



Original article

## Dream Recall and Its Relationship to Sleep, Perceived Stress, and Creativity Among Adolescents

Serge Brand, Ph.D.<sup>a,\*</sup>, Johannes Beck, M.D.<sup>a</sup>, Nadeem Kalak, M.Sc.<sup>a</sup>, Markus Gerber, Ph.D.<sup>b</sup>, Roumen Kirov, M.D., Ph.D.<sup>c</sup>, Uwe Pühse, Ph.D.<sup>b</sup>, Martin Hatzinger, M.D.<sup>d</sup>, and Edith Holsboer-Trachsler, M.D.<sup>a</sup>

<sup>a</sup> Depression and Sleep Research Unit, Psychiatric Hospital of the University of Basel, Basel, Switzerland

<sup>b</sup> Institute of Exercise and Health Sciences, Faculty of Medicine, University of Basel, Basel, Switzerland

<sup>c</sup> Institute of Neurobiology, Bulgarian Academy of Sciences, Sofia, Bulgaria

<sup>d</sup> Psychiatric Hospital of Solothurn, Solothurn, Switzerland

**Article history:** Received December 3, 2010; Accepted April 9, 2011

**Keywords:** Adolescents; Dream; Sleep; Gender differences; Creativity

### ABSTRACT

**Purpose:** To explore associations between dream recall, gender, sleep, perceived stress, and creativity in a large sample of adolescents. In adults, women report a higher frequency of dream recall than men. Moreover, increased awakenings seem to increase dream recall, whereas low sleep quality is associated with low dream recall. In addition, there is some evidence that dream recall is associated with personality traits such as creativity. For adolescents, comparable data from larger samples are missing to date.

**Method:** A total of 5,580 adolescents (mean age: 18.23 years; 3,711 females and 1,869 males) participated in the present study. Participants completed an Internet-administered questionnaire related to dreaming, sleep, perceived stress, and creativity.

**Results:** As compared with males, female adolescents reported a higher dream recall rate and felt a stronger impact of dreams on the subsequent day. Female adolescents also described themselves as more creative, and reported suffering more from sleep complaints and perceived stress. Multiple regression analyses further revealed that increased dream recall was independently predicted by factors such as female gender, sleep quality, and creativity, whereas perceived stress, awakenings during the night, and sleep duration had no predictive value.

**Conclusions:** Similar to the findings of studies conducted on adults, dream recall was also associated with female gender in a large sample of adolescents. Additionally, it seemed that several different factors such as good mood, increased sleep quality, and creativity influenced dream recall. These results can provide a basis for better understanding the psychology of dreams in adolescence. In contrast to nightmares, recalling dreaming is associated with health and well-being.

© 2011 Society for Adolescent Health and Medicine. All rights reserved.

When talking about dreams, people commonly have in mind vivid, animated, and bizarre experiences during sleep. Although throughout history and across cultures, dreams have been regarded as divine manifestations (cf. [1]), psychoanalytic ap-

proaches considered the interpretation of dreams as the Via Regia, the royal road to unconscious mental functioning [2]. Contemporary approaches define dreaming as a subjective experience that occurs during sleep and that consists predominantly of complex, time-shifting images [3]. Neurocognitive approaches describe dreams as neurophysiologic, cognitive, and emotional processes occurring every night during virtually the entire sleep period [4]. Recent views also regard dreams as psychological processes focusing on concerns and preoccupations. According

\* Address correspondence to: Serge Brand, Ph.D., Depression and Sleep Research Unit, Psychiatric Hospital of the University of Basel, Wilhelm Klein-Strasse 27, 4012 Basel, Switzerland.

E-mail address: serge.brand@upkbs.ch (S. Brand).

to these views, dreams may serve regulation of mood [5] and improved problem solving [6]. Moreover, there is evidence that dream content is related to health and psychological well-being. First, Kirov and Brand [7] noted that the occurrence of nightmares was related to increased risks for developing psychiatric disorders in adolescence. Second, Roberts and Lennings [8] reported that nightmares were related to personality traits such as neuroticism and, most importantly, to anxiety. Thus, it can be claimed that dreaming is related to health and well-being. However, for adolescents, data from large-scale surveys are missing till date. To counter this, the present study aimed at shedding some light on the relation between health, well-being, and dreaming among adolescents.

In this respect, research in adults has found at least five different associations between dreaming, sleep, and waking stage. First, a general finding is that dream contents seem substantially to reflect the dreamer's waking states and concerns. The continuity hypothesis posits that cognitive processes generated, developed, and used during waking states do continue and evolve during sleep and dreaming [3,9].

Second, as compared with adult males, adult females report higher rates of dream recall. This robust gender difference in dream recall [10] relates both to the general interest in dreams and more frequent nocturnal awakening among adult females as compared with males [11].

Third, although the continuity hypothesis posits that waking life may affect dream content and dream recall (cf. [3]), the inverse process has also been observed. Thus, it can be said that dream content and dream recall may affect waking life including morning mood [12,13].

Fourth, associations have been observed between dream recall and personality traits. For example, associations have been observed with neuroticism [14], with "thin boundaries" (i.e., people being rather sensitive, unconventional, with difficult relationships, and vulnerable [15]), and with creativity [16,17].

Fifth, dream recall has been linked to sleep patterns, although results are inconsistent. Although more frequent nocturnal awakenings were related to increased dream recall in a sample of 444 college students [11], Pagel and Shocknesse [18] observed that objectively assessed poor sleep continuity and poor sleep architecture in adults suffering from sleep disturbances were associated with poor dream recall.

To sum up, research from studies of adults indicates that the following factors are associated with greater dream recall: female gender; concerns and preoccupations while awake; personality traits; and sleep patterns (awakenings during the night). Moreover, dreams seem to influence mood on the subsequent day.

However, less is known about dreaming and its correlates in adolescents. Most studies have focused on adolescents' dream contents. For example, Nielsen et al [19] investigated dream contents in a sample of 1,348 Canadian students and found that, independent of adolescents' gender, dreams contained the following five prevalent themes: being chased; sexual experiences; falling; school, teachers, and studying; and arriving late. Importantly, these results were replicated by the study performed by King and DeCicco [20], which lends support to the continuity hypothesis (cf. [3]) in that the prevalent themes seemed to reflect everyday concerns related to school and psychosexual development. Focusing on cultural and religious influences on dreams, Salem et al [21] investigated 350 students (mean age: 21.4 years) at a university in the United Arab Emirates. The authors found

that, in accordance with the prevailing cultural and religious context, students took dreams very seriously. Dream contents could affect participants' personal lives by changing daily plans and decisions in social life. King and DeCicco [22], who questioned 197 college students (mean age: 22 years) on their beliefs about dreams, found that for the majority of participants' dreams contained important information and reflected relationships and decisions being made. Finally, among 12-to-18-year-old adolescents, Roberts and Lennings [8] showed that occurrence of nightmares was associated with personality traits such as neuroticism, but not with extraversion.

To summarize, in contrast to the consistent results from dream research in adults, findings on dreams with adolescents remain limited and have focused predominantly on dream contents. Moreover, although most studies have been conducted with participants at the boundary between late adolescence and early adulthood, there is very little research on large samples of younger adolescents.

The aim of the present study was therefore to shed more light on dreaming and its behavioral (psychological) correlates in adolescence. More specifically, we aimed to test whether some of the findings for adults, as outlined later in the text, can be replicated among adolescents. We believe that the present findings might also be of practical importance given the probability that pediatricians and counselors may encounter issues and concerns related to dream, sleep, and adolescents' behavior.

Five hypotheses were formulated. First, on the basis of the findings by Schredl [11] and Schredl and Piel [10], we anticipated greater dream recall by females as compared with males. Second, based on the continuity hypothesis [3,9], we expected more dream recall by participants who reported greater stress. Third, on the basis of the findings by Schredl and Piel [10], we expected that greater dream recall would be associated with more frequent awakening during the night. Fourth, on the basis of the findings by Schechter et al [16] and Belicki [17], we anticipated a positive association between dream recall and creativity. Fifth, on the basis of the findings by Schredl and Doll [12] and Schredl [13], we anticipated that dreams would influence mood the following day. Finally, we hoped to explore which variables could best predict dream recall.

## Methods

### Sample

A total of 6,276 participants participated in the study. Of these, 600 (9.56%) had >5% missing data and were therefore excluded from further analyses [23], as were 96 participants (1.53%) who systematically ticked only right-hand or only left-hand answer boxes and completed the questionnaire within a few minutes. Of the remaining 5,580 participants, 3,711 were female (66.5%; mean age in years:  $M = 18.43$ ,  $SD = 1.47$ ) and 1,869 were male adolescents (33.5%; mean age in years:  $M = 17.84$ ,  $SD = 1.29$ ;  $t(5,579) = 14.56$ ,  $p = .000$ ,  $d = .42$ ).

To recruit participants, the study was posted electronically on the homepages of 10 high schools in the cantons Basel and Basel-Land, two districts of the German-speaking Northwestern part of Switzerland. Data were collected between spring 2008 and spring 2010. The study was approved by the local ethics committee.

## Data collection

The study was performed by an Internet-administered approach. Previous studies comparing Internet-administered questionnaires with paper-and-pencil questionnaires have found no disadvantages of the electronic version (cf. [24–26]). A commercially available software (Globalpark; <http://www.globalpark.com>) was used for data collection. The software is an easily applicable tool for the creation of Internet-based studies. The software provider guarantees that all data are stored on a server accessible neither to any third party, nor to the persons carrying out the study. The user of the software receives the raw data related to the questionnaires, but not to the IP address of participants. Thus, both data security and participant anonymity were ensured. Moreover, to avoid repeat participation, the software was designed to block recruitment of subjects whose IP addresses have been already used.

Participants were informed about the purpose of the study and about the voluntary basis of their participation. They were also assured of the confidentiality of their responses, and informed consent was obtained on the first page of the questionnaire. Moreover, participants could stop or withdraw from the study without giving any further explanation. To improve compliance, participants could take part in a prize draw, although to do so they needed to provide an e-mail address. As a token, 30 iPod Shuffles were raffled. Data were automatically gathered and afterward converted into a PASW-file (Predictive Analysis Software; SPSS, Chicago, IL) for further analysis.

## Materials

Participants completed a series of questionnaires related to sleep, perceived stress, dreams, and creativity.

To assess sleep, the Insomnia Severity Index (ISI; [27]) and the Pittsburgh Sleep Quality Index (PSQI; [28]) were used. The ISI is a 7-item screening measure for insomnia and an outcome measure for use in treatment research. The items, answered on 5-point rating scales (0 = not at all, 4 = very much), refer in part to DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) criteria for insomnia [29] by measuring difficulty in falling asleep, difficulties remaining asleep, early morning awakenings, increased daytime sleepiness, impaired daytime performance, low satisfaction with sleep, and worrying about sleep. The higher the overall score, the more the respondent is assumed to suffer from insomnia (Cronbach's  $\alpha = .84$ ).

Sleep quality and quantity were assessed with the PSQI [28]. A German adaptation was taken from a conventional and widely used manual for psychological treatment of sleep complaints [30]. Participants answered questions about sleep quality (1 = very bad sleep quality; 8 = excellent sleep quality) and mood at awakening (1 = very bad mood; 8 = very good mood; Cronbach's  $\alpha = .89$ ) on 8-point rating scales. In addition, details of total sleep time (in hours) and the number of awakenings were requested.

A self-administered questionnaire was used to assess perceived stress. The questionnaire consisted of nine items and has proved to be a reliable and valid measure in two previous studies (cf. [31]). Participants were asked how often they felt taxed in different life situations (i.e., family life, friends, academic demands, etc.) within the last month. This measure was based on a scale ranging from 1 (=never) to 6 (=always), with higher scores reflecting perceived higher levels of stress (Cronbach's  $\alpha = .81$ ).

To assess issues related to dreaming, the following three questions were asked: (1) "The day after, I usually remember dreams." (2) "What I dream always has something to do with me." (3) "The day after, dreams usually have an impact on my mood." Answers were given on a 7-point rating scale ranging from 1 (=I do not agree at all) to 7 (=I do fully agree), with higher scores therefore reflecting greater agreement.

Finally, self-assessed creativity was measured with one item: "Generally, I'm a creative person; I like painting, drawing, writing or fantasizing." Answers were given on a 6-point rating scale ranging from 1 (=I do not agree at all) to 6 (=I do fully agree), with higher scores reflecting greater self-perceived creativity.

## Statistical analyses

First, Pearson's correlations were conducted to test associations between sleep, stress, dreaming, and creativity. Next, to examine gender differences, a series of *t*-tests were performed. In case of unequal variances, instead of the classical Student's *t*-test, the more robust Welch-test "w" was performed [32]. Additionally,  $\chi^2$  tests were performed to examine gender differences with respect to dichotomized answers related to dreaming. Finally, multiple regression analyses were performed to test which dimensions might best predict dream recall. An alpha of  $<.05$  was accepted as nominal level of significance. All statistical computations were performed with PASW for Apple.

## Results

### Descriptive results related to dreams

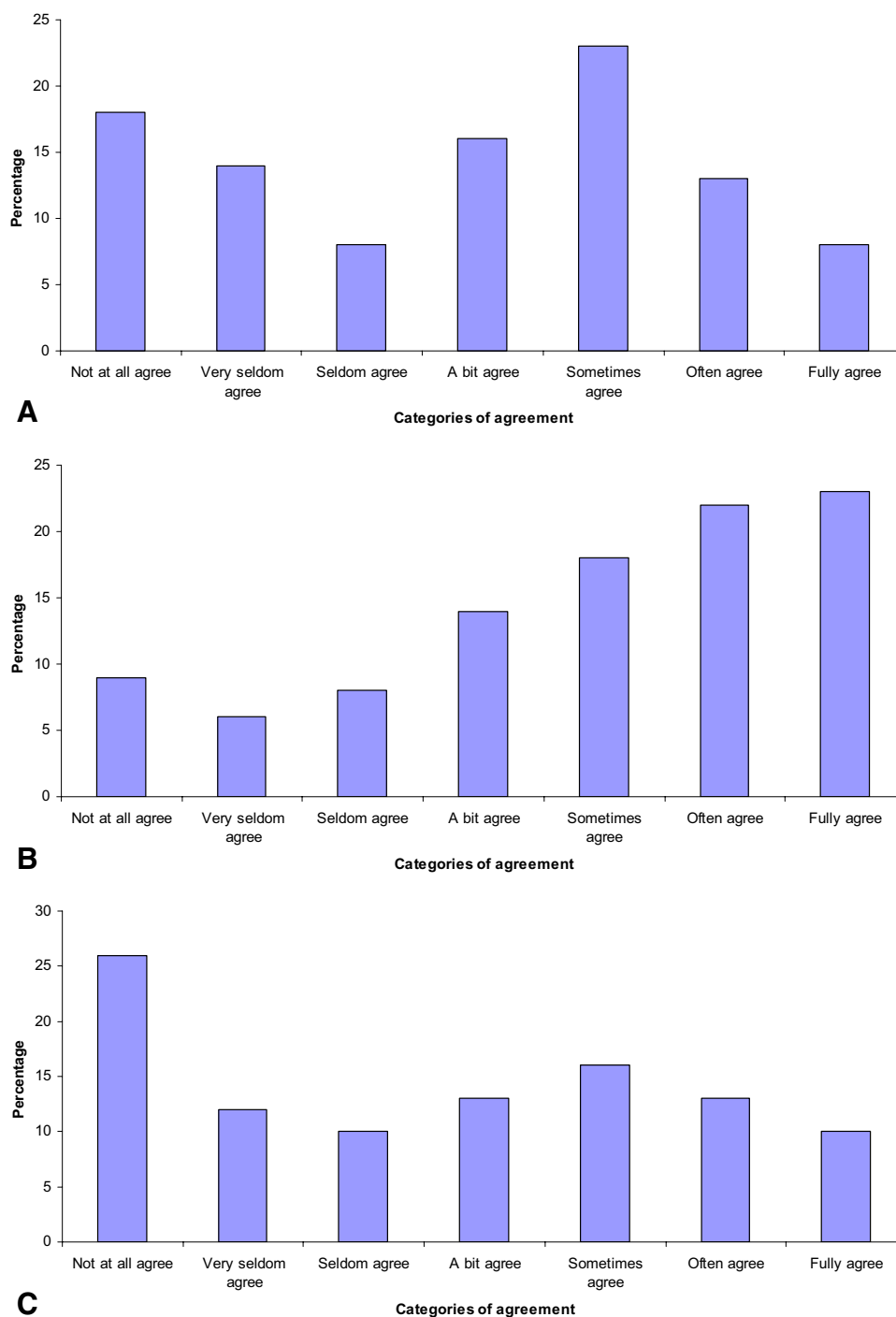
Figure 1 depicts levels of agreement (percentages) for the items related to dreams. Combining responses from "not at all" to "seldom," and those from "sometimes" to "fully agree," the following pattern of results was observed (to achieve a clearer division, the category "agree a bit" was omitted):

1. "The day after, I usually remember dreams.": 40% of respondents chose "not at all" to "seldom"; 44% of respondents chose "sometimes" to "fully."
2. "What I dream has always something to do with me.": 23% of respondents chose "not at all" to "seldom"; 63% of respondents chose "sometimes" to "fully."
3. "The day after, dreams usually have an impact on my mood.": 48% of respondents chose "not at all" to "seldom"; 39% of respondents chose "sometimes" to "fully."

Chi-square tests of responses dichotomized in this way revealed that, as compared with males, female participants remembered dreams more the following day ( $\chi^2 [df = 1, N = 5,580] = 15.00, p = .000$ ), agreed more that dreams are related to oneself ( $\chi^2 [df = 1, N = 5,580] = 131.83, p = .000$ ), and agreed more that dreams have an effect on mood the following day ( $\chi^2 [df = 1, N = 5,580] = 61.64, p = .000$ ).

### Associations between sleep, perceived stress, and dreaming

Table 1 shows the correlation matrix and the descriptive statistical data. Age was unrelated to perceived stress, creativity, sleep, or dreaming. Perceived stress was negatively related to creativity, mood, and sleep quality, but positively to sleep com-



**Figure 1.** (A) "The day after, I usually remember the dreams." (B) "What I dream has always something to do with me." (C) "The day after, dreams usually have an impact on my mood."

plaints (ISI) and reduced sleep duration. Perceived stress was also related to the view that dreams are related to oneself and to greater impact of dreams on mood. Sleep complaints (ISI) were associated with poor sleep, as assessed with the PSQI, as well as with less dream recall and with a view that dreams do not have an effect on mood the day after. Sleep duration was negatively

associated with the number of awakenings, but positively with sleep quality and with the view that dream contents are related to oneself. The number of awakenings was negatively related to mood and sleep quality, whereas no significant association was found with dreaming. Mood and sleep quality were positively associated with each other, whereas no significant relationship

**Table 1**

Correlations between dimensions related to age, stress, creativity, sleep, and dreams; descriptive statistics (means and standard deviations)

Variables	Variables											M (SD)
	1	2	3	4	5	6	7	8	9	10	11	
1. Age (years)	—											18.23 (1.44)
2. Perceived stress	.06	—										1.92 (.69)
3. Creativity	-.08	-.32***	—									2.89 (1.57)
4. Insomnia Severity Index	.02	.38***	.06	—								2.40 (.66)
5. Sleep duration	.11	-.40***	.35***	-.28***	—							6.71 (1.64)
6. Number of awakenings	.00	.21***	-.26***	.24***	-.61***	—						1.50 (4.2)
7. Mood in the morning	.06	-.27***	.31***	-.48***	.05	-.26***	—					4.15 (1.99)
8. Sleep quality	.02	-.31***	.19***	-.49***	.18***	-.35***	-.36***	—				5.26 (1.41)
9. Recall of dreams	-.05	.02	.29***	-.19***	.04	-.09	.07	.03	—			1.78 (1.95)
10. Dream content related to oneself	-.02	.18***	.04	-.11**	.25***	.10	.03	.16**	.29***	—		2.81 (1.90)
11. Impact of dreams on mood	-.12	.18***	.29***	-.24***	.04	-.02	-.05	-.07	.49***	.31***	—	1.60 (2.09)

\*\*  $p < .01$ .\*\*\*  $p < .001$ .

with dreaming was found. All dreaming-related dimensions (recall; relatedness to oneself; effect on mood the day after) were intercorrelated. To sum up, dreaming was positively and substantially associated with perceived stress and creativity, and negatively associated with sleep complaints.

### Gender differences

Table 2 provides the descriptive and statistical overview of the dimensions as a function of gender. As compared with male participants, female participants reported more stress. They also described themselves as more creative and reported that they suffered more from sleep complaints and experienced longer sleep duration, decreased sleep quality, and poorer mood in the morning. Females, as compared with male participants, also indicated that they recalled dreaming more and that their dreams had a higher effect on mood during the following day. No gender differences were found for the number of awakenings during the night or for the view that dream content is related to oneself.

### Determinants of dream recall; multiple regression analyses

To predict dream recall, the variables such as gender, sleep complaints (ISI), creativity, dream impact on mood, mood at

awakening, sleep quality, sleep duration, awakenings during sleep, and perceived stress were entered in a multiple regression analysis with a stepwise exclusion procedure (Table 3). Durbin-Watson coefficients to indicate independence of residuals were satisfactory (Table 3). After stepwise inclusion, multiple regression models sufficiently explained ( $R$  and  $R^2$ ) the dependent variable. The stepwise model revealed that female gender, decreased sleep complaints, greater creativity, greater effect of dreams on mood, better mood at awakening, and better sleep quality, all predicted dream recall in an independent manner. Perceived stress, sleep duration, and the number of awakenings during the night had no predictive value.

### Discussion

The key findings of the present study are that, in a large sample of adolescents, dream recall was related to gender, creativity, and sleep quality. Moreover, dreams seemed to exert an influence on mood during the following day.

Five hypotheses were formulated, and each of these is considered in the following paragraphs.

With the first hypothesis, we anticipated greater recall of dreams among females than among male participants, and data supported this expectation. Thus, our data are in accordance with previous findings in adults [10,11]. The underlying mechanisms

**Table 2**

Descriptive and statistical overview of the dimensions as a function of gender

Variables	Sample		Statistical comparison $t/w(df)$ $p$
	Females $n = 3,711$ M (SD)	Males $n = 1,869$ M (SD)	
Perceived stress	1.99 (.063)	1.82 (0.78)	$w(3,145.27) = 7.73, p = .000$
Creativity	3.15 (1.75)	2.77 (1.45)	$w(3,184.97) = 7.92, p = .000$
Insomnia Severity Index	2.47 (0.66)	2.28 (0.65)	$t(5,578) = 9.41, p = .000$
Sleep duration (hours)	6.87 (1.57)	6.40 (1.74)	$w(3,146.53) = 9.40, p = .000$
Number of awakenings	1.55 (4.82)	1.41 (2.28)	$t(5,578) = 1.08, p = .280$
Mood in the morning	4.10 (1.90)	4.25 (2.14)	$w(3,110.13) = 2.44, p = .019$
Sleep quality	5.21 (1.35)	5.36 (1.52)	$w(3,233.72) = 3.59, p = .001$
Dream recall	4.89 (2.02)	4.19 (1.91)	$w(3,029.32) = 6.49, p = .001$
Dream content related to oneself	3.22 (1.87)	3.18 (1.92)	$w(3,836.57) = 0.74, p = .458$
Dreams impact mood	4.80 (1.99)	4.20 (2.11)	$w(3,851.24) = 10.28, p = .000$

 $t = t$ -test;  $w = w$ -test.

Scales: "Creativity" = being a creative person; scales related to dreams: Scales always range from 1 to 6, with higher scores reflecting better recall, content more related to self, and greater impact on mood, respectively.



**Table 3**

Multiple linear regression model to describe the influence of gender, stress, creativity, and sleep patterns on dream recall

Dimension	Variables	Coefficient	Standard error	Coefficient ( $\beta$ )	95% CI	<i>t</i>	<i>p</i>	<i>R</i>	<i>R</i> <sup>2</sup>	Durbin-Watson-statistics
Dream recall	Intercept	1.50	.15	—	1.21 to 1.79	10.07	.000	.52	.27	1.46
	Gender	.25	.05	.06	.14 to .35	4.68	.000			
	ISI	-.32	.05	-.11	-.41 to -.23	-7.05	.000			
	Creativity	.14	.01	.13	.11 to .16	10.02	.000			
	Dream impact mood	.43	.01	.46	.41 to .45	36.19	.000			
	Mood at awakening	.13	.02	.12	.10 to .16	8.24	.000			
	Sleep quality	.08	.02	.06	.04 to .12	4.12	.000			
Excluded variables: perceived stress; number of awakenings during the night; sleep duration										

Gender: 1 = male; 2 = female.

ISI = Insomnia Severity Index: higher scores indicate more sleep complaints. *R* = multiple correlation coefficient; *R*<sup>2</sup> = multiple coefficient of determination; Durbin-Watson-statistics coefficients between 1.5 and 2.5 indicate that the residuals of independent variables are independent.

could not be assessed, although it is conceivable that females are more sensitive to dreams because they perceive themselves to be both more creative (cf. [3,16,17]) and feel that dreams have a greater impact on mood the following day. However, the present data did not replicate Schredl and Piel's [10] finding that among females, greater dream recall was associated with increased awakenings. Thus, it cannot be stated that the more often females awoke after sleep onset, the more they were able to report dreams.

With the second hypothesis, based on the continuity hypothesis [3,9], we anticipated that dream recall would be related to dreamers' waking states and concerns, but data did not fully support this assumption. More stressful experiences in daily life were unrelated to dream recall, but were associated with the view that dreams are related to oneself and that they have an effect on mood the following day. At this point, it is unresolved whether the continuity hypothesis could be confirmed or not, because we did not assess whether dream content was related to stresses experienced in daily life. Moreover, results from the multiple regression analyses showed that stressful experiences had no predictive value when other variables such as female gender and sleep patterns were considered.

With the third hypothesis, we predicted that dream recall would be related to awakenings during the night, but the present results did not support this prediction. This particular finding contradicts previous research [11]. Rather, our data seem to support findings based on objective sleep assessments [18] indicating that poor dream recall is related to poor sleep. In the same manner, results from multiple regression analyses indicated that awakenings during the night had no predictive value once other variables were considered.

Fourth, we expected that dream recall would be related to the personality trait of creativity, and the present results indeed did support this prediction. Thus, the findings of the present study are in accordance with previous research [16,17]. The underlying mechanisms are poorly understood, and the present data do not provide a conclusive answer. However, at least three explanations are proposed. First, as suggested by Schechter et al [16] and Belicki [17], creative people may pay more attention to creative, fanciful, and extraordinary mental processes such as dreams. Second, creative people show increased dream recall and favorable sleep patterns in parallel; indeed, numerous studies highlight the close association between favorable sleep and favorable psychological functioning (cf. [33]). Therefore, it is conceivable that creative people in particular may be psychologically well

balanced and that the present pattern of associations is mediated by covariates not assessed in the present study. Finally, inverting the hypothesized direction of influence from creative personality to greater dream recall, it is possible that people are more creative *because* they experience and recall these vivid, animated, and bizarre experiences during sleep.

Fifth, following Schredl and Doll [12] and Schredl [13], we expected that dreams would have an influence on mood the following day, and the present data did support this prediction; 39% of participants agreed to some extent that this was the case. Research on the effect of dreams on mood and waking life focuses primarily on three issues: (1) the effect of nightmares on affective-cognitive states the next day (cf. [34]), (2) dreams as problem solving processes and creative inspirations [35], and (3) elaboration of dreams within psychotherapeutic work (cf. [3]) to gain insight and more awareness. Thus, keeping in mind these three highly specific foci and the lack of any further qualitative dream content analysis in the present study, the high degree of agreement might be regarded as surprising. However, the results from the multiple regression analyses suggest that the effect of dreams on mood the next day was associated with creativity, female gender, increased daily stressful life experiences, and favorable sleep.

Finally, multiple regression analyses further showed that several independent factors such as favorable sleep pattern, female gender, creativity, and sleep quality did independently predict dream recall. This suggests that future research should take into account several different factors concomitantly.

Several limitations warrant against overgeneralization of the findings. First, participants were exclusively recruited from high schools, and consequently the sample is not representative of adolescents as a whole. Second, although Internet access is available at the schools for students, we cannot rule out a systematic sampling bias caused by limited Internet access. In particular, adolescents with difficulties understanding the German language and those with little or no access to the Internet at home were completely excluded. Moreover, although several studies [24–26] reported high compliance and equivalent scores for Web-based questionnaires as compared with paper-and-pencil questionnaires, we cannot rule out systematically biased results as a result of the methodology used. Third, a major limitation is the use of some arbitrary questions and short questionnaires to assess “stress” and “creativity,” instead of validated questionnaires. Introducing validated questionnaires would perhaps have given other results and associations. However, it was our

intent to keep the survey as short as possible to make it attractive and easy to complete. We acknowledge that future research should apply validated tools. Fourth, the cross-sectional design of the study precludes conclusions about the direction of influence. Thus, for example, it remains unclear whether creativity leads to greater recall of dreams, or whether recalling these vivid, animated, and bizarre experiences during sleep itself inspires increased creativity. Fifth, the pattern of results may be because of other variables such as psychiatric symptoms (e.g., eating disorders, personality disorders, addictions, depressive disorders) or motivation, which were not assessed in the present study. Sixth, results may potentially be biased because only adolescents who were willing to fill in the questionnaires were included in the study. Seventh, the present study was primarily quantitative; dream contents were not assessed. However, the present approach has some merit in counterbalancing previous studies focusing predominantly on qualitative aspects of adolescents' dreams [17–20]. Finally, expert ratings, which might have counterbalanced possible self-rating biases, were not obtained, which further limits the validity of the present pattern of results. Specifically, future research focusing on creativity might introduce, for example, teachers' view, which may better reflect the extent a student is creative in arts, in writing texts, or in problem solving in mathematics or physics.

## Conclusions

For a large sample of adolescents, dreams do matter though, and as in the study on adults, they matter more for females. As the pattern of results suggests, different independent factors such as good mood, sleep quality, female gender, and creativity are related to dream recall.

## Acknowledgments

The authors thank Nick Emler (Surrey, UK) for proofreading the manuscript. The study was performed without external funding, and all authors declare no conflicts of interest.

## References

- [1] Palagini L, Rosenlicht N. Sleep, dreaming, and mental health: A review of historical and neurobiological perspectives. *Sleep Med Rev* (in press).
- [2] Freud S. The interpretation of dreams. Modern Library Edition [first publication in German: 1900]. Toronto, Ontario, Canada: Random House Inc., 1994.
- [3] Schredl M. Characteristics and contents of dreams. *Int Rev Neurobiol* 2010; 92:135–54.
- [4] Fosse R, Stickgold R, Hobson JA. Brain-mind states: Reciprocal variation in thoughts and hallucinations. *Psychol Sci* 2001;12:30–6.
- [5] Hartmann E. Outline for a theory on the nature and functions of dreaming. *Dreaming* 1996;6:147–70.
- [6] Cartwright R. The contribution of the psychology of sleep and dreaming to understanding sleep-disordered patients. *Sleep Med Clin* 2008;3:157–66.
- [7] Kirov R, Brand S. Nightmares as predictors of psychiatric disorders in adolescence. *Curr Trends Neurol* (in press).
- [8] Roberts J, Lennings CJ. Personality, psychopathology and nightmares in young people. *Pers Individ Dif* 2006;41:733–44.
- [9] Domhoff GW, Hall CS. Finding meaning in dreams: A quantitative approach. New York, NY: Plenum, 1996.
- [10] Schredl M, Piel E. Interest in dream interpretation: A gender difference. *Dreaming* 2008;18:11–5.
- [11] Schredl M. Explaining the gender difference in dream recall frequency. *Dreaming* 2010;20:96–106.
- [12] Schredl M, Doll E. Emotions in diary dreams. *Conscious Cogn* 1998;7: 634–46.
- [13] Schredl M. The effect of dreams on waking life. *Sleep Hypn* 2000;2:120–4.
- [14] Pesant N, Zadra A. Dream content and psychological well-being: A longitudinal study of the continuity hypothesis. *J Clin Psychol* 2006;62:111–21.
- [15] Hartmann E. Boundaries in the mind. New York, NY: Basic Books, 1965.
- [16] Schechter N, Schmeidler GR, Staal M. Dream reports and creative tendencies in students of arts, sciences and engineering. *J Consult Psychol* 1965; 29:415–21.
- [17] Belicki K. Recalling dreams: An examination of daily variation and individual differences. In: Gackenbach J, ed. *Sleep and Dreams*. New York, NY: Garland, 1986:187–206.
- [18] Pagel JF, Shocknesse S. Dreaming and insomnia: Polysomnographic correlates of reported dream recall frequency. *Dreaming* 2007;17:140–51.
- [19] Nielsen TA, Zadra AL, Simard V, et al. The typical dreams of Canadian University students. *Dreaming* 2003;13:211–35.
- [20] DeCicco TL. Dreams of female university students: Content analysis and the relationship to discovery via the Ullman method. *Dreaming* 2007;17:98–112.
- [21] Salem M, Ragab MA, Razik AYA. Significance of dreams among United Arab Emirates University students. *Int J Dream Res* 2009;2:29–32.
- [22] King DB, DeCicco TL. Dream relevance and the continuity hypothesis. *Dreaming* 2009;19:207–17.
- [23] Schafer JL, Graham JW. Missing data: Our view of the state of the art. *Psychol Methods* 2002;2:147–77.
- [24] Mangunkusumo RT, Moorman PW, Van Den Berg-de Ruiter AE, et al. Internet-administered adolescent health questionnaires compared with a paper version in a randomized study. *J Adolesc Health* 2005;36:70.e1–e6.
- [25] Vereecken CA, Maes L. Comparison of a computer-administered and paper-and-pencil-administered questionnaire on health and lifestyle behaviors. *J Adolesc Health* 2006;38:426–32.
- [26] Wang YC, Lee CM, Lew-Ting CY, et al. Survey of substance use among high school students in Taipei: Web-based questionnaire versus paper-and-pencil questionnaire. *J Adolesc Health* 2006;37:289–95.
- [27] Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index (ISI) as an outcome measure for insomnia research. *Sleep Med* 2001;2:297–307.
- [28] Buysse DJ, Reynolds CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: New instrument for psychiatric practice and research. *Psychiatry Rev* 1989; 28:193–213.
- [29] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Available at: [www.dsm5.org/Pages/Default.aspx](http://www.dsm5.org/Pages/Default.aspx). Accessed November 19, 2010.
- [30] Backhaus J, Riemann D. Schlafstörungen bewältigen [coping with sleep complaints]. Weinheim, Germany: GfK, Beltz Psychologie Verlags Union, 1996.
- [31] Brand S, Gerber M, Pühse U, Holsboer-Trachsler E. Depression, hypomania and dysfunctional sleep-related cognitions as mediators between stress and insomnia: The best advice is not always found on the pillow. *Int J Stress Manag* 2010;17:114–34.
- [32] Welch BL. The generalization of "Student's" problem when several different population variances are involved. *Biometrika* 1947;34:28–35.
- [33] Brand S, Gerber M, Hatzinger M, Beck J, et al. High exercise levels are related to favorable sleep patterns and psychological functioning in adolescents: A comparison of athletes and controls. *J Adolesc Health* 2010;46:133–41.
- [34] Köthe M, Pietrowsky R. Behavioral effects of nightmares and their correlations to personality patterns. *Dreaming* 2001;11:43–52.
- [35] Barrett D. The committee of sleep: How artists, scientists, and athletes use dreams for creative problem-solving—And how you can too. New York, NY: Crown, 2001.