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Prospective Memory and Sleep Quality

Yuhan Wang[1,a,*]
[1]*Department of Xiangya School of Public Health, Central South University, Changsha, China*
a. 631021227@qq.com
**corresponding author*

Abstract: The objective of this study is to investigate the relationship between sleep quality and prospective memory in young adults. This investigation involved 115 cognitively healthy young adults aged between 17-28 years. Through scanning the QR code, participants completed two kinds of online questionnaires , including the Comprehensive Assessment of Prospective Memory (CAPM) and the Pittsburgh Sleep Quality Index (PSQI). The author used the One-Sample Kolmogorov-Smirnov test and the independent samples t-test to examine the correlation between the average CAPM score and PSQI score. The study reveals that changes of sleep quality strongly affect prospective memory. There is a direct correlation between the two, i.e., the worse the sleep quality, the poorer the prospective memory. Those with PSQI score ≤ 5 had significantly lower prospective memory scores than those with PSQI score > 6. This work also aims to tests the reliability of measuring tools, thereby to provide a reference for the filed of neuroscience research.

Keywords: Sleep quality, prospective memory, PSQI, CAPM, university students

1. Introduction

Prospective memory (PM) is defined as the capacity to remember and perform intended actions at the appropriate time in the future[1]. PM holds significant practical and safety implications in various aspects of our daily lives, including remembering household chores, attending work meetings, and adhering to timely medication schedules.

Theoretical interpretation of PM generally suggests that PM involves: (1) the formation/coding of intentions, (2) associating intentions with suggestions (e.g., a certain time pass, or an expected event in an environment), (3) keeping suggestions and intentions matched in an ongoing task to prevent continuous revision, (4) identifying instructions to perform expected actions, (5) retrieving expected actions from memory, and (6) correctly performing expected actions [2].

Extensive research has been conducted on prospective memory (PM) due to its vital role in daily functioning, particularly in recent studies that investigate the impact of sleep on PM. Research and which have demonstrated that sleep improves prospective memory. Conversely, sleep deprivation has been found to have detrimental effects on prospective memory performance [3]. Many studies investigate the relationship between sleep quality and prospective memory have utilized psychological assessments, experimental designs, and laboratory methodologies. These methods are often onerous both in terms of experimental conditions and the demands on survey participants, which often limits the extent of investigations.

Therefore, our aim is to investigate the association between prospective memory and sleep quality

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using a more practical and straightforward approach through the administration of a questionnaire survey. The author selected the most suitable questionnaires for our study: the Comprehensive Assessment of Prospective Memory and the Pittsburgh Sleep Quality Index.

The CAPM is widely utilized as a prominent method for examining and studying prospective memory. It measures how often people fail to remember future tasks, as well as their level of worry about these lapses and the reasons for remembering or forgetting [4].

The PSQI, devised by Buysse et al. in 1989, is a commonly utilized measure that evaluates sleep patterns and indications of insomnia over a period of one month. The accuracy and reliability of the CAPM scale have been demonstrated in diverse settings, including both clinical and non-clinical environments [5].

The target of this survey is to explore the connection of sleep quality and prospective memory in young adults and validate the hypothesis that lower sleep quality is linked to poorer prospective memory performance. In this study, most of our subjects were university students. Once all the questionnaires were completed, the author calculated the CAPM mean scores and PSQI scores to examine the correlation between the two variables.

2. Methods

2.1. Participants

A total of 129 participants (59 men and 70 women) were recruited from six countries. Most participants identified as Chinese ($n = 91$, 70.54%), while the remaining participants identified as British ($n = 16$), Canadian ($n = 15$), Australian ($n = 4$), American ($n = 2$), and Dutch ($n = 1$). The subjects were recruited from the investigators' social networks and international student university affiliates. To limit the influence of other memory impairments (often associated with aging) the author set the inclusion age range as 17-28 years. Consequently, seven participants (aged 50, 41, 36, 34, 32, 31 & 30) were excluded. An additional seven participants were excluded from the analysis due to their primary data (sample size, mean value, standard deviation) being obviously wrong and unable to be corrected. Hence, one hundred and fifteen individuals (50 men and 65 women) were included in the final cohort to participate in the survey.

2.2. Measures

In this study, the author employed both the CAPM questionnaire and the PSQI questionnaire. The CAPM mean score was utilized as the dependent variable, while the PSQI score served as the independent variable for each participant in the analysis. Next, the author evaluated the correlation between the CAPM questionnaire and the PSQI questionnaire.

SPSS

SPSS is the abbreviation for Statistical Product and Service Solutions, which is a set of IBM software products and related services for statistical analysis, data mining, predictive analysis and decision support tasks.

One-Sample Kolmogorov-Smirnov Test

The one-sample Kolmogorov-Smirnov test is used to test whether a sample comes from a specific distribution. We can use this procedure to determine whether a sample comes from a population that is normally distributed (see Kolmogorov-Smirnov Test for Normality).

Independent Samples T-test

The independent t-test, also called the two-sample t-test, independent-samples t-test or student's t-test, is an inferential statistical test that determines whether there is a statistically significant difference between the means in two unrelated groups. This means that there are different people providing scores for each group. The purpose of this test is to determine if the samples are different from each other.

2.3. Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI), developed by Buysse et al., is a self-report assessment tool widely used to measure sleep quality over a one-month period. PSQI consists of 19 projects that generate overall sleep quality scores and the following seven component scores: sleep quality, sleep incubation period, sleep duration, routine sleep efficiency, sleep disorders, sleep medication use and daytime function disorder. The number of projects and group components is designed to represent the standard areas evaluated by clinicians when reporting sleep complaints individually. According to the authors of the scale, the advantages of PSQI include the ability to: (a) determine patterns of sleep dysfunction within 1 month by evaluating qualitative and quantitative data; (b) calculate a simple global score to reflect the number and severity of sleep problems [6]. This questionnaire has demonstrated robust validity and reliability in a wide range of settings, including both clinical and non-clinical environments. This questionnaire comprises seven categories with nineteen items. Participants rate each item on a scale from 0 (no difficulty) to 3 (severe difficulty). As a result, the total PSQI score ranges from 0 to 21. Based on research findings, a total score greater than 5 has been established as a reliable cut-off point, with high sensitivity and specificity, that accurately distinguishes between good and poor sleep [7].

2.4. Comprehensive Assessment of Prospective Memory (CAPM)

The CAPM was specifically developed to specifically evaluate prospective memory. The CAPM questionnaire has section A, section B and section C, with 39 items in both section A and section B. Participants rate each item on a five-point scale, where 1 corresponds to "never," 2 to "rarely," 3 to "sometimes," 4 to "often," and 5 to "very often." Participants are recommended to finish all items, but they may also select "not applicable" if an item is not relevant to them. The author utilized Section A of the CAPM questionnaire in our survey to assess the frequency of perceived prospective memory failures in instrumental activities of daily living (IADL) and basic activities of daily living (BADL) . To calculate the average CAPM score for each participant, the author summed their numerical responses (ranging from 1 to 5 as explained earlier) for all completed items, excluding those marked as "not applicable." The sum was divided by the total number of completed items. Thus, each CAPM mean score for an individual participant could fall within the range 1 to 5, with elevated ratings indicating a greater incidence of perceived PM shortcomings.

2.5. Procedure

“Wenjuanxing” is a professional online questionnaire survey platform which boasts 64.54 million users in China [8]. The author designed and distributed questionnaires through this platform and generated a QR code that could be sent directly to each participant.

Once a participant had understood and completed the informed consent, it was anticipated that they would need to spend approximately fifteen minutes to complete the questionnaire.

When the questionnaire fillers finish filling out and submitting the questionnaires, the surveyors will monitor the completion in the backdrop of the website and can process the samples and aggregate the data.

3. Results

As shown in Table 1, the Kolmogorov-Smirnov test results confirm the original hypothesis, which means that the CAPM mean scores are normally distributed ($p > 0.05$).

Table 1: One-Sample Kolmogorov-Smirnov Test

		CAPM mean score
N		115
Normal Parameters[a,b]	Mean	2.336
	Std. Deviation	0.70897
Most Extreme Differences	Absolute	0.116
	Positive	0.116
	Negative	-0.054
Kolmogorov-Smirnov Z		1.243
Asymp. Sig. (2-tailed)		0.091

As shown in Table 2 and Table 3, the independent sample t-test revealed that the overall CAPM mean score for the sub-group of respondents with $PSQI\ score \leq 5\ (n = 40, M = 2.02, SD = .44)$ was significantly lower than that of the sub-group of respondents with $PSQI\ score > 5\ (n = 75, M = 2.50, SD = .77)$, $t(112) = -4.29, p < .01, d = .67, 95\%\ CI = [-.71; -.26]$.

Table 2: Group Statistics

	PSQI score	N	Mean	Std. Deviation	Std. Error Mean
CAPM mean Score	≤ 5	40	2.0214	.43735	.06915
	> 5	75	2.5038	.76909	.08881

Table 3: Independent sample t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	14.232	< .001	-3.659	113	< .001	-.48242	.13183	-.74359	-.22124
Equal variances not assumed			-4.286	112.48	< .001	-.48242	.11255	-.70542	-.25941

4. Conclusion and Discussion

The study reveals that lack of quality sleep has a significant negative affect prospective memory. The worse the sleep quality, the poorer the prospective memory. Those with a PSQI score ≤ 5 had significantly lower prospective memory scores than those with a PSQI score > 5. This discovery agrees with previous research that has demonstrated how sleep enhances both the recall and memory

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storage aspects of prospective memory [9].

This research is subject to several methodological constraints. In China, the CAPM questionnaire has been commonly utilized in previously conducted studies. These involved translating the original questionnaire into Chinese. However, prior to the translation, there was an investigation conducted to discern the suitability of the original version in terms of cultural relevance. A total of four items have been removed, with 3 further items only being modified in order to better align with the cultural context in China. Of those items that were modified, they were found to be robust across various demographics, including age, gender, and educational background. The author opted to use the original version of the CAPM questionnaire to ensure consistency. However, as it happened that most of the participants in our study were Chinese, the translated version of CAPM would have been more appropriate. Secondly, the study's sample pool was restricted to individuals from the investigators' university affiliates and personal relationships. This may have limited the diversity of the participants in terms of their cultural background and education level. The age range was restricted between seventeen and twenty-eight years. Thus, the results may not be applicable to the older population. Therefore, the author recommend that further surveys include a wider range of respondents. Thirdly, as questionnaires were distributed online in the form of a QR code, and some of the ineligible participants were excluded, the ratio of men to women who participated in our survey was somewhat imbalanced, with 11 more men than women. The author recommends that an equal number of male and female participants be selected for further experiments in the future to exclude the effect of gender on the results. At the same time, the author recommends that the questionnaire be completed offline so that the investigator can explain in detail to the participants how to fill out the questionnaire to avoid ambiguities. Fourthly, the results relied solely on self-reported information instead of clinical trials. So we can’t effectively detect the correlation between PSQI and CAPM questionnaires at a clinical level. Considering the potential limitations in accurately self-reporting problems among patients with neurological or cognitive disorders, conducting the survey in a face-to-face manner would be valuable. It is worth to mention that our survey was not conducted in time-limited circumstances, resulting in the background monitoring of the questionnaire filling site showing that each person’s filling time varies too much so we can’t control the survey time variable, which could potentially affect the survey results. So we recommend that the experiment be done with a set time limit to ensure that the irrelevant variables for all fillers are the same.

Buysse subsequently claimed in his study the possibility of using PSQI in non-clinical populations with the aim of obtaining more normal results. His findings confirmed that there were significant differences between the overall PSQI scores and all sub-scores (except for sleep disorders) in non-clinical and clinical samples. The results of our selection of non-clinical samples for survey are not fully consistent with those of other clinical sample-validated studies. For this, we need to design new methods for evaluating the sleep health of non-clinical samples.

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