

The relationship between lucid dream frequency and sleep quality: Two cross-sectional studies

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Summary. Lucid dreams are dreams that involve awareness of dreaming while dreaming. As lucid dreaming is accompanied by heightened cortical activation, e.g., in the prefrontal cortex, it was speculated whether lucid dreaming interferes with the restorative function of sleep. Two cross-sectional studies have found inhomogeneous results regarding the relationship between lucid dream frequency and subjective sleep quality. The present studies included a student sample (N = 444) and a population-based sample (N = 1380). Regression analyses revealed a significant relationship between lucid dream frequency and poor sleep quality (this relationship was weaker in the student sample) which disappeared when nightmare frequency was statistically controlled. One possible interpretation of the findings is that lucid dreamers seem to have more nightmares and, therefore, poorer sleep quality, i.e., sleep quality is not directly impaired by having a lucid dream. However, alternative causal explanations are equally plausible, e.g., trait variables like the openness to experience might relate to all these variables. Future research should examine this relationship by comparing within-subject differences in sleep quality between nights with and without the occurrence of a lucid dream using a diary paradigm. Whether intensive practice of lucid dream induction techniques, e.g., the wake-up-back-to-bed technique, might have negative effects on sleep quality cannot yet be answered.

Keywords: Lucid dreaming, sleep quality, nightmares

1. Introduction

Lucid dreaming is a dream that involves awareness of dreaming (Schredl & Erlacher, 2004). Depending on the individual dreamer one can experience increased insight, control, access to waking memories, dissociation from one's own body, logical thought, and more positive emotion in lucid dreams compared to non-lucid dreams (Voss, Schemelleh-Engel, Windt, Frenzel, & Hobson, 2013). About 50% of the general population reported that they experiences at least one lucid dream (Schredl & Erlacher, 2011); in student samples the percentage goes up to 80% (Saunders, Roe, Smith, & Clegg, 2016). Its occurrence is associated with a higher perception of self-control, creativity, openness to experience and having thin boundaries (Garfield, 1988; Hess, Schredl, & Goritz, 2017). There are several techniques including autosuggestion, reality checks, Wake-up-back-to-bed (WBTB), etc... that have been demonstrated to be differently successful in increasing lucid dream frequency (Stumbrys, Erlacher, Schädlich, & Schredl, 2012). On the one hand, lucid dreaming has many benefits like wish fulfillment, solving waking problems, overcoming fears/nightmares, spiritual experiences/meditation, physical/mental healing, or training motor skills (Schädlich & Erlacher, 2012;

Stumbrys & Erlacher, 2016), on the other hand, lucid dreaming is associated with increased brain activation during REM sleep (Dresler et al., 2012; Voss, Holzmann, Tuin, & Hobson, 2009) and, thus, might reduce sleep quality and/or the feeling of being refreshed in the morning.

The relationship of lucid dreaming with sleep quality has not yet been addressed in detail and so far only two studies (Aviram & Soffer-Dudek, 2018; Denis & Poerio, 2017) have presented correlational data on that topic. Denis and Poerio (2017) recruited university students and staff members and from forums about lucid dreams and sleep paralysis (N = 1928 participants (53% female, mean age: 34.17 ± 13.62 yrs., range: 18-82 yrs.)). Sleep quality was measured with the eight-item Sleep Condition Indicator (SCI), considering sleep onset time, waking at night, problems with sleeping, overall sleep quality, and further the extent to which poor sleep effects mood, energy, relationships, as well as concentration, productivity and finally rating general trouble with sleep and how long sleep problems have been present (Espie et al., 2014). The study revealed no significant correlation between lucid dreams and sleep quality ($r = -.02$, ns.). Additionally, the multiple linear regression controlling for dream recall, daydreaming frequency, positive constructive daydreaming, dissociative experiences, mindfulness, imagery, depression, anxiety, life stress, conspiracy beliefs and paranormal beliefs confirmed that there was no significant relation between lucid dreams and sleep quality (Denis & Poerio, 2017).

Aviram and Soffer-Dudek (2018) recruited 187 undergraduates (71% female, mean age: 23.39 yrs., SD ± 1.45, range: 18-28 yrs.). The sleep problems were measured with the eleven-item Global Sleep Assessment Questionnaire, (Roth et al., 2002), covering symptoms associated with insomnia, (for example: "During the past 4 weeks, how often did

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you have difficulty falling asleep, staying asleep, or feeling poorly rested in the morning?”). Insomnia symptoms occurring with a mental disorder, obstructive sleep apnea, restless legs syndrome/periodic limb movements, parasomnia and shift work sleep disorder were also included. The study revealed a weak positive association between a general lucid dream frequency index and sleep problems ($r = .15$, $p < .05$) (Aviram & Soffer-Dudek, 2018). This lucid dream index is a composite score of the following five items: brief, prolonged and spontaneous lucid dream frequencies, as well as the frequency of attempts deliberately initiating lucid dreams and the frequency of successfully achieved lucidity in a dream due to deliberate attempts. Subsequent analyses showed that this relation, however, was only significant for the frequency of attempts deliberately initiating lucid dreams ($r = .23$; $p < .01$), not for the other four variables of this frequency index. Additionally, for the sub sample of the participants who applied lucid dream induction techniques, the number of lucid dream induction techniques correlated with sleep problems ($r = .37$; $p < .01$; $n = 64$). Furthermore, for the sub sample of participants who have experienced a lucid dream, a general lucid dream intensity index (consisting of the percentage of dreams in which experiencing confidence of knowing to be dreaming, the percentage of dreams being in an active role, the percentage of dreams in which being able to control the dream content and the duration of lucidity in seconds and number of scenes) showed no significant relation with sleep problems, ($r = -.04$; $n = 142$; ns.) (Aviram & Soffer-Dudek, 2018). The positive or negative dream emotions before lucidity onset were measured in percentage (“Try to estimate in what percentage of your lucid dreams, you remember that the dream started out with a negative tone, or was a nightmare”) on two 11-point scales from 0%-100%. Because the two items showed a high inverse correlation ($r = .70$; $p < .001$), the negative items were reversed and averaged to create the subscale “Emotions before lucidity”, high scores meaning positive emotions. The emotions before lucidity onset showed a significant negative correlation to sleep problems ($r = -.23$; $p < .01$; $n = 142$), meaning that fewer positive emotions before lucidity are related to more sleep problems. The 3-item lucid dream subscale of the Iowa Sleep Experience Survey (Watson, 2001) consisting of three seven-point Likert scales (1) I am aware of dreaming, even as I dream, (2) I am able to control or direct the content of my dreams, and (3) I am able to wake myself out of a dream that I find unpleasant or disturbing also correlated significantly with sleep problems ($r = .26$, $p < .01$).

The results that the negative dream emotions before lucidity are related to poor sleep quality and the index with an item using lucidity to wake from an unpleasant dream is associated with less sleep quality (Aviram & Soffer-Dudek, 2018) suggest that the significant relation between lucid dreams and sleep quality might be mediated by nightmare frequency. In cross-sectional studies lucid dream frequency correlated with nightmare frequency, (Hess et al., 2017), and as persons who have more nightmares also have poorer sleep quality, (Schredl, 2003), the hypothesis that nightmares mediate the relationship of lucid dreaming and sleep quality seems plausible. Furthermore, frequent attempts with lucid dream induction techniques are correlated with poor sleep quality, (Aviram & Soffer-Dudek, 2018). This might be explained by the fact that one’s motivation to deliberately induce lucid dreams can be the reduction of nightmare fre-

quency as lucid dreaming is an effective coping strategy for nightmares, (Brylowski, 1990; Zadra & Pihl, 1997). However, the previous studies, (Aviram & Soffer-Dudek, 2018; Denis & Poerio, 2017), have not controlled the relationship between lucid dream frequency and sleep quality for nightmare frequency.

This study aims at investigating the relationship between lucid dreams and sleep quality. We hypothesized that lucid dreaming frequency might not be associated with sleep quality if nightmare frequency is statistically controlled.

2. Study 1

2.1. Method

2.1.1 Participants

The sample included 444 persons whose mean age was 23.52 ± 5.67 years ($N = 442$, two missing values). There were 376 women and 68 men, the majority of whom were psychology students.

2.1.2 Research Instruments

For measuring lucid dream frequency, an eight-point rating scale was presented: “How often do you experience so-called lucid dreams (see definition)?” 0 = never, 1 = less than once a year, 2 = about once a year, 3 = about 2 to 4 times a year, 4 = about once a month, 5 = about 2 to 3 times a month, 6 = about once a week, 7 = several times a week). The following definition was presented: “During lucid dreaming, one is – while dreaming – aware of the fact that one is dreaming. It is possible to deliberately wake up or to control the dream action or to observe passively the course of the dream with this awareness.” Nightmare frequency was measured by a similar eight-point scale (“How often do you experience nightmares?”). Both scales showed high retest reliability for a four-week interval: $r = .89$ ($N = 93$, $p < .001$) for lucid dream frequency and $r = .75$ ($N = 93$, $p < .001$) for nightmare frequency (Stumbrys, Erlacher, & Schredl, 2013).

Dream recall frequency was measured by a seven-point rating scale (0 = never, 1 = less than once a month, 2 = about once a month, 3 = twice or three times a month, 4 = about once a week, 5 = several times a week and 6 = almost every morning). The retest reliability of this scale for an average interval of 70 days is high ($r = .85$, $N = 198$, $p < .0001$; Schredl, 2004).

Two composite scores, subjective sleep quality (11 items) and feeling of being refreshed in the morning (7 items) of the SF-B sleep questionnaire (Görltmeier, 1986) were selected for the present study. The time references are the previous two weeks. The composite scores (averages) ranged from 1 to 5, since most scales of the sleep questionnaire are constructed as five-point Likert scales. The inter-item consistency for the composite scores range from $r = .77$ to $r = .87$ and the retest reliability (4 weeks) was about $r = .70$ (Görltmeier, 1986). Construct validity was shown in several factor analyses, and comparisons with expert ratings were satisfactory: for example, $r = -.67$ between sleep quality and the degree of insomnia (Görltmeier, 1986).

The LISST sleep questionnaire is composed of 75 items and was constructed as a screening instrument to detect different sleep disorders, (Weeß, Schürmann, & Steinberg, 2002). The sum scores for problems with sleep quality

Table 1. Lucid dreaming frequency and nightmare frequency (Study 1)

Category	Lucid dream- ing frequency (N = 439)	Nightmare frequency (N = 440)
Several times per week	2.51%	2.73%
About once a week	7.97%	9.32%
Two or three times a month	10.25%	18.18%
About once a month	16.17%	21.82%
About two or four times a year	26.65%	25.68%
About once a year	10.93%	8.86%
Less than once a year	7.52%	7.73%
Never	18.00%	5.68%

(8 items) and tiredness during the day (5 items) were selected for the present analyses. The single items followed a six-point Likert scale format (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often, 6 = always), e.g., "I have difficulties to fall asleep." Sufficient internal consistencies as well as accurate discrimination between patients with different sleep disorders and healthy controls have been demonstrated, (Weeß et al., 2002).

2.1.3 Procedure

Participants were recruited at the universities of Mannheim, Heidelberg and Landau for a study entitled "Sleep, dreams, and personality". They were paid for participation. The participants completed the questionnaires over a two-week period and returned them to one of the experimenters. Of the 457 packages, 444 persons returned their materials.

Statistical analyses were carried out with the SAS 9.4 software package for Windows. Regression analyses were carried out to study the relationship of lucid dream frequency with measures of sleep quality. Age and gender were included in order to control for possible confounding effects. If data from participants were missing, the total sample size for the respective analyses was reduced as those participants were excluded.

2.2. Results

In Table 1, the frequencies of the lucid dream frequency scale and the nightmare frequency scale are depicted. Most of the participants stated that they had experienced a lucid dream at least once and the majority also experienced nightmares. The Spearman rank correlation between these two variables was $r = .238$ ($p < .0001$, $N = 438$). The distribution of the dream recall frequency scale ($N = 441$) was as follows: almost every morning (16.55%), several times a week (39.46%), about once a week (25.85%), twice or three times a month (11.34%), about once a month (4.08%), less than once a month (2.27%), and never 0.45%.

Mean sleep quality was 3.89 ± 0.62 ($N = 437$) which is comparable with the healthy controls groups of Görtelmeyer (1986). The mean of the feeling of being refreshed in the morning (2.88 ± 0.74 , $N = 436$) was slightly lower compared to the norm samples. The composite score of problems with sleep quality averaged to 17.56 ± 6.37 and the tiredness during the day index to 12.75 ± 4.51 . As expected, the correlation between sleep quality and problems with sleep quality was very high: $r = -.738$, $p < .0001$, $N = 437$. Also, tiredness during the day was related to the feeling of being refreshed in the morning: $r = -.471$, $p < .0001$, $N = 436$.

In Table 2, the first four rows depict the regression analyses for lucid dreaming frequency related to the subjective sleep parameters (age and gender were introduced as control variables). Lucid dream frequency was positively related to problem with sleep quality and also showed marginally significant effects on sleep quality and tiredness during the day. No systematic correlation of the feeling of being refreshed in the morning and lucid dreaming frequency was found. If nightmare frequency was entered additionally into the four regression analyses (see four bottom rows of Table 2), the relationship between lucid dream frequency and the sleep variables was no longer significant (not even marginally significant). On the other hand, nightmare frequency was related to poor sleep quality, not feeling refreshed in the morning, and tiredness during the day. In an additional regression analysis, dream recall frequency was added; however, the relationships between sleep quality, lucid dreaming frequency, and nightmare frequency were not altered. Interestingly, dream recall frequency showed a small but significant relationship to good sleep quality in this analysis (standardized estimate = .0679, $\chi^2 = 4.0$, $p = .0447$, age and gender was also controlled for).

Table 2. Regression analyses for subjective sleep variables (Study 1)

Genre	Age			Gender (1=f, 0=m)			Lucid dreaming frequency			Nightmare frequency		
	SE	t	p	SE	t	p	SE	t	p	SE	t	p
Sleep quality (SF-B) (N = 430)	-.1131	-2.3	.0198	-.1115	-2.3	.0210	-.0899	-1.9	.0615			
Feeling of being refreshed (SF-B) (N = 429)	.0900	1.8	.0660	-.0273	-0.6	.5477	-.0186	-0.4	.7008			
Problems with sleep quality (LISST) (N = 437)	.1098	2.3	.0224	.1057	2.2	.0273	.1048	2.2	.0281			
Tiredness during the day (LISST) (N = 437)	.0457	0.9	.3455	.0648	1.3	.1794	.0802	1.7	.0954			
Sleep quality (SF-B) (N = 429)	-.1590	-3.3	.0004	-.0775	-1.7	.1007	-.0378	-0.8	.4279	-.2640	-5.4	<.0001
Feeling of being refreshed (SF-B) (N = 428)	.0682	1.4	.1680	-.0106	-0.2	.8284	.0080	0.2	.8714	-.1240	-2.5	.0149
Problems with sleep quality (LISST) (N = 436)	.1347	2.8	.0054	.0888	1.9	.0636	.0756	1.6	.1988	.1492	3.0	.0027
Tiredness during the day (LISST) (N = 436)	.0702	1.4	.1503	.0465	1.0	.3316	.0475	1.0	.3316	.1453	2.9	.0039

SE = Standardized estimate (parametric regression)

3. Study 2

3.1. Method

3.1.1 Participants

Overall, 1380 persons (777 women, 603 men) completed the online survey. The mean age of the sample was 51.63 ± 14.13 years (range: 17 to 93 years).

3.1.2 Research instruments

The online questionnaire covered questions regarding sleep quality, dream behavior, and lucid dream frequency, being a selection out of the MADRE questionnaire, (Schredl, Berres, Klingauf, Schellhaas, & Göritz, 2014).

The scales measuring frequency of lucid dreams, nightmare frequency, and dream recall frequency were those utilized in Study 1.

Perceived sleep quality in general, (average over the last four weeks), was measured by a five-point scale ranging from 1 = very good, 2 = good, 3 = average, 4 = poor to 5 = very poor. For the frequency of daytime sleepiness, the scale ranged from 1 = very rarely, 2 = rarely, 3 = occasionally, 4 = often and 5 = very often.

3.1.3 Procedure

The participants completed the online survey between January 25, 2017 and January 31, 2017. The link of the study entitled "Sleep and dream behavior" was posted on the online panel www.wisopanel.net and the registered persons were informed via email about the new study. Within this panel, 9864 persons with an interest in online studies and with heterogeneous demographic backgrounds were registered at that time. The participation was voluntary and unpaid. Statistical procedures were carried out with the SAS 9.4 software package for Windows. Regression analyses for the relationship of lucid dreaming frequency with measures of sleep quality and nightmare frequency were computed. Age and gender were controlled for possible confounding effects.

3.2. Results

The frequencies of the lucid dream frequency scale and the frequency scale of nightmares are displayed in Table 3. Over half of the participants had experienced at least one lucid dream and about 75% have had nightmares. The Spear-

Table 3. Lucid dreaming frequency and nightmare frequency (Study 2)

Category	Lucid dreaming frequency (N = 1380)	Nightmare frequency (N = 1380)
Several times per week	2.83%	3.77%
About once a week	4.64%	5.65%
Two or three times a month	7.32%	7.90%
About once a month	7.46%	9.57%
About two or four times a year	13.70%	16.88%
About once a year	6.45%	9.86%
Less than once a year	12.32%	19.49%
Never	45.29%	26.88%

man rank correlation between these two variables reached $r = .384$ ($p < .0001$, $N = 1380$). The distribution of dream recall frequency ($N = 1380$) was as follows: almost every morning (8.19%), several times a week (20.58%), about once a week (16.74%), twice or three times a month (14.49%), about once a month (11.38%), less than once a month (16.74%), and never (11.88%).

Mean sleep quality was 3.41 ± 0.96 ($N = 1380$) and the mean frequency of tiredness during the day was 2.98 ± 1.06 ($N = 1380$).

Lucid dream frequency was positively related to frequency of tiredness during the day and negatively related to sleep quality, (age and gender were introduced as control variables; see Table 4). After adding nightmare frequency into the regression analyses the relationships between lucid dream frequency and sleep quality and frequency of tiredness during the day did not reach significance. Nightmare frequency, however, was significantly related to both sleep variables, (see Table 4).

4. Discussion

The results of study 1 and study 2 both indicate a relation between lucid dreams and sleep quality, which disappears when nightmare frequency is statistically controlled; this applies for a student sample, as well as for a population-based sample. The relation was weaker for the student sample compared to the population-based sample, possibly due to the reduced variance in this homogenous sample with high dream recall.

Before discussing the findings in detail, several methodological issues have to be addressed. Although, our samples were recruited under the names "Personality, dream and sleep" and "Sleep and dream behavior" and, thus, are likely to include persons with some interest in dreams (in both samples dream recall frequency was slightly higher compared to representative samples; Schredl et al., 2014; Schredl & Erlacher, 2011), they were not specifically selected for high interest and possibly a fair amount of previous experiences with lucid dreaming and lucid dream induction techniques – Denis and Poerio (2017) included also members of lucid dream forums into their sample. In the population-based sample in study 2 the number of persons who have never experienced a lucid dream was almost identical to a representative sample (Schredl & Erlacher, 2011). This could be an advantage of our study since the general interest in lucid dreams, reading a lot about them or practicing induction techniques might influence the "natural" lucid dream behavior, for example, the estimation of sleep quality after having a lucid dream (joy of a successful lucid dream induction).

Subjective sleep measures had to be estimated for the previous 2 or 4 weeks, whereas dream recall frequency, nightmare frequency, and lucid dream frequency were current (within the last months) but very rare lucid dreamers might not have a single lucid dream within the measurement period of the sleep items. This mismatch might have introduced error variance and reduced possible relationships between lucid dream frequency and sleep parameters. On the other hand, the correlations between nightmare frequency and sleep quality were within the range reported in the literature (Levin & Nielsen, 2007). Using sleep quality averages is not allowing to gain insight into the question whether the sleep quality of single nights with lucid dreams as compared to nights without lucid dreams differ within a

Table 4. Regression analyses for subjective sleep variables (Study 2)

Genre	Age			Gender (1=f, 0=m)			Lucid dreaming frequency			Nightmare frequency		
	SE	χ^2	p	SE	χ^2	p	SE	χ^2	p	SE	χ^2	p
Sleep quality (N = 1380)	-.0006	0.0	.9828	.0417	2.3	.1310	-.1119	16.8	<.0001			
Tiredness during the day (N = 1380)	-.1968	49.3	<.0001	-.1367	24.3	<.0001	.1228	20.3	<.0001			
Sleep quality (N = 1380)	-.0377	1.8	.1822	.0247	0.8	.3750	-.0253	0.7	.3938	-.2381	59.3	<.0001
Tiredness during the day (N = 1380)	-.1522	28.8	<.0001	-.1191	18.3	<.0001	.0338	1.3	.2524	.2551	68.0	<.0001

SE = Standardized estimate (ordinal regression)

participant. A diary paradigm with sleep quality and lucid dream occurrence are reported each morning could provide a more differentiated answer. For the single items, measuring sleep quality and tiredness during the day (Study 2), no reliability indices were available as they have never been used in previous studies. One might speculate that using sleep scales (e.g., those used in Study 1) might have an positive effect on the findings.

The relationships that we found between lucid dreams and sleep quality were comparable to Aviram and Soffer-Dudek (2018). Our findings that the relation between lucid dreams and sleep quality disappeared when nightmare frequency was controlled, suggest that lucid dreamers have poorer sleep only because of their increased tendency to have nightmares. This implies that the occurrence of lucid dreams is not per se related to sleep quality. That is, lucid dreamers seem to have more nightmares (Hess et al., 2017), and persons who have nightmares have poorer sleep quality, (Schredl, 2003). The finding that the frequency of negative dream emotions before lucidity onset is related to poor sleep quality (Aviram & Soffer-Dudek, 2018), also supports our hypothesis that the nightmarish quality of the dream before lucidity onset causes the poor sleep quality; not the lucidity itself. However, one has to be aware that both studies were cross-sectional, i.e., causal interpretations are not supported by the empirical findings. One might speculate, for example, that nightmare frequency is related to sleep quality due to other variables like stress or neuroticism (see: Schredl, 2003). To investigate other personality variables like openness to experience (Hess et al., 2017), or thin boundaries (Hartmann, 1991), might also be very promising.

Denis and Poerio (2017) did not find a significant relationship between lucid dreams and sleep quality (not controlling for nightmare frequency). This could be due to the methodological issues mentioned above: recruiting an unknown percentage of participants from lucid dream forums that might have a high motivation to deliberately induce lucid dreams and, thus, are biased regarding sleep quality estimates after successfully inducing a lucid dream.

To summarize, we could confirm our hypothesis that the relationship between lucid dreams and poor sleep quality is mediated by nightmares without implicating any causal relationships. To further examine this relationship it would be interesting to measure intra-individual differences in sleep quality between nights with and without lucid dreaming using a diary paradigm. Based on our findings, we would hypothesize that a person has poorer sleep quality only after a lucid dream that was initiated by a nightmare but not after lucid dreams without nightmarish qualities. It is important in this context to elicit whether the lucid dream was

spontaneous or result of applying a lucid dream induction method as some methods, e.g., the wake-up-back-to-bed technique affects sleep rhythms drastically (Stumbrys & Erlacher, 2014).

Clarifying the relation between lucid dreams and sleep quality seems an important topic, since persons who worry about possible health risks of lucid dreams, e.g., reduced sleep quality, might not engage in lucid dreaming and thus miss out on the positive and enriching aspects like coping with nightmares, training motor skills, or promote mental welfare.

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