachment orientation. We suggest that REM sleep plays a role in processing experiences and emotions related to attachment, and that certain features of sleep and dreaming reflect attachment orientations.

Keywords

REM sleep; NREM sleep; REM latency; attachment status; dreams; mood

There is now abundant evidence that social relationships, particularly close emotional relationships, can significantly affect health status (Cacioppo et al., 2002; Uchino, Holt-Lunstad, Uno, Campo, & Reblin, 2007). The impact of social relationships on a wide variety of measures of health status has been studied via the theoretical concept known as "attachment." Bowlby (1969, 1982) first introduced the concept of attachment, which he conceptualized in terms of a biobehavioral regulatory system that adjusts physical and emotional proximity between juveniles and caregivers. Ainsworth, Blehar, Waters, and Wall (1978) noted that several styles or patterns of attachment existed in a typical population of infants and children, with some children being securely attached to their mother and others

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being insecurely attached. Evidence was later presented (Hazan & Shaver, 1987) to suggest that similar attachment styles exist in adolescence and adulthood. This paper reports on how adult attachment styles may be seen to link up with sleep architecture and sleep-related mentation, but before stating the hypotheses underlying this report, a brief review of attachment prototypes, and the literature on emotional memory processing is provided.

Attachment Prototypes

Attachment researchers presented evidence that attachment styles in both adults and children are mediated by internal working models of the relation between self and significant others (“attachment figures”) (Bretherton & Munholland, 1999; Shaver & Mikulincer, 2002). Internal working models are thought to be composed of emotionally charged representations of the self in relations with close others. Models of self and models of others can be either positively or negatively valenced. The resulting four possible attachment types have been labeled secure, preoccupied, dismissive, and fearful (Bartholomew & Horowitz, 1991). Individuals are classified as securely attached if they possess a positive model of self and others. Preoccupied individuals have a negative model of self and a positive model of others. Dismissive individuals have a positive model of self and a negative model of others, and fearful individuals have a negative model of both self and others. Psychometric and conceptual investigations of these attachment patterns (summarized by Mikulincer & Shaver, 2007) indicate that they can be viewed as regions in a two-dimensional space defined by attachment anxiety and avoidance. People’s scores on the attachment anxiety and avoidance dimensions have been empirically linked with a broad array of theoretically relevant psychological and behavioral processes.

Emotional Memory Processing

Substantial amounts of emotional memory processing and ‘off-line’ emotional memory consolidation occur during sleep. REM is hypothesized to be the physiological state that specializes in emotional memory processing. As pointed out by many research teams (Maquet et al., 1996; Nishida, Pearsall, Buckner, & Walker, 2009), the neurochemistry and neurocognitive activation patterns (high acetylcholine activity in amygdalar-limbic regions) of REM make it ideal for consolidation of emotional memories. Empirical studies show that REM is indeed responsible for consolidation of emotional memories (Hu, Stylos-Allan, & Walker, 2006; Nishida, Pearsall, Buckner, & Walker, 2008; Wagner, Gais, & Born, 2001; Wagner, Hallschmid, Rasch, & Born, 2006). Physiological processes associated with non-Rapid Eye Movement (NREM) sleep, however, facilitate other kinds of procedural and declarative memory (Stickgold & Walker, 2007). Internal working models of attachment may therefore be partially formed, consolidated, or revised within specific sleep-related processing systems. If so, this regulatory system might help to explain sleep’s effects on social functioning (Killgore, Kahn-Greene, et al., 2008; Killgore, Killgore, et al., 2007) and health status (Knutson & Van Cauter, 2008). If sleep-related memory processing is associated with the development of internal working models of attachment, an examination of sleep-related mentation (after awakenings or in dream content) might reveal psychological mechanisms relevant to the formation, consolidation, and revision of such models.

Sleep and Attachment

A number of recent reports have documented statistically significant associations between measures of sleep and attachment processes in infants (McNamara, Belsky, & Fearon, 2003), children (Keller, El-Sheikh, & Buckhalt, 2008), and adults (Scharfe & Eldredge, 2001; Sloan, Maunder, Hunter, Moldofsky, 2007; Mikulincer & Shaver, 2011; Troxel, Cyranowski, Hall, Frank, & Buysse, 2007; Verdecias, Jean-Louis, Zizi, Casimir, & Browne, 2009). In adults, Verdecias et al. (2009) reported that individuals characterized by a

preoccupied/anxious attachment style were likely to report elevated rates of daytime napping and the use of sleep-inducing medications, independent of their demographic and subjective characteristics. Scharfe and Eldredge (2001) found that, among college students, higher scores on fearful and preoccupied attachment styles (both being high on attachment anxiety) were associated with poorer subjective sleep quality. Only two studies have investigated the association between attachment patterns and measures of sleep architecture (see Table 2 for definitions of sleep terms). Troxel et al. (2007) reported that, among depressed women, those with higher levels of attachment anxiety had a lower percentage of stage 3/4 sleep and shorter sleep latencies. In anxiously attached individuals, Sloan et al. (2007) reported an association between insecure attachment and the degree of α -power sleep (a form of light sleep), independent of anxiety or depressive symptoms.

The Present Study

Our main goal was to assess the extent to which REM sleep architecture and REM-related mentation processes are associated with attachment patterns. McNamara, Andresen, Clark, Zborowski, and Duffy (2001) previously reported that preoccupied individuals recalled more dream material, especially attachment-related dream content, than did avoidant individuals, suggesting that attachment orientations are indeed associated with sleep-related mentation.

In this project we assessed the association between REM sleep mentation (using NREM as a control for REM) and three attachment styles: anxious, secure and avoidant. If, as McNamara et al. (2001) proposed, REM sleep mechanisms (but not NREM sleep mechanisms) are associated with the maintenance and revision of attachment-related emotional memory content (via emotional memory processing), then participants classified as anxiously attached might be expected to exhibit increased REM sleep time and reduced latency to REM sleep. Their dreams might contain more negative appraisals of self but not of significant others after REM sleep awakenings, reflecting their hypothesized negative models of self and positive models of others. Finally individuals classified with anxious attachment orientations might also report enhanced dream recall after REM sleep compared with NREM sleep awakenings (reflecting enhanced REM processing in general and perhaps more intense processing of emotional memories in dreams).

Methods

Participants

Sixty-eight healthy participants between the ages of 18 and 50 years were recruited from the Boston area and local universities (see Table 1). The study was approved by the Internal Review Board of the Boston University School of Medicine, and informed consent was obtained from all participants. All were healthy by self report; none were habitual users of drugs or alcohol, and none had a history of depression or were using antidepressant medication. Two participants were excluded from the study for severe sleep apnea as assessed by a Board Certified Sleep Medicine specialist (S.A.). Another participant was excluded because of abnormal sleep architecture (never entering REM sleep). A fourth was excluded because of errors in the testing procedures. Thus, 64 participants were included in the data analyses.

Measures

Wechsler Test of Adult Reading (WTAR)—To obtain a measure of general verbal IQ, we administered the Wechsler Test of Adult Reading (WTAR) to all participants. The WTAR (Wechsler, 2001) possesses adequate psychometric properties, is scaled according to age, and is co-normed with the WAIS-III and the WMS-III.

Depression Anxiety Stress Scale (DASS₂₁)—The DASS₂₁ (Lovibond & Lovibond, 1995) consists of 21 items that assess depression, anxiety, and stress with seven questions in each subscale. Psychometric properties of the DASS are excellent (Antony, Bieling, Cox, Enns, & Swinson 1998; Crawford & Henry, 2003; Henry & Crawford, 2005).

Attachment measures—Two assessment instruments were used to assess attachment patterns: the Attachment Questionnaire (AQ; Hazan & Shaver, 1987) and the Relationship Styles Questionnaire (RSQ; Bartholomew & Horowitz, 1991). The first instrument classifies people into three categories – secure, anxious, and avoidant. The second instrument yields four categories – secure, preoccupied (anxious), dismissive, and fearful based on answers to a series of questions about relationships. Half of the participants received the AQ and half received the RSQ. Previous studies have found that these two measures are comparable (Bartholomew & Shaver, 1998; Brennan, Shaver, & Tobey, 1991) and any dissimilarity would negate results rather than enhance them. For present purposes, we classified individuals with fearful and dismissing patterns into a single avoidant category, so that there were three categories derived from both measures. We recognize that the instruments we used to classify participants into attachment groups are not commonly used today and thus we inadvertently minimized statistical power that we might have had had we relied on the more commonly used instruments.

Pittsburgh Sleep Quality Index (PSQI) and Sleep Diary—Participants completed the Pittsburgh Sleep Quality Index (PSQI), a one-month retrospective measure, and a sleep/dream daily diary. The diary gathered information about sleep habits (hours of sleep, number of awakenings, time participant went to bed) and dreams upon awakening for five days before entering the sleep lab. This information allowed us to screen for aberrant sleep behaviors before participants entered the sleep lab. A Global Sleep Quality Index score was derived from the PSQI based on seven components of subjective sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Higher scores on both the PSQI and the diary-based index reflect poorer quality sleep.

Overnight polysomnography (PSG)—Polysomnographic (PSG) recording included EEG activity recorded from the C3 and C4 electrodes (referenced to an average of A1 and A2), EOG activity, submental EMG activity, airflow, respiratory effort, EKG activity, oximetry, and video monitoring. Methods and sleep scoring followed guidelines of the American Academy of Sleep Medicine (Iber, Ancoli-Israel, Chesson, & Quan, 2007). Sleep architecture measures included total sleep time (TST; minutes); number of awakenings; wake time after sleep onset (WASO; minutes); sleep latency (minutes); sleep efficiency (%); number of minutes and percentage of total sleep time spent in Wakefulness, REM, NREM Stages 1, 2, and 3; arousals; and arousal index (see Table 2 for definitions and Table 4 for participant means). Standard clinical measures were used to detect physiological signs of obstructive sleep apnea and other sleep disorders, and recordings were assessed by an expert sleep neurologist (S.A.) using standard diagnostic criteria.

Awakenings Procedures

After a habituation night, participants returned to the sleep lab at 9:00 pm the following night and were instrumented for PSG to assess overnight sleep architecture. To investigate sleep-related mentation, we used an awakenings paradigm adapted from Walker, Brakefield, Morgan, Hobson, and Stickgold (2002). When a person is awakened from a particular sleep state, brain state activation patterns associated with that state persist for several minutes and influence cognitive performance and perhaps mood (Balkin et al., 1999; Bertini & Violani, 1992; Reinsel & Antrobus, 1992). Thus, the awakenings procedure provides a brief window of opportunity to observe and study specific sleep-state-related mentation. Participants were

awakened in counterbalanced order across REM and NREM sleep states 10 minutes after entering a REM episode or a Stage II NREM episode. Immediately upon being awoken, participants described any recalled dreams and completed a short battery of sleep-related mentation assessments containing individual tasks in a randomized order.

Mood and arousal were assessed with the Positive and Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988). We used self-ratings on the item “alert” to assess level of arousal after awakenings.

Sleep-Related Appraisals of Self and Other

Participants were given a list of 20 trait words (four versions were prepared consisting of 10 positive and 10 negative traits each) and were asked to rate how well these traits applied to themselves (the self), another person (a significant other), and themselves in a dream (the dream self). The particular significant other was chosen by the participant before he or she went to sleep. Trait adjectives were drawn from Anderson (1968), with words reflecting highest ‘likableness’ used as positive traits and those reflecting lowest likableness used as negative-traits. Within each list, negative and positive trait adjectives were equated for ‘likeableness’ (or dislikeableness, in the case of negative traits) and frequency of use. Positive words had an average Anderson likableness rating of 452.58 and an average Anderson frequency of 0.88. Negative words had an average likeableness of 119.3 and an average frequency of 0.76. Each participant received every version of the list, but the condition in which each version was received was randomized. We predicted lower appraisals of self, as compared with other, after REM sleep awakenings for anxious participants and the opposite profile for avoidant individuals.

Self and Other Appraisals in Sleep-Related Dream Content

Recalled dreams were transcribed and scored for content by a blind rater. We used the standardized Hall and Van de Castle content scoring system (Domhoff, 1996; Hall & Van de Castle, 1966) to tabulate self and other content in dreams. This scoring system yields percentages for characters, setting, social interactions, and self-concept. Schneider and Domhoff (<http://www.dreamresearch.net>; 1999) provide a spreadsheet program, DreamSat, which tabulates dream content scores based on raw data and automatically computes derived scales and percentages. Depiction of self in dreams was evaluated with the Hall and Van de Castle system’s Self-Negativity Scale, which indicates the extent to which the dreamer is depicted negatively in the dream relative to other dream characters.

Statistical Analyses

Analyses were carried out using Systat and SAS for the PC as well as SuperANOVA v.1.11 and StatView v.5.0 for the Macintosh (Abacus Concepts, Berkeley, CA). Demographic, trait and sleep variables for which a priori hypotheses were not made were analyzed using one-way ANOVA with the three attachment categories constituting the independent variable. When an ANOVA yielded a significant main effect, Duncan New Multiple Range post-hoc tests (Kramer, 1956) were used to compare the means for the three attachment groups.

Based on a priori predictions described above, REM sleep percent and latency were first compared between avoidant and anxious groups using one-tailed, unpaired *t*-tests. The three attachment groups were then compared using one-way ANOVA, as done for the other PSG variables described above.

Sleep-related mentation data were analyzed using mixed model ANOVAs with attachment category as a between-subject factor and specific within-subjects factors described in the

Results section below. The Greenhouse-Geiser correction for sphericity was applied to all within-subjects variables for which there were significant main effects or interactions.

ANOVAs were used to compare all three attachment groups on sleep outcomes. Chi-square analyses tested dream recall frequency following laboratory awakenings. We used the DreamSat program (Schneider, 2001; <http://www.dreamresearch.net>) to compute all of the scale scores, percent differences, and the p values we report on Hall van de Castle content differences.

Results

Twenty-nine (29) individuals were categorized as securely attached and 35 as insecurely attached. Of the insecurely attached group, 20 were avoidant and 15 were anxious. Among the three attachment categories, there were no significant differences in mean age, years of education, WTAR scaled scores, or DASS Depression and Anxiety and Total scores (see Table 1). DASS *Stress* scores were significantly different [$F(2,61) = 3.80, p < 0.05$]. Duncan New Multiple Range post-hoc analyses showed that the anxious group had significantly higher ($p < 0.05$) DASS Stress scores than the secure group, but not higher than the avoidant group, nor did the avoidant group differ from the secure group.

PSQI and Sleep Diary

The subjective sleep measures from the sleep diary and the Pittsburgh Sleep Quality Index (PSQI) were analyzed for group differences (Table 3). An ANOVA on the complete data set revealed significant attachment-category differences in PSQI [$F(2,61) = 4.34, p < 0.05$]. Duncan New Multiple Range post-hoc analyses showed that participants classified as avoidant had significantly elevated ($p < 0.05$) PSQI scores ($M = 5.90, SD = 2.31$), indicating poorer sleep, compared to participants classified as secure ($M = 4.21, SD = 1.82$). Anxious and avoidant participants did not differ in PSQI score. Only the avoidant group had a PSQI score that exceeded the standard 5.0 clinical cutoff for good vs. poor sleep.

There were no significant differences among the three attachment groups in self-reported sleep-onset time or average total sleep time. However, there was a trend toward different numbers of self-reported awakenings [$F(2,61) = 2.64, p < 0.10$]. The anxious group reported significantly ($p < 0.05$) more awakenings ($M = 1.28, SD = 0.83$) than the avoidant group ($M = 0.66, SD = 0.75$) whereas neither the anxious nor the avoidant group differed significantly from the secure group ($M = 1.10, SD = 0.92$).

Sleep Architecture

There were no attachment-group main effects on the sleep quality and architecture parameters for which no a priori hypotheses were stated (see Table 4). As predicted, REM sleep latency was reduced in the anxious group compared to the other attachment groups [$F(2,61) = 2.97, p < 0.06$]. Duncan New Multiple Range Post-hoc analyses showed that participants classified as anxious evidenced significantly reduced REM latency scores relative to participants classified as secure ($p < 0.05$) but did not differ from avoidant nor did avoidant differ from secure.

Sleep-Related Mentation

PANAS—There were no significant differences in mean PANAS scores for REM and NREM sleep awakenings or across the three attachment groups, indicating comparable affective states after awakenings. As a proxy measure of arousal upon awakening, ratings of the word “alert” were compared across the three attachment categories and specifically for

the anxious and avoidant groups using mixed ANOVAs with Phase (REM, NREM sleep) as a within-subjects factor. None of the main effects or the interaction was significant.

Self and Other Appraisals—Participants were allowed to choose which dream character they would refer to as the other. All “others” could be classified as family/friends or as a romantic partner. Secure individuals chose their romantic partner 21.4% of the time, anxious/preoccupied individuals chose their romantic partner 23.1% of the time, and avoidant participants never chose a romantic partner.

It was hypothesized that the anxious individuals would rate themselves less positively or more negatively in relation to their ratings of the ‘other’ following REM sleep awakenings. Therefore, self and other ratings following REM sleep awakenings were examined in a mixed ANOVA using attachment group as a between-subjects factor and valence (negative, positive) nested within personages (self, other) as within-subject factors. None of the main effects or interactions was significant, nor were there any significant findings when “dream self” ratings were used instead of general self ratings.

Dream Recall Rates—We found no significant differences in dream recall rates across the 3 attachment groups.

Hall and Van de Castle Analyses of Dreams—Dream content analysis with the Hall and Van de Castle scoring system revealed that a Social Interaction variable was significantly different within the dreams of the avoidant compared to the anxious groups. Relative to the avoidant group, the anxious group had a significantly higher percentage of aggression/friendliness content (aggression/friendliness percentage = aggressive interactions/aggressive + friendly interactions; avoidant = 36%, anxious = 57%, $p < 0.05$), meaning that more dreams contained aggression relative to friendly interactions. The remaining Social Interaction variables (aggressor percent, befriender percent, and physical aggression percent) were significantly different among the attachment groups. In addition, there was a trend within the Self-Concept category indicating higher self-negativity percentages in the anxious group compared with the avoidant group (avoidant = 44%, preoccupied/anxious = 75%, $p < 0.10$). The other Self-Concept variables (bodily misfortunes, negative emotions, dreamer involved success, and torso/anatomy) did not show any trends and were not significantly different among the attachment groups. There were no significant differences among any of the Settings variables (indoor or familiar) or the Characters variables (percent of male/female, familiarity, friends, family, dead & imaginary, and animal percents).

Discussion

We found that relative to participants with secure attachment orientations, those with an anxious orientation evidenced reduced latencies to REM sleep; relative to participants with avoidant attachment orientations those with an anxious orientation also evidenced significantly enhanced aggression/friendliness content and greater self-negativity content in dreams recalled after a REM but not a NREM awakening.

McNamara et al. (2001) proposed that REM sleep is used by preoccupied or, more broadly conceived, attachment-anxious individuals to process attachment-related experiences and emotions, and that REM sleep is consequently up-regulated (increased in duration and intensity as measured by indices of REM sleep architecture and REM-related mentation such as dream recall and content) in such individuals. In contrast, avoidant individuals, who are known to use defenses to down-regulate (or “deactivate”; Cassidy & Kobak, 1988; Mikulincer, Dolev, & Shaver, 2004) attachment processes when awake, may also down-

regulate the processing of attachment-related memories and emotions during sleep (as indicated by decreased duration and intensity of indices of REM sleep architecture and REM-related mentation such as dream recall and content). Those with secure orientations were predicted to fall between the high REM values associated with anxious orientations and the low REM values associated with avoidant orientations.

The results from our sleep measurements, however, provide only mixed support for McNamara et al.'s (2001) suggestion concerning a role for REM sleep in the maintenance of attachment orientations in anxiously attached individuals. While measurements of REM sleep indices were in the predicted directions, they were not always significant. One of the main predictions flowing from McNamara et al.'s theoretical suggestions was that REM sleep-related *mentation* would be associated with emotional memory content and internal working models of attachment. Thus, the self would be negatively evaluated (compared with the evaluation of a significant other) by anxious participants in REM dreams and after REM awakenings. By contrast the self would be positively evaluated by avoidant participants in their dreams and after awakenings. But statistical tests of these associations did not reach significance. Nevertheless, solid statistical support for the theory suggested by McNamara et al. (2001) was obtained when measures of REM sleep latency and broader categories of REM dream content measures were analyzed.

There was higher REM sleep pressure (in the form of shorter latencies to REM) noted in the anxious group as compared with the secure groups. This was not due to depression, because people with a history of depression were excluded from the study and no signs of depression emerged on the DASS mood scales. Indeed there were no significant differences on the DASS depression scale between the three attachment groups. In addition, there were no significant differences between the avoidant, anxious, and secure categories on the PANAS mood scales after awakenings.

Another possibility that might explain greater REM sleep pressure and enhanced dream recall in the anxious participants was that they were simply over-aroused. But the PANAS "alert" item ratings after awakenings from REM and NREM sleep did not vary across the three attachment groups, and there were no significant differences on PSG-measured arousal or sleep efficiency across the three attachment groups (Table 4).

Why, then, do individuals who score high on anxious attachment exhibit enhanced REM sleep pressure, greater aggression and enhanced self-denigration themes in their dreams? Because there is considerable evidence that attachment-anxious individuals are emotional, expressive, ambivalent, and prone to rumination (see Mikulincer & Shaver, 2007, for a review), they may exhibit these same kinds of tendencies while sleeping (see Mikulincer, Shaver, & Avihou-Kanza, this issue). It may also be that anxious individuals who are emotionally preoccupied with a significant other may harbor aggressive feeling toward that individual as well. Avoidant individuals, in contrast, tend to inhibit or suppress emotion and try not to think about emotional vulnerabilities while awake. Some of the same defensive processes may operate while they are asleep.

Participants in our study classified as avoidant had significantly elevated Pittsburgh Sleep Quality Index scores indicating poorer sleep, compared to participants classified as secure. This poor quality sleep is consistent with the idea that these individuals defensively resist sleep because sleep and sleep mentation involves some amount of processing of attachment-related content and unpleasant emotional memory content.

In other words, the sleeping and dreaming mind/brain shares many tendencies with the waking mind/brain. Attachment working models are well ingrained organizers of the mind, and they may continue to organize or influence mental processes during sleep. This is one of

the reasons why, ever since Freud, dream reports have been valuable sources of insight about underlying conflicts, preoccupations, and defenses.

Freud also pointed to the importance of early childhood experiences in the formation of lifelong psychic and emotional functioning. These early observations of Freud suggest that it may be possible that attachment orientations that are formed in early childhood will be associated with later adult functioning, including sleep and dream function. Csóka et al. (this issue) examined potential associations in a large sample ($n = 5020$) of otherwise healthy adults between early maternal separation and nightmare and dream content experience in adulthood. They found significant associations between early maternal separation and frequent nightmares and negative dreams. Current depression contributed to the association between early separation and nightmares, but not the association between negative dream affect and early separation. Taken together with the results reported concerning REM pressure and negative dream content in participants classified with an anxious attachment orientation it seems clear that the deep associations between attachment and sleep and dream function that Freud pointed to over a century will require further and sustained exploration.

Acknowledgments

This research was supported by NIMH Grant no. 5R21MH076916-02 (P.M.). The project described was supported by CTSA Grant Number 1UL1RR025771 from the National Center for Research Resources (NCRR), a component of the National Institute of Health (NIH). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of NCRR or NIH. We would also like to thank Deirdre McLaren for scoring dreams.

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Table 1

Demographics and mood measures for sleep study participants by attachment type.

	Secure (n=29)	Anxious (n=15)	Avoidant (n=20)	F(2,61)
Age (in years)	20.83 (14.41)	20.53 (2.33)	21.25 (3.55)	<1
Sex (No. females)	62.1%	53.3%	50.0%	<1
Education (in years)	14.41 (1.64)	14.53 (1.81)	14.03 (2.21)	<1
WTAR (scaled score)	118.90 (6.66)	121.00 (5.17)	120.20 (11.26)	<1
DASS Total	8.21 (6.01)	11.80 (5.86)	10.60 (6.97)	1.848
DASS Stress	3.79 (2.53)	6.07 (2.58)	5.25 (3.16)	3.800*
DASS Anxiety	1.76 (2.12)	2.07 (1.58)	2.35 (2.94)	<1
DASS Depression	2.66 (2.81)	3.67 (3.39)	3.00 (2.71)	<1

*
p < 0.05.

Note:

[†]A χ^2 analysis comparing the percentage of females in each group was also not statistically significant. DASS=Depression, Anxiety and Stress Survey

Table 2

Definitions of sleep terms

Term	Definition
Non-rapid eye movement (NREM) sleep	This sleep state constitutes the majority of sleep. It is made up of Stage II light sleep and Stage III and IV deep sleep characterized by slow wave forms on the EEG. The American Academy of Sleep medicine has recently recommended classifying NREM stages of sleep into 3 phases: N1 (like Stage I), N2 (like Stage II) and N3 that encompasses former stages III and IV.
Polysomnography	Measurement of brain and physiologic functions when the individual is asleep. Many body functions such as movements of the limbs and eyes, brainwaves, heart rhythm, and breathing are measured
Rapid eye movement (REM) sleep	A period of sleep characterized by very high brain activation levels in the limbic system, rapid movement of the eyes under closed eyelids, muscle paralysis and sexual activation (penile erection in men and clitoral engorgement and pelvic thrusting in women). REM occurs approximately every 90 minutes and increases in duration as the night progresses.
REM latency	The amount of time (in minutes) from sleep onset until the first episode of REM.
Sleep architecture	The overall picture of a person's sleep that includes measurements of sleep cycles and amounts of Rapid Eye Movement (REM) and Non-Rapid Eye Movement (NREM) sleep.
Sleep efficiency	A percentage that compares the amount of time spent awake to the amount of time spent sleeping during the night. The higher the percentage, the more sleep took place over the course of the night.
Sleep onset latency	The amount of time (in minutes) it takes for a person to initiate sleep from when EEG recording begins.
Sleep-related mentation	The cognition (typically dreams) that is associated with the sleep state that the person was in before being awoken.

Table 3

Subjective sleep measures prior to entering sleep lab

	Secure (n=29)	Anxious (n=15)	Avoidant (n=20)	F(2,61)
Mean total sleep time (in min)	451.67 (66.77)	448.59 (62.11)	457.38 (69.63)	<1
Mean sleep onset latency (in min)	14.28 (9.45)	9.90 (6.83)	17.50 (15.23)	2.00
Number of awakenings	1.10 (0.92)	1.28 (0.83)	0.66 (0.75)	2.64
PSQI global score	4.21 (1.82)	4.80 (1.78)	5.90 (2.31)	4.34

Table 4

Sleep architecture characteristics and subjective sleep measures for the entire night by attachment category.

	Secure (n=29)	Anxious (n=15)	Avoidant (n=20)	F(2,61)
Mean total sleep time (in min)	337.57 (38.93)	340.13 (41.29)	341.93 (32.95)	<1
Mean sleep onset latency (in min)	25.98 (24.87)	16.37 (13.31)	28.73 (36.41)	< 1
Sleep efficiency (%)	0.79 (0.08)	0.83 (0.83)	0.78 (0.09)	1.35
Number of arousals	43.28 (16.15)	51.07 (20.41)	43.45 (13.71)	1.20
Arousal Index	7.66 (3.12)	8.92 (3.53)	7.61 (2.32)	1.01
Stage 1 (in min)	9.25 (3.77)	11.15 (5.02)	9.96 (3.57)	1.10
Stage 2 (in min)	176.42 (31.58)	180.86 (29.35)	182.53 (30.78)	<1
Stage 3/4 (in min)	77.67 (24.92)	79.19 (27.83)	72.79 (18.40)	<1
Total NREM (in min)	263.33 (30.57)	271.19 (29.87)	265.28 (25.30)	<1
Total REM (in min)	74.21 (27.31)	68.93 (21.12)	76.62 (24.76)	<1
Average latency to REM (in min)	96.34 (35.46)	73.67 (17.01)	86.82 (26.61)	2.97