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Chapter · June 2015

DOI: 10.5682/9786062803797

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Chapter XIII

SLEEP AND CREATIVITY: A LITERATURE REVIEW

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Note: This paper is supported by FCT (CIEO – Research Centre for Spatial and Organizational Dynamics, University of Algarve, Portugal)

Abstract: *Sleep and creativity have been widely studied in the field of psychology, being essential to understand human behavior. However, the relationship between these variables has not been examined through a systematic literature review. The aim of this study was to realize a review of the studies that related sleep and creativity. Thus, we performed a survey of the studies conducted between 1990 and 2014, which were published in journals indexed in the major electronic databases, in particular EBSCO and Web of Science (WoS). We analyzed 1258 papers that respected the search criteria and were selected by combining the keywords "sleep" and "creativity". Of these, 94 articles met the criteria concerning the relationship between sleep aspects and types of creativity or creative thinking. From the abovementioned articles, we picked 11 studies respecting the inclusion criteria. The obtained results indicate a positive relationship between sleep and creativity, nevertheless it was observed a significant variability in terms of sleep constructs and creativity dimensions. Although we can affirm that there is a positive relationship between these constructs, we must recognize the limits of this statement.*

Key-words*: creativity, sleep, systematic literature review.*

INTRODUCTION

Sleep is a complex behavioral state and one of the greatest mysteries of modern neuroscience (Rechtschaffen & Bergmann, 2002). Yet, the latest approaches and techniques are already able to describe and interpret many of its' biological mechanisms (Carter et al., 2012), providing not only a description of the sleeping conditions, but also of the processes that lead to a good quality of sleep (Miró, Cano-Lozano, & Buela-Casal, 2005). During sleep, the brain does not process the information received by the sense organs, however it is an active brain state (Pace-Schott & Hobson, 2002). One of the most important contributions of sleep is the development of new synapses and memory consolidation (Ashworth, Hill, Karmiloff-Smith, & Dimitriou, 2014). Indeed, sleep consolidates recent memories and, at the same time, allows implicit information processing by changing its' representational structure (Diekelmann & Born, 2010).

Consolidation theory suggests that, through sleep, both learning and memory processing

benefit creativity, and new memories are favored by memory representations reactivated, becoming stronger, more robust, and preserved in a long period of time (Marrone, Schaner, McNaughton, Worley, & Barnes, 2008; Oudiette et al., 2011). Rapid eye movement (REM) sleep, in particular, increases the creative process more than any other sleep phase, helping the formation of new associative networks in the brain and useful connections between ideas, working as an enabler for creativity (Cai, Mednick, Harrison, Kanady, & Mednick, 2009). Both scientists and artists have suggested that sleep facilitates creativity (Ritter, Strick, Bos, Van Baaren, & Dijksterhuis, 2012).

The direct relationships between sleep and creativity have rarely been addressed, but studies relating sleep to cognitive skills, such as memory and motivation, suggested that sleep may directly influence learning and the formation of new concepts, ideas, or solutions, in other words it leads to the development of creativity (Marguilho, Jesus, Viseu, Rus, & Brandolim, 2014).

An individual can state that he is in the presence of creativity when something new is produced, whether it is a product, a decision, a process, or an insight. Wagner, Gais, Haider, Verleger, and Born (2004) reinforced this idea. They affirmed that sleep consolidates recent memories and, in consequence, develops a new insight over a problem, allowing a change in the structural representation of the subject. For instance, Healey and Runco (2006) observed that children were able to learn a new task and improve their performance after a sleep period. This learning process also involves other aspects, such as motivation and certain aspects of personality (Jesus, Rus, Lens, & Imaginário, 2013).

Nowadays, creativity is recognized as an urgent transdisciplinar and transcultural requirement (Kaufman & Sternberg, 2006). A growing research interest in creativity has been observed in recent years, most likely because this concept is the most effective and natural answer to the world's increasing complexity (Runco, 2004). Innovation, new solutions and decisions, better education, and high competitive work environments have turned creativity into a valuable asset and research theme, despite its' complex nature (Starko, 2010).

The main goal of this study was to provide a literature summary regarding the relationship between sleep and creativity. To our knowledge, this is the first literature review relating these constructs. We also aimed to suggest paths for future research on sleep and creativity.

METHOD

Data Sources

The selection of studies was conducted in January 2015 focused on the papers published between 1990 and 2014, using the electronic databases Web of Science (WoS) and EBSCO. The inclusion criteria defined were: (a) English, French, Spanish, and Portuguese as publication languages; (b) studies published in peer-reviewed scientific journals; and (c) presence of the necessary data to analyze what has been studied and how it was studied. The keywords used to conduct the search were: (a) "sleep" and "creativity"; (b) "sleep" and "creative"; and (c) "sleep intervention" and "creativity". The studies included in the literature review and cited in the present manuscript are identified with an asterisk (*) in the references section.

Procedure

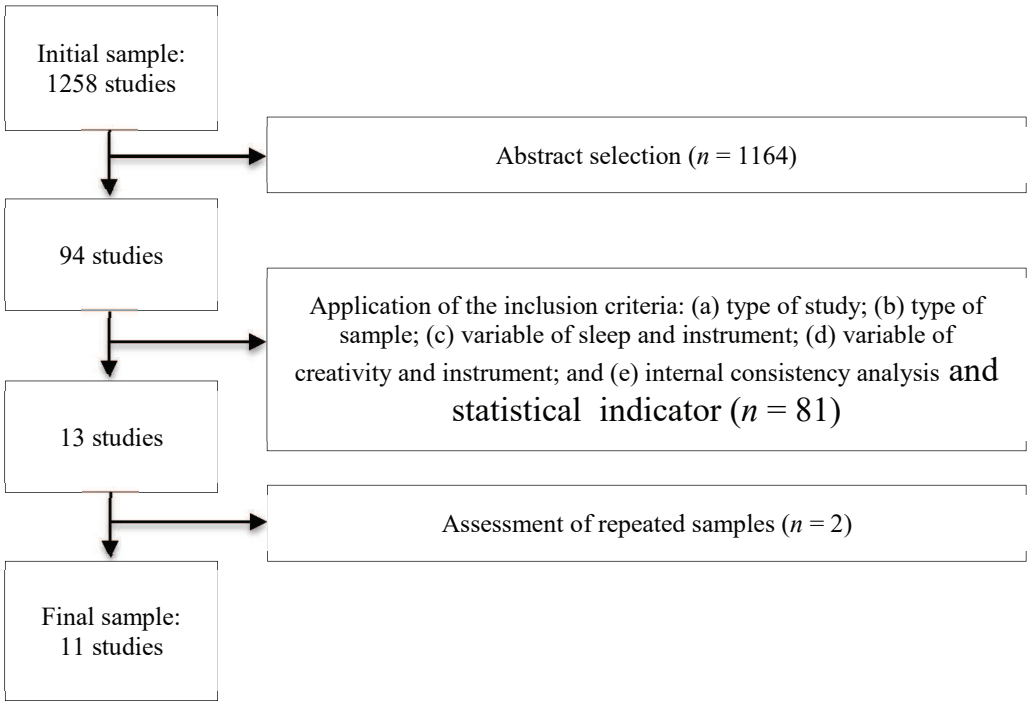
Search results were coded to facilitate comparisons using the following criteria: (a) author; (b) year; (c) sample size; (d) sample type (i.e., children, adolescents, adults, and the elderly); (e) type of creativity (i.e., product, process, person, and situation); (f) type of sleep (i.e., quality, insomnia, REM sleep, and dreams); and (g) type of study. The taxonomy of Montero and León (2007) was applied for the studies' classification. In the first stage, 1258 articles were selected. After reading the abstracts, only studies containing empirical data on the relationship between sleep and creativity were considered. Afterwards, a full reading of the documents allowed choosing those that contained relevant statistical information. In

a third step, we assessed the occurrence of repeated studies.

RESULTS

Theoretically, we confirmed that the selected studies were based on identical assumptions. The characterization of sleep had the same approach, although there were differences in relation to: (a) sleep stage analyzed; (b) sleep quantity/quality; and (c) morningness/eveningness factors. Also, in creativity, we found differences in the studied aspects, some studies focused on the (a) creative process; (b) creative personality; and (c) product creation. The selection criterion was to not discriminate between these factors, since they all addressed different perspectives of creativity. The methodological approach was the same in all studies. They presented empirical characteristics and correlation values that could be subject to objective analysis and comparison. After the first selection, we identified 1258 articles. The selection of abstracts reduced our sample to 94 studies, which were read taking into consideration the criteria: (a) type of study; (b) type of sample; (c) variable of sleep and instrument; (d) variable of creativity and instrument; and (e) internal consistency analysis and statistical indicator. This analysis retrieved 13 articles, of these, 2 were rejected because they referred to the same sample. A total of 11 articles, identified by an asterisk in the references section, were the basis for the present literature review (Figure 1).

Figure 1. Flow of studies in each phase of the systematic literature review. On the left are the studies that remained after each phase. On the right are the removed studies in each evaluation step



With regard to the studies' participants, we registered a total of 6629 participants. Of those, 2174 were males and 4376 were females (Table 1). The percentage of males (32.80%) is lower relatively to the percentage of females (67.20%). The highest sample was found in one article (Brand et al., 2011), which represented 84% of the total of participants. The age of the participants varied between 20 and 30 years old (young-adults), in turn only 9% of the sample included children and elderly.

Table 1. Characteristics of the Participants Included in the Literature Review (N = 6629)

ID	Authors	Type of sample (Age/Status)	*N*	
			Total	M/F
1	Wimmer et al. (1992)	All ages/General population	12	12/0
2	Schredl (1995)	Young/Students and working population	94	62/32
3	Randazzo et al. (1998)	Young/Students and working population	16	7/9
4	Schredl (2004)	Young/Students and working population	444	68/376
5	Healey and Runco (2006)	Children/Students	60	27/33
6	Giesbrecht and Merckelbach (2006)	Young/Students	205	65/140
7	Giampetro and Cavallera (2007)	Young, adult, and elderly/Students and working population	120	52/68
8	Cai et al. (2009)	Young/Working population	77	[a]
9	Brand et al. (2011)	Young and adults/Students	5580	1869/3711
10	Drago et al. (2011)	Adults/Working population	8	4/4
11	Vartanian et al. (2014)	Adults/Working population	13	10/3
	Total		6629	2176/4376

Note. M = Male; F = Female; [a] This study did not discriminate the participants by gender.

Several instruments were used to assess sleep and creativity, according to the purpose of each author and taking into account that both constructs include several factors that can be analyzed. At an earlier stage of this review, the instruments most commonly used to measure creativity and sleep were, respectively, the Torrance Test of Creative Thinking and the Pittsburg Quality Sleep Test. In the final phase of the review, regarding the sleep variable, the most used instruments were the Dreamuse questionnaire and polysomnography (Table 2).

The main conclusions regarding the relationship between sleep and creativity are presented in Table 4.

Table 2. Characteristics of the Instruments Used in Studies Included in the Systematic Review

ID	Sleep variable		Creativity variable	
	Type	Instrument	Type	Instrument
1	Dream	Dreamuse questionnaire	Person	Self-defined
2	Dream	Dream Recall Frequency	Person	The verbal creativity test of Schoppe (1975)
3	Sleep quality	Multiple sleep latency test	Person	Attitude Towards Creativity
4	Sleep quality	SF-B Sleep Questionnaire	Person	Attitude Towards Creativity
5	Sleep quality	Child Depression	Process	Torrance Test of Creative Thinking

6	Dissociative experiences	Dissociative Experiences Scale	Person	Creative Experiences Questionnaire
7	Morningness / eveningness	Reduced Morningness – Eveningness Questionnaire	Process	Torrance Test of Creative Thinking
8	REM sleep	Polysomnography	Process	RAT - Related Association Test
9	Sleep quality/quantity	Pittsburgh Sleep Quality Index	Person	NEO-PI-R, German version
10	Sleep patterns (REM/NREM)	Polysomnography	Process	Torrance Test of Creative Thinking
11	Sleep quantity	Stanford Sleepiness Scale	Person	Big Five Inventory (BFI)/MRI

Note. "Type" refers to the type of sleep or creativity considered by each study.

Overall, studies showed a moderate and statistically significant ($p < .05$) correlation between sleep and creativity, with an arithmetic mean of .27 and weighted average of .34 (Table 3). Below, we can observe the correlation results between the variables of sleep and creativity. Study 11 (Vartanian et al., 2014) does not possess a correlation value, but we kept it due to the clear presentation of its results.

Table 3. Correlation Scores in the Analyzed Studies

ID	Authors	*r*
1	Schredl (2004)	.19
2	Schredl (1995)	.27
3	Randazzo et al. (1998)	.33
4	Wimmer et al. (1992)	.26
5	Healey and Runco (2006)	.31
6	Giesbrecht and Merckelbach (2006)	.38
7	Brand et al. (2011)	.35
8	Cai et al. (2009)	.26
9	Giampetro and Cavallera (2007)	.18
10	Drago et al. (2011)	.13
11	Vartanian et al. (2014)	-
	Mean	.27

Note. r = correlation coefficient value; All r values were statistically significant ($p < .05$).

Table 4. Main Results of Each of the Analyzed Studies

ID	Results
1	This study suggested that sleep plays a functional role in the discovery of new reasoning processes to solve problems raised in the previous day. However, the type of sleep that enabled this process was not analyzed.
2	The sleep variable in this study was the dream recall frequency. The authors concluded that people with greater creativity have greater recall of their dreams.
3	This study compared the performance, in a cognitive test, of 16 subjects after periods of REM and NREM (non-rapid eye movement) sleep, and wakefulness. The tests applied after REM sleep were associated with better results in 32% of cases. The results suggested that REM sleep facilitates new ways to solve problems, better than NREM sleep and wakefulness.

4	The findings of this research showed a positive relationship between the memory of dreams and creativity and openness to new experiences.
5	There was a significant difference between the sleeping patterns of children who had higher results in creativity tests comparatively to those that had lower scores on the same creativity tests.
6	Dissociation and fantasy proneness were related to some types of sleep experiences, such as narcolepsy or vivid dreams.
7	Data showed that eveningness was correlated with the ability to apply divergent thinking strategies to visual content. The subjects prone to the night dimension (i.e., sleep pattern in which the subject has a sleep routine during the morning and wakefulness during the late night) had higher results in the components of creative thinking, fluidity, flexibility, and originality. We can assume that the evening type individuals tend to possess more ideas, hypotheses, and memories, allowing them to easily change their conceptual strategy.
8	REM sleep facilitated the formation of new combinations between ideas and the integration of new ideas. The study also indicated that sleep develops creative solutions, facilitating the connection between the information available in the brain through cholinergic and noradrenergic neuromodulation during REM sleep.
9	This study had the largest sample, therefore the most representative. The results indicated a significant and positive correlation (r = .21, p = .01) between sleep quality and creativity, and a moderate and significant correlation (r = .35, p = .01) between the amount of sleep and creativity. The authors stated that sleep enhanced creative problem solving for items that were primed before sleep, but this was only true for naps that included REM sleep.
10	NREM sleep is associated with low levels of cortical arousal, which can increase the ability to access remote associations that are critical for creative innovations. Furthermore, the A1 cycle (NREM sleep cycles, A1-A4) reflects the frontal lobe activity. The frontal lobes are important for divergent thinking, a critical aspect of creativity.
11	The results of this study revealed, with high consistency, that openness to experience is related to working memory processes, decision making, persistence, and concentration occurring in the pre-frontal cortex.

SLEEP

Studies 9 (Brand et al., 2011), 5 (Healey & Runco, 2006), 4 (Schredl, 2004), 3 (Randazzo et al., 1998), and 11 (Vartanian et al., 2014) analyzed the quantity and quality of sleep. These variables are usually employed in exploratory studies, given that the instruments use participants' responses and no experimental observation is required.

Studies 8 (Cai et al., 2009) and 10 (Drago et al., 2011) assessed sleep cycles (i.e., REM and NREM) which are important factors in sleep analysis and allowed the understanding of their relationship with creativity. Studies 2 (Schredl, 1995) and 4 (Schredl, 2004) evaluated the dream as part of sleep. Study 6 (Giesbrecht & Merckelbach, 2006) measured dissociative experiences during sleep. Lastly, study 11 (Vartanian et al., 2014) analyzed the amount of sleep using subjects that slept for 8 hours and sleep-deprived subjects after one night.

Regarding the instruments, the authors used different options, but we emphasize the difference between self-response instruments and the ones' employed in clinical studies (polysomnography). This method (i.e., polysomnography) is used in medicine and measures different aspects of sleep and variables such as electroencephalography (EEG), eye movement, musculoskeletal activity, or electrocardiogram (ECG). Within our selection, the variables analyzed were REM and NREM sleep.

CREATIVITY

Meusburger, Funke, and Wunder (2009) found more than 100 definitions in the literature about this concept. Similarly, Hilário et al. (2010) identified 239 instruments to assess creativity. So, for this review, we have not defined any parameters regarding which instrument was used by the authors.

The selected researches indicate that studies 5 (Healy & Runco, 2006), 8 (Cai et al., 2009), 9 (Giampetro & Cavallera, 2007), and 10 (Vartanian et al., 2014) used the

dimension process to assess creativity and the other studies employed the dimension person. This option is understandable, given that the assessment of the dimensions product or situation would require an experimental approach, where the subject would have to create a product or interact in a situation.

Concerning the measures applied, we highlight the use of the Torrance Test of Creative Thinking. This instrument, which measures creativity as a process, was created by Torrance, Torrance, Williams, and Horng (1978) based on the work of Guilford in the 1950's and originally involved verbal and non-verbal tasks that assess factors such as flexibility, fluency, originality, and elaboration.

NEO-PI-R (German version: Ostendorf & Angleitner, 1994) was one of the other instruments used. It measures, essentially, the person dimension of creativity and is based on the analysis of five major personality traits (i.e., neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness).

DISCUSSION

Our study showed that sleep has a positive influence on creativity, confirming the hypothesis that these two constructs are related. However, the analysis also showed the existence of different factors in sleep processes which should be thoroughly analyzed, particularly their relationships with creativity and its' different dimensions.

Positive relationships between creativity and dreams have been observed by several authors (e.g., Brand et al., 2011; Schredl, 1995, 2004). These relationships were confirmed by the test of creative performance after periods of REM sleep, demonstrating that this type of sleep promoted the formation of associated memories and integration of non-associated information (Cai et al., 2009). NREM sleep may also be important for creativity, given that this sleep stage is associated with low levels of cortical arousal, which can increase the ability to access remote associations that are critical for creative innovations (Drago et al., 2011). Likewise, NREM sleep reflects frontal lobe activity which is important for divergent thinking, a vital aspect of creativity (Drago et al., 2011).

Morningness and eveningness are also important aspects for creativity. Giampetro and Cavallera (2007) showed that eveningness was correlated with the ability to apply different thinking strategies to visual content. Subjects with an eveningness sleep pattern were more open to new experiences and presented greater divergent thinking. The subjects with a morningness pattern had higher results in creative thinking, as fluidity, flexibility, and originality, while the evening type tended to create more ideas, hypotheses, and memories, allowing them to easily change their conceptual strategy. The question of sleep schedules may be an important factor in creativity, in many cases working at night might have a significant impact on cognitive and professional performance.

Regarding sleep quality, Healy and Runco (2006) observed a significant difference, in sleep quality, between children with different creativity levels. Indeed, sleep deprived children had worse results in creativity tests in relation to well-slept children (Randazzo et al., 1998).

In the case of creativity, there are also different perspectives in the published studies. Only two dimensions of creativity were studied, person and process. Creativity associated with personality (i.e., creative person) refers to an individual characteristic and process (i.e., creative process) is the bridge between the person and the product. Three of the four studies that examined the process dimension used the Torrance Test of Creative Thinking. This instrument is a self-report questionnaire that has been adapted and perfected over the years, and is widely used and accepted for creativity assessment.

Findings of the studies which evaluated the process dimension of creativity (studies 5, 7, 8, and 10) showed a direct relationship between sleep and forms of creative thinking, whether verbally, visually, or verbal fluency. With regard to the person dimension, it was also observed, in the

remaining studies, a positive relationship with sleep. Subjects submitted to creativity tests revealed to be more open to new experiences, have the ability to use divergent thinking, and motivation for new tasks.

Cai et al. (2009) registered that sleep enhanced creative problem solving for items that were primed before sleep, but only for naps that included REM sleep. Contrasting with these results, Drago et al. (2011) observed that subjects with NREM sleep time produced more remote associations and divergent thinking, increasing creativity.

Moreover, Wimmer et al. (1992) and Randazzo et al. (1998) found differences in creative abilities in sleep restricted individuals. These individuals had worse performance in creativity measures. These conclusions are shared by Vartanian et al. (2014) which adds a more complete analysis in aspects such as working memory, concentration, and resilience through magnetic resonance imaging (MRI) and by biologically locating these processes. According to this author, sleep loss has a negative influence on pre-frontal cortex, impairing functions like fluency and divergent thinking.

Few attributes of human performance have so much impact on our lives as creativity, which can be improved through training (Scott et al., 2004). Although there are ways to facilitate and develop creativity, unconscious processes have been seldom addressed and introduced in various contexts (Ritter & Dijksterhuis, 2014). The benefits of an incubation period (i.e., performing less demanding tasks for shorter interleaved periods) are clear for the development of creativity (Sio & Ormerod, 2009), and include, for instance, the improvement of the verbal component of this concept (Davies, Gilhooly, Gilhooly, Harries, & Cairns, 2013).

Considering sleep as a multifaceted phenomenon, we can conclude that there is a positive relationship between the different sleep structures and the various dimensions of creativity. However, research on the relationships between sleep and creativity is scarce and these results indicate that sleep should be considered as a major issue with regard to creativity and innovation. A good sleep routine can indeed increase levels of innovation, creative solutions, and development of new strategies in education, management, marketing, research, and other creative areas.

Nevertheless this relationship is not straightforward. Future research should consider possible moderators and mediators, by evaluating, for instance, the combination of conscious and unconscious processes, or verify how practical knowledge, amount of time, and investment in a task can change sleep influence on decision making and creative production. Another critical aspect in sleep and creativity research is to understand if individuals with previous knowledge on a subject exhibit the same creativity level after sleep than individuals without any prior knowledge, but benefiting from sleep. Also, other studies should deepen some critical issues such as sleep patterns and cycles, and quality and quantity of sleep. There are also gaps in studies dealing with the different dimensions of creativity, which could open new perspectives for further research.

Understanding and training creativity and creative thinking plays an important role in many different areas, such as education, management, research, and arts. Therefore, a continued investment in creativity research is essential for human and economic development. We believe that intervention programs on creativity must take in consideration different conditions, such as level of knowledge in the area in question, motivation, and other cognitive issues (e.g., stress, anxiety, resilience, and fluency). Research in this area must take these factors into account as mediators in the relation between sleep and creativity. Despite the influence of other variables, we may state that, in general, sleep has a positive influence on creativity and that this relationship should be examined in future studies.

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