Title
Dreamlike events are correlated with the length of sleep mentation reports.

Journal
Archives italiennes de biologie, 155(1-2)

ISSN
0003-9829

Authors
Rosenlicht, N
Primich, C
McQuaid, JR
et al.

Publication Date
2017-07-01

DOI
10.12871/000398292017127

Peer reviewed

Dreamlike Events are Correlated with the Length of Sleep Mentation Reports

Nicholas Z. Rosenlicht, M.D.[1] , Charles Primich, N.P.[2] , John R. McQuaid, Ph.D.[1,2] ,

Thomas Maloney, Ph.D.[3], Ian G. Campbell, Ph.D.[4], Irwin Feinberg, M.D.[4]

[1]University of California – San Francisco, San Francisco, CA, [2]San Francisco VA Medical Center, San Francisco, CA; [3]Department of Psychiatry, Icahn School of Medicine at Mount Sinai, New York, NY; [4]University of California – Davis, Davis, CA

Laboratory of Origin: UC Davis Sleep Lab, 1712 Picasso Ave., Davis, CA 95617

Addresses of Authors: Nicholas Rosenlicht, M.D., 1569 Solano Ave. #324, Berkeley, CA 94707.

Charles Primich, N.P. and John McQuaid Ph.D.: VAMCSF (116), 4150 Clement St., San Francisco, CA 94121

Thomas Maloney Ph.D.: Icahn School of Medicine at Mount Sinai, One Gustave L. Levy Place, Box 1230, New York, NY 10029,

Ian Campbell, Ph.D. and Irwin Feinberg, M.D.: UC Davis Sleep Lab, 1712 Picasso Ave., Davis, CA 95617

Running Title: Dreamlike events

Correspondence concerning this article should be addressed to Nicholas Rosenlicht, M.D., 1569 Solano Ave. #324, Berkeley, CA 94707. Contact: Tel: 510-558-3488; Fax: 855-558-3489; E-mail: nicholas.rosenlicht@ucsf.edu.

Acknowledgements: Research supported in part by a Faculty Research Grant from UC Davis, VA Research Funds, and NIA AG 5 RO1-07224

Abstract

We investigated the relationship between length and dreamlike quality in sleep mentation reports. Reports were obtained by waking subjects at sleep onset (SO) and at 5 and 10 minutes into the second (REMP2) and fourth REM periods (REMP4). Reports were recorded, transcribed, and scored blindly for total word count (TWC) and dreamlike quality as measured by a composite dream scale score (CDS).

Dreamlike quality was strongly correlated with TWC; both CDS and TWC scores increased across successively later awakenings. Significant differences were found in both TWC and CDS between SO and REMP4 and also between REMP2 and REMP4; however, differences were not significant between SO and REMP2 or between the 5 and 10 minute awakenings in REMPs 2 and 4. These findings provide further evidence that the amount of dreamlike mentation is related to the within-sleep arousal level rather than to REMP duration and that the dreamlike quality of reports increases as they become longer.

Keywords: rapid eye movement, non-rapid eye movement, dreaming, sleep mentation.

Introduction

Substantial evidence demonstrates that dreaming is not unique to REM (rapid eye movement) sleep. Still, controversy remains as to whether there are qualitative differences between reports of mentation obtained from REM and NREM (non-rapid eye movement) sleep (Cavallero, Cicogna, Natale, Occhionero, & Zito, 1992; Foulkes, 1996, 1997; Rosenlicht & Feinberg,1997). While mentation reports elicited after awakenings from REM sleep are more frequently bizarre and dreamlike than those obtained from NREM sleep they are also, on average, longer. Therefore a higher number of dreamlike events may simply reflect differences in the amount of mentation reported. Quite lengthy and bizarre reports can occasionally be obtained from NREM awakenings, particularly at sleep onset (Foulkes & Vogel, 1965; Vogel, Barrowclough, & Giesler, 1972) and late in the sleep cycle (Fosse, Stickgold, & Hobson, 2004). Considerable evidence indicates that the frequency of dreamlike events in sleep mentation reports is closely associated with report length (Antrobus, 1983; Cavallero et al., 1992; Cavallero, Foulkes, Hollifield, & Terry, 1990; Fein et al., 1985; Foulkes & Schmidt, 1983). In most studies, control of narrative length reduced or eliminated differences in dreamlike events between REM and NREM reports. Disagreement remains, however, as to whether *all* differences can be attributed to report length (Casagrande, Violani, Lucidi, Buttinelli, & Bertini, 1996).

An earlier study in our laboratory found that that length of narrative reports was not dependent on length of time in REM period, but was strongly related to time of night (Rosenlicht, Maloney, & Feinberg, 1994). Thus, report length did not differ after 5 vs. 10 minutes of REM sleep; in contrast, reports obtained from REM period 4 (REMP4) were almost twice as long as those from REM period 2 (REMP2). Here, using a dreamlike element scale we reanalyzed the data from that earlier experiment to determine whether dreamlike elements were correlated with length of report or arousal level. We included reports obtained from early and late awakenings, including those following 5 or 10 minutes of REM sleep, and from sleep onset.

Methods

Subjects

Subjects were 22 (12 male) paid college student volunteers who ranged in age from 19.0 to 27.1 years (M 22.8, SD 2.54 yrs). They were screened for inclusion in the study by a structured interview and self-report questionnaires. Individuals with ongoing sleep problems, substance abuse, or emotional or physical illness were excluded from participation.

Procedure

EEG (C3-A2) and EOG were recorded in standard fashion on a Grass Model 78 polygraph for two consecutive nights, following an accommodation night, with bedtime and wake up time approximating each subject's customary sleep habits. Two subjects were studied per night, each in a private bedroom in a university sleep laboratory. Subjects were awakened abruptly three times each night by calling their name over an intercom: once at sleep onset (SO), once during REM period 2 (REMP2), and once during REM period 4 (REMP4). In a counterbalanced manner over the two nights, subjects were awakened either five or ten minutes after the first unambiguous eye movement in REMP2 and REMP4. SO awakenings were obtained each night 2 minutes after the first unambiguous sleep spindle with no intervening arousal. Two subjects did not have a sleep onset awakening on either night, and two other subjects had a sleep onset awakening on only one night. Sleep mentation was elicited with a structured interview script (D. Foulkes, personal communication 1991) immediately following awakening and recorded on audiotape. The on-line sleep stage judgments of the awakening technician were later confirmed by a second scorer.

Measures

The sleep mentation reports were transcribed and coded. Two judges blind to subject identity and awakening condition scored each report for mean total word count (TWC) employing the methods of Foulkes and Shepherd (Foulkes, D., Shepherd, J. Manual for a scoring system for children's dreams. Unpublished manuscript. 1971), repetitions, explanations, associations, and other extraneous comments that did not specifically reflect recall of sleep mentation were not counted. When discrepancies in TWC were greater than 5%, the two raters reviewed the discrepancy and reconciled by consensus agreement.

The sleep mentation reports were also scored for dreamlike elements using the method of Goodenough, Shapiro, Holden, and Steinschriber (1959) with the addition of a scale for affect. The reports were scored on six parameters: 1) Overt reference to the laboratory; scored on an inverse scale of 0 for reports containing explicit elements of the experimental situation and 1 if none were present, 2) Self-representation; scored as 0 if absent and 1 if the subject was present and part of the action in the report, 3) Bizarreness; scored as 0 for ordinary elements as in a daytime fantasy, 0.5 for unusual elements or unlikely combinations, and 1 for very bizarre, fantastic or exaggerated events or elements, 4) Visual Imagery; scored as 0 if visual imagery was absent and 1 if present, 5) Activity; scored as 0 for a low level of activity, 0.5 for an intermediate level, and 1 for intense physical activity or at least 3 events or activities described, and 6) Affect; scored as 0 for no affect or emotion recalled, 0.5 for vague or mild feelings, and 1 for strong emotions such as fear or lust. The summed total score was divided by 6 to produce a composite dream scale score (CDS) ranging from 0 to 1.

Results were analyzed to examine the following questions:

1. Are the number of dreamlike elements significantly correlated with the length of sleep mentation reports?
2. Does the magnitude of the correlation coefficient differ between the various waking conditions; sleep stage, time of night, or length of time in REM?

Results

Of 126 awakenings 113 yielded dream material. Five SO, four 5 minute REMP2 and four 10 minute REMP2 awakenings yielded no dream material (there were approximately twice as many SO awakenings as for the other conditions). All REMP4 awakenings yielded dream content. Mean TWC and CDS for each awakening condition are shown in Table I and Figure 1.

Correlation of CDS and TWC

CDS and TWC were significantly correlated at all awakening conditions, such that greater CDSs were associated with higher TWCs (see Table II). Correlation coefficients ranged from 0.5 to 0.62 with significant overlap of the 95% upper and lower confidence limits for all conditions (Table II).

A repeated measures MANOVA was conducted with two dependent variables (TWC and CDS) and one within-subjects factor (time) assessed at the 5 time points (SO, REMP2 at 5 minutes, REMP2 at 10 minutes, REMP4 at 5 minutes, and REMP4 at 10 minutes). Multivariate tests were significant for time ($F[8, 11] = 3.99$, $p < .05$). The TWC scores increased significantly in later wakenings ($F[4, 72] = 6.09$, $p < .001$), as did CDS scores ($F[4, 72] = 6.15$, $p < .001$).

Both TWC and CDS increased across the sleep period. Analyzing data from the 18 subjects who completed all awakening conditions, mean TWC increased from SO (123.0, averaging 2 nights of sleep onset awakenings) to REMP2 (215.1 averaging both 5 and 10 minute awakenings) to REMP4 (448.7, also averaging the 5 and 10 minute awakenings) (F [2, 34] = 7.01, p = .003). Post hoc analyses found significant differences in TWC between SO and REMP4 ($p = .015$), as well as between REMP2 and REMP4 ($p = .003$), but not between SO and REMP2 ($p=0.21$). Mean CDS also increased from .42 at SO to .49 at REMP2 and .70 at REMP4 ($F [2, 34] = 8.62$, $p < .001$). Post hoc analyses found significant differences in CDS between SO and REMP4 ($p < .001$), and between REMP2 and REMP4 ($p = .004$), but as with TWC, CDS from SO and REMP2 did not differ significantly ($p=0.43$).

Dream reports restricted to REM awakenings were compared for all 22 subjects for analysis of REM duration and REM period effects on TWC and CDS. In a 2 factor repeated measures ANOVA, TWC differed between REMP2 and REMP4 ($F[1,21]=12.2$, $p=0.002$) but did not differ between 5 and 10 minute awakenings ($F[1,21]=3.02$, $p=0.097$). REM period and REM duration effects did not interact ($F[1,21]=0.02$, $p=0.88$). Composite dream score also increased significantly from REMP2 to REMP4 ($F[1,21]=9.51$, $p=0.006$ but did not differ between 5 and 10 minute awakenings

(F[1,21]=2.03, p=0.17). For CDS, REM period and REM duration effects did not interact (F[1,21]=3.16, p=0.90),

Discussion

These results support the findings of earlier investigations that indicate a close association between length of sleep mentation reports and their dreamlike quality. Here, both measures increased with the duration of prior sleep, which we interpret as a surrogate for increasing within-sleep arousal level (or diminishing sleep depth). Whether bizarre dreamlike events stimulate longer reports, or longer reports contain more dreamlike elements cannot be determined from our data. Whatever its basis, the relationship between TWC and CDS does not appear to differ between REM and NREM (SO) awakenings, between longer and shorter durations of preceding REM sleep, or earlier vs. later REM periods. The finding that mentation recalled from REMP4 was significantly longer and more dreamlike than the other waking conditions, along with the consistent relationship between TWC and CDS noted above, suggests that similar processes of dream production and recall operate in the different stages of sleep, with amount of accessible mentation dependent on arousal level. Further studies with independent measures of arousal level at the time of awakening would test this hypothesis.

We included mentation from sleep onset awakenings, in addition to that from REM periods 2 and 4, because of reports that SO mentation is frequently indistinguishable from that obtained following REM (Foulkes & Vogel, 1965; Vogel et al., 1972). However, we found that while sleep onset reports share the relation of dreamlike quality to narrative length found in the other awakenings times, SO reports were briefer than expected from previous studies. This may be due to differences in methods. Our SO awakenings were carried out a full two minutes after the first unambiguous sleep spindle, with no intervening arousal. These awakenings may therefore have been further from actual wake-sleep transition that those of Foulkes and Vogel. A parametric study of this question would be of interest.

Our findings are consistent with the bulk of the literature which argues against distinctive REM mentation. Cavallero (1987, 1990) found that dream sources (based on memory associations), as well as dream content, are similar for REM and NREM sleep. Cipolli et al. (1988) showed that thematic units from different sleep stages in the same night were more closely related than they were for the same stage across different nights; see also Cavallero et al. (1992). Cicogna, et al. (1998) found no differences in mental activity on morning awakenings from different stages of sleep and subsequently (2000) found that slow wave sleep (SWS) and REM content differences were more quantitative than qualitative. These observations are consistent with the idea that mental activity occurs continuously during sleep and is not exclusive to REM. Fosse et al. (2004) found that when mentation reports from early night REM were compared to late night (longer) NREM mentation, there was no difference in frequency of hallucinations or directed thinking. For further arguments against a unique association of dreaming and REM sleep, see Rosenlicht & Feinberg, (1997) and Antrobus (1991), as well as Foulkes' (1996) excellent and comprehensive review of modern dream research.

The view that enhanced recall from REMP4 over REMP2 is due to variation in arousal level (or depth of sleep or "CNS activation") parsimoniously explains the generally longer reports from REM as compared to NREM sleep. The inverse relation between depth of sleep and recalled mentation is also supported by the experimental results of De Gennaro et al. (2010). They found that the number of dreams recalled was markedly depressed in morning awakenings from recovery sleep following a night of sleep deprivation, and the number recalled did not differ significantly whether subjects awoke from REM or NREM sleep.

Greater recall due to higher arousal levels (rather than more mental activity) might result in more dreamlike elements. The notion that memory processes are critical for dream reports is not new. In 1969 Feinberg and Evarts suggested the possibility that "differences in mental content on awakenings from the different stages of sleep reflect differences in the nature of recall rather than in the ongoing mental activity at the time of awakening" (p. 340). Similarly, Antrobus (1991) suggested that "dreamlike mentation might be produced throughout the night, but only during REM sleep is the association cortex sufficiently active to support a lengthy mentation report" (p. 103).

One factor that complicates the interpretation of experimental studies of dreaming is their inevitable reliance on subjective report. While researchers have assumed that dream reports are memories of mental experiences that were ongoing prior to awakening, this inference has not been proved. Even if it is correct, it seems likely that dream reports are multiply determined. They probably include sleep mentation prior to awakening and mentation stimulated by the arousal process. These elements might be further elaborated and integrated during recall and report. Variations in level of CNS arousal with time of night, and sleep stage could affect any of these processes.

It is relevant here that the eponymous rapid eye movements of REM, initially thought to represent the scanning of dream images, are not predicted by dream imagery (Moskowitz and Berger (1969), Firth and Oswald (1975), Jacobs et al. (1972), Koulack (1972). It now seems likely that these small muscle movements are simply the result of the intense firing of hard-wired motor neurons that occurs in REM sleep throughout the brain; whereas the output to large somatic muscles must be inhibited to prevent awakening, the output to small muscles controlling eye movements need not be actively inhibited, since their firing does not provoke waking (Feinberg et al 1987).

The bulk of the evidence, including the findings here, demonstrates that REM-NREM mentation differences, if any exist, are so small that they are unlikely to hold significance for brain function. This leads to a paradigm shift because the question originally provoked by the discovery of REM sleep, why we have periods of dreaming interspersed with non-dreaming sleep, must be radically revised. The neuroscience question becomes: what brain functions are served by the periodic emergence of an awake-type EEG (REM) during NREM sleep? This question has been substantially ignored since it became accepted that NREM rather than REM sleep is the restorative component of mammalian sleep (Feinberg 1974) and the mathematical formulation of this notion in the “two-process- model” (Borbely1982).

There are long-established findings that suggest that REM might perform a function needed to optimize the amount of NREM sleep. One possibility is that periodic bouts of REM provide a cofactor needed for NREM sleep to resume until optimal levels are reached (Feinberg, 1974). A related possibility is that hard-wired brain systems require less “NREM reversal” than more plastic brain systems and those hard-wired systems must therefore discharge this excess excitation (which might cause waking) by periodic REM (see Feinberg and March 1995). This latter paper also proposed a mechanism that could produce cyclic alternation of NREM and REM sleep.

These speculations suggest a functional relation between NREM and REM sleep and they are supported by considerable indirect evidence cited in the original publications. But their merit must be determined experimentally. Nevertheless, the data here add support the view that the focus in REM sleep research should change from searching for correlates of dreaming to determining the biological function of these periodic bursts of partial arousal and disinhibited neural firing that occur in virtually all mammalian sleep.

References

Antrobus, J. REM and NREM sleep reports: comparison of word frequencies by cognitive classes. *Psychophysiology, 20*(5), 562-568, 1983 doi: 10.1111/j.1469-\8986.1983.tb03015.x

Antrobus, J. Dreaming: cognitive processes during cortical activation and high afferent thresholds. *Psychol Rev, 98*(1), 96-121, 1991.

Antrobus, J., Kondo, T. , Reinsel, R., Fein, G. Dreaming in the Late Morning: Summation of REM and Diurnal Cortical Activation. *Cosciousness and Cognition*, *4*, 275-299, 1995.

Borbély AA. A two process model of sleep regulation. *Human Neurobiology,* 1(3):195-204, 1982

Casagrande, M., Violani, C., Lucidi, F., Buttinelli, E., & Bertini, M. Variations in sleep mentation as a function of time of night. *Int J Neurosci*, *85*(1-2), 19-30, 1996. doi: 10.3109/00207459608986348

Cavallero, C. Dream sources, associative mechanisms, and temporal dimension. *Sleep, 10*(1), 78-83, 1987.

Cavallero, C., Cicogna, P., Natale, V., Occhionero, M., & Zito, A. Slow wave sleep dreaming. *Sleep, 15*(6), 562-566, 1992.

Cavallero, C., Foulkes, D., Hollifield, M., & Terry, R. Memory sources of REM and NREM dreams. *Sleep, 13*(5), 449-455, 1990.

Cicogna, P. C., Natale, V., Occhionero, M., & Bosinelli, M. A comparison of mental activity during sleep onset and morning awakening. *Sleep, 21*(5), 462-470, 1998.

Cicogna, P., Natale, V., Occhionero, M., & Bosinelli, M. Slow wave and REM sleep mentation. *Sleep Res Online, 3*(2), 67-72, 2000.

Cipolli, C., Fagioli, I., Baroncini, P., Fumai, A., Marchio, B., & Sancini, M. The thematic continuity of mental experiences in REM and NREM sleep. *Int J Psychophysiol, 6*(4), 307-313, 1988.

De Gennaro, L., Marzano, C., Moroni, F., Curcio, G., Ferrara, M., & Cipolli, C. Recovery sleep after sleep deprivation almost completely abolishes dream recall. Behav Brain Res, 206(2), 293-298, 2010.

Fein, G., Feinberg, I., Insel, T. R., Antrobus, J. S., Price, L. J., Floyd, T. C., et al. Sleep mentation in the elderly. *Psychophysiology, 22*(2), 218-225, 1985. doi: 10.1111/j.1469-8986.1985.tb01590.x/abstract

Feinberg, I. Changes in sleep cycle patterns with age. *Journal of Psychiatric Research*, 10(3-4), 283-306, 1974.

Feinberg, I., & Evarts, E. V. Some implications of sleep research for psychiatry. *Proc Annu Meet Am Psychopathol Assoc, 58*, 334-396, 1969.

Feinberg, I., Floyd, T., March, J. Effects of sleep loss on delta (0.3-3 Hz) EEG and eye movement density: new observations and hypotheses. *Electroencephalography and Clinical Neurophysiology*, 67(3), 217-21, 1987.

Feinberg, I., March, J. Observations on delta homeostasis, the one-stimulus model of NREM-REM alternation and the neurobiologic implications of experimental dream studies. *Behavioural Brain Research*, 69, 97-108, 1995.

Firth, H., Oswald I. Eye movements and visually active dreams. *Nature,* 12(5), 602-6, 1975.

Fosse, R., Stickgold, R., & Hobson, J. A. Thinking and hallucinating: reciprocal changes in sleep. *Psychophysiology, 41*(2), 298-305, 2004. doi: 10.111/j.1469-8986.2003.00146.x

Foulkes, D. Dream research: 1953-1993. *Sleep, 19*(8), 609-624, 1996.

Foulkes, D. A contemporary neurobiology of dreaming? *Sleep Research Society Bulletin, 3*(1), 2-4, 1997.

Foulkes, D., & Schmidt, M. Temporal sequence and unit composition in dream reports from different stages of sleep. *Sleep*, *6*(3), 265-280, 1983.

Foulkes, D., & Vogel, G. Mental Activity at Sleep Onset. *J Abnorm Psychol*, *70,* 231-243, 1965.

Goodenough, D. R., Shapiro, A., Holden, M., Steinschriber, L. A comparison of "dreamers" and "nondreamers": eye movements, electroencephalograms, and the recall of dreams. *Journal of Abnormal and Social Psychology, 59*, 295-302, 1959. doi: 10.1037/h0040532

Hall, C. Do we dream during sleep? Evidence for the Goblot hypothesis. *Perceptual and Motor Skills, 53*, 239-246, 1981. doi: 10.2466/pms.1981.53.1.239

Jacobs, L., Feldman, M., Bender, M. The pattern of human eye movements during sleep. *Transactions of the American Neurological Assoc*., 95:114-9, 1970.

Koulack, D. Rapid eye movements and visual imagery during sleep. *Psychological Bulletin*, 78(2), 155-8, 1972.

Moskowitz , E., Berger R. Rapid eye movements and dream imagery: are they related? *Nature*, 224(5219):613-4, 1969.

Rosenlicht, N., Feinberg, I. REM sleep = dreaming: Only a dream. *Sleep Research Society Bulletin, 3*(1), 10-13, 1997.

Rosenlicht, N., Maloney, T. & Feinberg, I. Dream report length is more dependent on arousal level than prior REM duration. *Brain Res Bull, 34*(2), 99-101, 1994. doi: 10.1016/0361-9230(94)90004-3

Vogel, G. W., Barrowclough, B., & Giesler, D. D. Limited discriminability of REM and sleep onset reports and its psychiatric implications. *Arch Gen Psychiatry, 26*(5), 449-455, 1972.

Figure Legends

Figure 1. Average dream report dreamlike quality (composite dream score) is plotted against dream report length (total word count) for each awakening condition. Data are averages for all subjects who completed each condition, n=18 for sleep onset and n=22 for all other conditions. Composite dream score increased with increasing total word count.

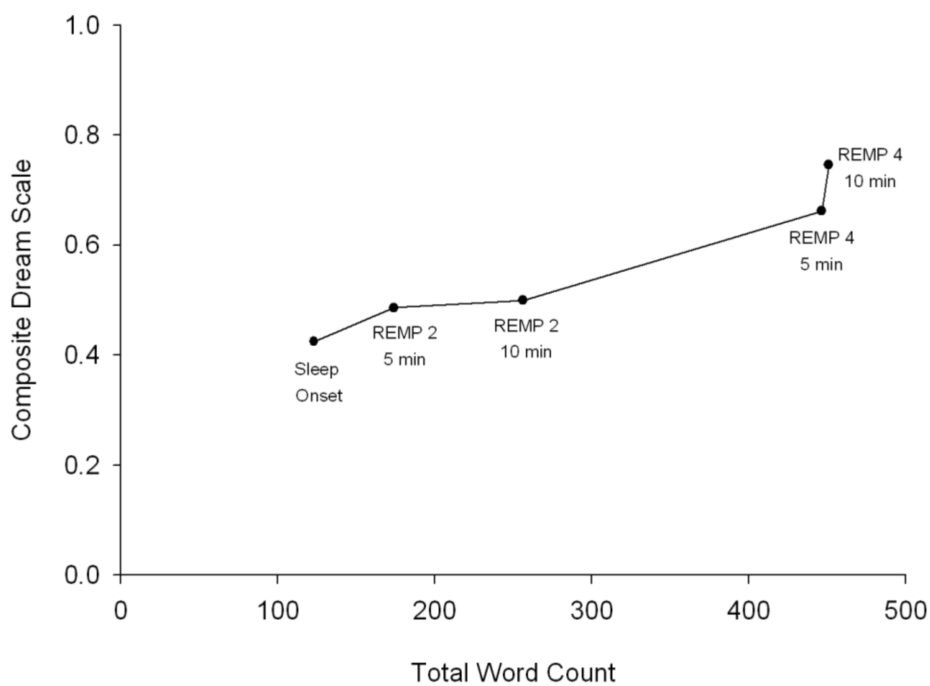

Table I. Mean total word count (TWC) and mean composite dream score (CDS) for each awakening condition.

Awakening Condition	Sleep Onset (2 night avg)	REMP 2 5 min	REMP 2 10 min	REMP 4 5 min	REMP 4 10 min
TWC	123	174	256	446	451
CDS	0.42	0.49	0.5	0.66	0.75

Table II. Correlation between TWC and CDS by each awakening condition.

Awakening Condition	TWC	CDS	n	r	p	95% lower	95% upper
Sleep Onset	123	0.42	38	0.62	<0.0001	0.37	0.78
REMP 2	215	0.49	44	0.54	0.0002	0.28	0.72
REMP 4	449	0.70	44	0.53	0.0002	0.28	0.72
5 min	310	0.57	44	0.5	0.0005	0.24	0.69
10 min	354	0.62	44	0.54	0.0001	0.29	0.72