

# Sleep Evaluation Influenced by Negative Emotions and Memories After Awakening Among Adolescents and Young Adults

Huan Wen Lu

Faculty of Industrial Design  
Eindhoven University of Technology  
Noord-Brabant, The Netherlands  
Email: klu@live.nl

SeungHee Lee

Faculty of Art and Design  
Graduate School of Comprehensive Human Sciences  
Univeristy of Tsukuba  
Ibaraki, Japan  
Email: seungheekansei@gmail.com

**Abstract**—This paper examined the influence of sleep experience on self-sleep evaluation among adolescents and young adults. 64 participants (age between 16-27, 36 males, 28 woman) have participated in a questionnaire study. Sleeping habits and subjective sleeping experience have been mapped and analyzed. In a follow-up study, three participants have been tracking their sleep experience, daily activities and sleep hygiene. The results have shown that the participants of both studies sleep less than average, but within the margin for healthy sleep. However, 25,8% of the participants evaluate their sleep as insufficient or as an unpleasant experience. The case study showed that the evaluation process of sleep experience is unbalanced. Memories of bad sleep and negative emotions have a bigger impact on sleep evaluation scores. Memories of pleasant sleeping experiences are more easily replaced by new thoughts and are often forgotten during the sleep evaluation process.

**Keywords**— *sleep hygiene; sleep evaluation; activity tracking; bad sleeping experience.*

## I. INTRODUCTION

Insufficient sleep, difficulties waking up and a bad mood are consequences of experiencing bad sleep. In the long run, unpleasant sleeping experience and mental fatigue may lead to sleeping disorder [1]. Out of this, only a small fraction of the big group of problem sleepers has officially been diagnosed with a sleep disorder and are receiving professional help and treatment [2]. The common sleeper is thus, unaware of what good sleep and bad sleep implies. On the other hand, information found on the internet is not always accurate or is difficult to understand for everyday people. As a result, the difference between good sleep and bad sleep is therefore often misunderstood [3]. Sleep can be influenced by many different factors, where sleep hygiene and consuming behavior plays an active role [4].

In recent studies regarding sleep quality perceptions, it has been suggested that there is a wide variety in how accurately insomnia sufferers perceive their sleep [5]-[8]. Insomnia sufferers tend to underestimate the overall sleep time and have a negative view on sleeping compared to normal sleepers. Furthermore, investigations into sleep misperceptions have shown that people with a healthy sleep hygiene have proven to be more accurate to evaluate their sleep [9]-[11]. In this regard, the goal of this study is to map down and analyze

the sleep data of adolescents and young adults to find how self-sleep evaluation is influenced by sleep experience.

The topic of this paper is introduced in section I. In section II, the methodology, target audience and the setup of both studies is explained. Section III shows the obtained results and subject evaluation of both studies. The discussion and conclusion are written in section IV and V.

## II. METHODS

This study is divided into two parts: (1) the sleep evaluation analysis of the younger generation in the area of Eindhoven and (2) a case study of three subjects to find how self-sleep evaluation is influenced by sleep experience. Adolescents and young adults were approached to participate in a survey and share their past experiences, thoughts about sleep quality and how they would evaluate their own sleep. Moreover, people regardless of background, gender, or medical dossier were allowed to participate in this questionnaire. The only requirement was to be within the age group of 16 to 27 years old.

According to the adolescents and young adults participating in this study, they are facing more problems related to sleep such as: feeling tired, insufficient sleep, irregular sleep patterns and stress. To look further into the case of sleep evaluation, a specific case study is designed to track the sleeping experience and consuming behavior of adolescents and young adults outside a clinical environment.

A total of 64 participants (28 female) successfully filled in the sleeping evaluation questionnaire. Figure 1 and 2 show the age distribution and occupation. The occupations are distributed among three groups: 66% are in education or training, 31% are employed, and 3% are unemployed and not in education. Among this group, 16 participants (25,8 %) stated they have troubles regarding one, or more of the following points: falling asleep, staying asleep, going to bed, waking up, or tiredness. In all cases the participants were not officially diagnosed with any sleeping disorder.

The following statements were hypothesized: (1) Adolescents and young adults do not have a clear overview of what good sleeping experience means. The true definition of good sleep is not clearly defined, causing misunderstandings; (2)

sleep evaluation is influenced by time. The moment when it is evaluated makes a difference in evaluation score. People have different opinions about their sleep during the day; (3) only a small percentage of the adolescents and young adults do have (symptoms of) sleeping problems; (4) consuming and activity behavior prior going to bed does have a measurable impact on sleep experience. Physical exercise, caffeine and alcohol consumption may have an influence on one's sleep.

Based on the results of the sleep evaluation analysis, three subjects were chosen out of the 64 participants to participate in a case study. They were chosen from the initial group of participants based on questionnaire results, Pittsburgh Sleep Quality Assessment (PSQI) score and willingness to participate. What is more, the subjects completed an interview process, about their personal standing on the subject of sleep, survey results and past sleeping experiences. They, consisted of two non-problem sleepers and one problem sleeper, where the last has not been diagnosed with a mental sleep disorder. In this research, the following assumptions were made: a non-problem sleeper is someone who (a) sleeps everyday at least six hours; (b) falls asleep in less than 30 minutes; (c) is sleeping in a bedroom environment; (d) is excluded from any disorders or illnesses; (e) has a PSQI score of less than five. A problem sleeper is defined if he or she does not qualify for at least one of the statements written above.

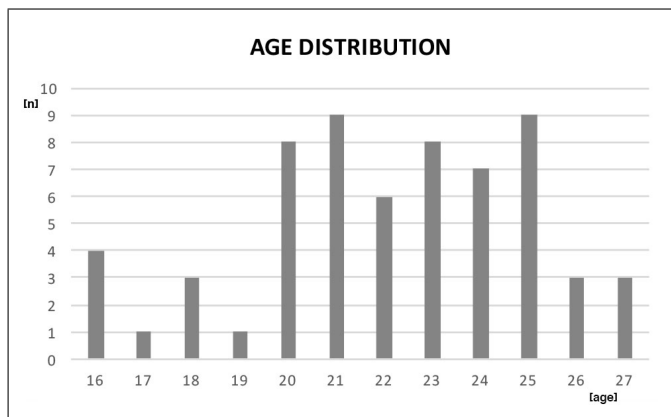


Figure 1. Age Distribution Participants

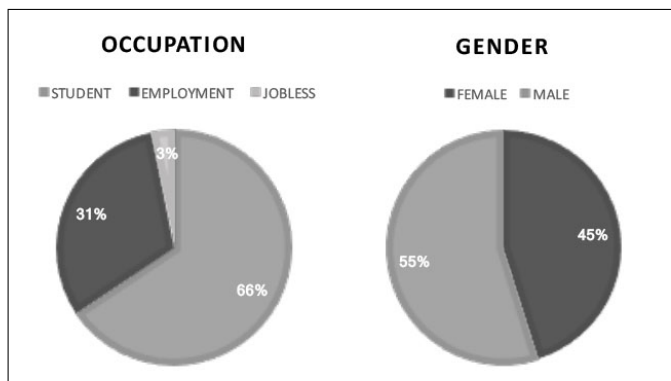


Figure 2. Occupation and Gender

### A. Sleep Evaluation Questionnaire

Each participant was given a set of questionnaires to complete in their own time. Included in the set were three different questionnaires related to: sleep quality, sleep experience, and daily activities for the past month. Moreover, questions were based on different studies for diagnosing sleep disorders: Pittsburgh Quality Sleep Index (PSQI) [12], Consensus Sleep Diary (CSD) [13] and Stanford Sleeping Scale (SSS) [14]. The questions in the survey were slightly modified to be applicable to the public audience who is not familiar to mental sleep disorders [15]. In the end, the participants were asked if they would like to volunteer as subjects in the case study.

### B. Case Study Procedure

Based on the results of the questionnaire study, three subjects were chosen: two males (22 and 24), and one female (26). One of the subjects (24/M), claimed to have sleep troubles consisting of: falling asleep, irregular sleeping patterns and feeling tired during the day. Au contraire, during the study, the subjects were required to keep track of: (a) food, beverages, medication, and tobacco consumed/used; (b) physical exercise (what exercise and how long); (c) activities from at least 2 hours prior going to bed; and (d) sleep evaluation after awakening. Furthermore, they did not change their sleeping schedule, consuming, and activity behavior. Before starting the experiment, the volunteers were guided on how to use the tracking tools, interviewed about their thought of the experiment, and a questionnaire related to sleep experience was given to fill in. Besides, two tracking tools were provided to register the activities: (1) a notebook, consisting of questions and feedback requests on their sleep, a blank table and some additional blank comment space; and (2) a smartphone application with questions related to their sleeping experience, tracking option for consumables and activities and a comment section (see Figure 3). Either one of the two diaries had to

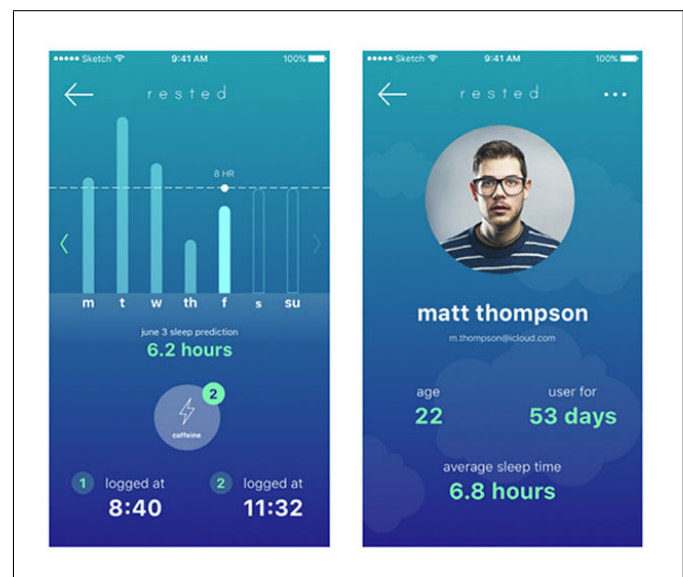


Figure 3. Tracking Application: Rested Beta 0.2

be filled. Before starting the experiment, the volunteers were guided on how to use the tracking tools, interviewed about their thought of the experiment, and a questionnaire related to sleep experience was given to fill in.

The tracking application for the smartphone was created to make tracking easier and accessible for the subjects. At the end of the experiment, the subjects were once again interviewed with the same questions as the pre-experiment interview and were given the same questionnaire about sleep experience to fill in.

The results from all data provided by the participants and subjects have been analyzed through a cause and effect study. The relationship of consuming, activity behavior, and sleeping evaluation were mapped into multiple subgroups and analyzed. The groups consisted of occupation, age, and sleep evaluation score.

### III. RESULTS

The results from the sleep evaluation questionnaire are shown in Figures 4, 5, and 6. These include sleep evaluation score, bedtime, wake time, and a plot of sleep evaluation against the total amount of sleep. In this regard, sleep evaluation is based on a [0-10] point scale, where 0 is the most negative and 10 the most positive sleep experience. Participants filled the questionnaire individually, without further instructions, while questions left open were not taken into account. From the aforementioned, the participants are divided into sub-groups: (a) Good sleepers (8+), normal sleepers (5-7), bad sleepers (4-); (b) student and non-student; and (c) by age group: between 16 and 19 years old, consisting of mainly students attending high school, from 20 to 23 years old, consisting of mainly students attending university or college, and 24-27 years old, consisting of mainly working adults.

The results are compared to guidelines given on sleep for adolescents. According to previously published research, the body has optimal rest and growth when adolescents sleep on average eight hours per day. Healthy sleep is sleeping between 6 and 9 hours per day [16]. However, a different study reported that only 15% of the adolescents are sleeping eight hours [17]. Among the participants, 14,5 % (9 out of 62) did sleep the

Group	Age	Average Sleep [hours]	S.D.	Bed time	Wake time	Rating sleep	Time Fall asleep [minutes]
All participants	22,1	6,61	0,86	00:30	07:15	6,08	22,9
Students	21,3	6,44	0,92	00:45	07:15	5,77	22,9
Non-Students	23,9	7,00	0,78	00:15	07:10	6,79	23,2
16-19	17,1	6,89	0,83	00:15	07:15	6,44	17,2
20-23	21,5	6,32	0,96	00:45	07:15	5,77	25,3
24-27	25,1	6,91	0,81	00:15	07:15	6,36	22,0
Rating <4	21,9	6,00	1,03	01:00	07:00	3,44	26,3
Rating 5-7	21,9	6,64	0,87	01:00	07:30	6,04	20,7
Rating 8>	22,6	7,11	0,78	23:45	07:00	8,50	23,6

Figure 4. Sleep Evaluation Data 1

Group	Age	% want to sleep more	% awoken by alarm	% Sleeping alone	% Screen use prior sleep
All participants	22,1	93,50%	87,10%	83,80%	96,80%
Students	21,3	97,67%	88,37%	83,72%	100,00%
Non-Students	23,9	84,21%	94,74%	84,21%	92,56%
16-19	17,1	100,00%	77,78%	88,89%	100,00%
20-23	21,5	93,55%	96,77%	90,32%	100,00%
24-27	25,1	90,91%	90,91%	72,73%	95,45%
Rating <4	21,9	100,00%	100,00%	100,00%	100,00%
Rating 5-7	21,9	89,29%	85,71%	78,57%	100,00%
Rating 8>	22,6	94,44%	88,89%	77,78%	94,44%

Figure 5. Sleep Evaluation Data 2

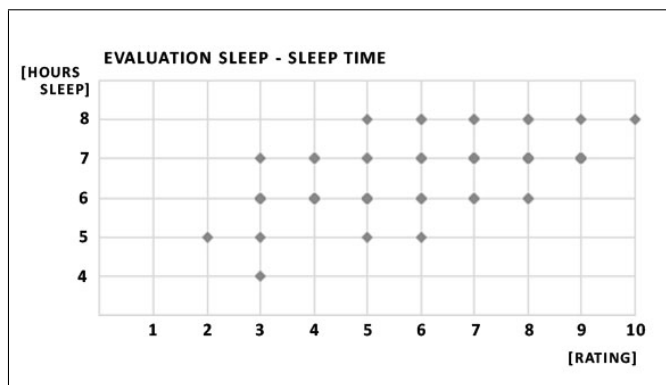


Figure 6. Sleep Time Versus Evaluation Score

recommended 8 hours of sleep per day. In the questionnaire, certain sleep - wake behaviors were asked and are shown in Figure 5 and 6. In overall, the participants in the age group of 16-19 and 24-27 are the most satisfied with their sleep. Participants aged from 20-23 experience the worst sleep.

The results from the case study are shown in Figure 7. A diary study gave more accurate values in sleep wake times and daily activities of the subjects. In addition, according to the data sheet, it was clear that the subjects underestimate their amount of sleep. The total amount of sleep is approximately half an hour to an hour more than the time submitted at the questionnaire. The subjects were always looking at the worst case scenario. Therefore they were underestimating their total sleep time.

Consuming and activity behavior having an impact on sleep experience does not clearly show in the results from the case study; likewise, interviews with the participants gave different answers without a clear conclusion. Notwithstanding, regular eating and drinking habits do have a small influence on one's sleep. In a different study, it was stated for optimal sleep hygiene, food, drinks, and physical exercise is not recommended prior bed time. In contradiction to the previous statement, one of the subjects (26/F) was having intense physical exercise 2-3 times per week prior going to bed. In the after-interview, she clearly stated "Physical exercise improves

	Case 1	Case 2	Case 3			
Age/Gender:	22/M	24/M	26/F			
Occupation:	Student	Student	Student			
Overall sleep rating:	7	4	8			
Average sleep:	7,5	7*	6,6	6*	7,2	7*
Weekday:	7,1	6,1	6,9			
Free day:	9,75	8,1	8,5			
Average bedtime:						
Weekday:	00:28	01:46	23:47			
Free day:	03:13	02:32	01:20			
Activities prior Bed:	Homework Watching series/movies Drinking** Music	Smartphone use Homework Drinking** Student association	Physical Exercise Showering Smartphone use			
Other information:	Sleeps alone	Sleeps alone Difficulties falling asleep Very tired in morning	Sleeps with partner			

\*Average sleep submitted during initial questionnaire.  
\*\*Occasionally drinking alcohol [2-4x per week]

Figure 7. Case Study Data Summary

my sleep experience, it helps me to fall asleep more easily and it helps to clear my mind”.

The evaluation of sleep is influenced by memories and feelings related to bad sleep. Subjects (22/M and 24/M) gave their opinion that bad sleep has more impact on their morning routine. The difference between good and bad sleep experience cannot be compared as many factors affect this judgment. The moment of evaluation is also very important. For example, evaluating your sleep directly after waking up, will result in a lower evaluation score; whereas doing it after taking a shower, or having a morning coffee, will improve the evaluation score. It has been stated by the subjects that memories of bad sleep are stronger and more memorable, while memories of good sleep are easily forgotten and replaced by new thoughts of activities and events.

On another topic, the tracking application was favored over the traditional paper notebook, during the two-week study: all three subjects preferred to use the smartphone application. One of the subjects (22/M) gave his opinion about activity tracking: "Tracking my activities gave me more insight about my daily routines and consuming behavior. However, I did not change my behavior a lot". The subjects were interested in sleep hygiene and behavior change, however, they were not willing to change their own daily routines.

#### IV. DISCUSSION

The case study sampled sleep experience and activity behavior across multiple nights and outside clinical settings. The findings found in this study are based on the results provided by the participants, which are subjective statements and believes they have themselves. Moreover, the findings supported previous studies about the sleep patterns of adolescents and

young adults, but a bigger sample size is required to give a final conclusion. Inevitably, the coherence between consuming and activity behavior prior going to bed is unclear and cannot be confirmed in this study. Consuming and activity behavior, a part of sleep hygiene, has on a certain degree effect on one’s sleep. The positive effect has been stated in previous studies as well, but sleep hygiene is due to contradictory result material not used in this study. It can be concluded that activity and consuming behavior do have a relation to sleep experience.

When reviewing the findings and implications discussed herein, it is important to consider the limitations which may have influenced these findings. The data is in all cases subjective information provided by the participants themselves. The participants’ self-evaluation is based on own knowledge and attitude towards sleep. People who are biased towards good sleeping experience, are evaluating their sleep with more care. As a result, these people were very satisfied with their own sleep.

The other group has a more diverse opinion on sleep, these individuals consisted mainly of college and university students. Hence, due to projects, exams and social relations, there is less structure in their sleep hygiene. Pressure from school, social relationships and (part-time) work is in some cases more important than sleep, which results in their sleep evaluation to be below average. Subsequently, people with a more negative view on sleep, are always looking at the worst case scenario. As a result, they were underestimating their total sleep time on a regular base. It is thought that, as a result of this study, sleep evaluation is influenced by many more factors outside of the domain of sleep. Negative emotions and memories do have a significant impact on sleep evaluation.

From the results of the sleep evaluation questionnaire, it can be argued that: (a) adolescents and young adults of this study do not reach the quota of sleep recommended for their age group, but are within margin of healthy sleep behavior; (b) subjective thoughts about sleep experiences are more negative than the actual sleep experience. 25,8 percent of the participants rate their sleep overall bad (less or equal than four on the 10-point scale), and there are only five cases where people sleep less than the norm of at least five hours; (c) most of the people are misinformed about what good quality sleep means. Their view on sleep in general very negative. This may be caused by all the information available on the Internet about various sleep disorders.

#### V. CONCLUSION AND FUTURE WORKS

Adolescents and young teenagers do sleep less, but within the margin for healthy sleep. However, the evaluation process of subjective sleep experience is unbalanced. Memories and emotions related to unpleasant sleeping experience are more memorable and present than pleasant sleeping experiences. Pleasant memories are more easily replaced by new thoughts and are often forgotten during the sleep evaluation process. As a result, negative emotions and memories have more influence on the results of subjective sleep evaluation.

In future studies, the domain of subjective sleep experience is not only limited to factors as overall sleep time, wake time, sleep quality, but factors as feelings, memories and emotions could be included in addition. Following the Japanese trend of design emotion, the approach of Kansei design, where research and development are focused towards the customer's psychological feelings and emotions could be used as one of the starting points.

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