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# An Investigation of Lighting Levels and Sleep Quality

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## Abstract

Sleep quality in young adults is compromised. Instead of the recommended 7 hours, young adults' schedule interruptions disturb sleep to a typical six and a half hours, with common disturbances in falling asleep and staying asleep. Recent literature has identified an association between academic performance, negative mood state and low activity level in young adults with sleep disturbances. Young adulthood is a time for the installation of sleep health. Both individual and schedule impositions to the young adults' sleep schedule are to be modified to obtain Sleep Health. Recent research has identified daytime light effects on sleep such as blue light from electronics as alerting and low level light for relaxation. The aim of this study was to identify sleep quality effects with varying light exposures. It was hypothesized that bright (>450 lux) light conditions would be considered focusing and low light (<220 lux) would be considered calming. We hypothesized that sleep quality would improve by 5% with the introduction of a calm light condition. Undergraduates from a small midwestern university were invited to participate in the study in exchange for a gift card. Six participants completed the study, two males, four females all between 21 - 24 years old. Both hypotheses were supported by qualitative analysis.

## Keywords

Light, Sleep Quality, Lighting, Sleep Disturbance

## 1. Introduction

Young adults sleep has been reported to be compromised due to daytime schedule interruptions [1] [2]. The expected seven hours of sleep for young adults, ages 18

- 30 years, is rarely met—five to six hours is typical [1]-[4]. Sleep health is contingent on consistent sleep time of an adequate amount [5] [6]. Reduction in mood such as depression, anxiousness, irritability and lower levels of creativity have been reported to correspond to inadequate sleep health in young adults [1]. Furthermore, intreated sleep health corresponds to the onset of sleep disorder symptomology and possible sleep disorder diagnosis [1]. Medical researchers have identified a significant correlation between sleep health and onset of cardiovascular and endocrine symptoms of disease [1] [7].

### 1.1. Sleep Research Findings

In the study of sleep, the timing of light investigations identified the role of light in turning off sleep thus entailing importance of asleep schedule during darkened hours of the day with awaking at the start of natural sunlight [8] [9]. Investigations of light energy levels and sleep involved a focus on the role of regular sleep at a set time during the twenty-five hours cycle, thus a circadian rhythm [1] [10]. Sleep health and lighting studies have also identified the utility of stimulation of neural pathways through the visual system with bright light to regulate and stimulate endogenous melatonin release which regulates the circadian rhythms keeping the individual asleep [6]. Daytime hours of wakefulness place the individual in various lighting levels environments.

### 1.2. Light Level Studies and Sleep

Recent studies have identified the contributing role of types of ad timing of lighting during daytime hours and sleep health. The most common finding has been with "blue Light" as too alerting near bedtime [5] [8]. In addition, low level lighting such as darkened rooms in evening hours for television viewing has been identified as well [9] [10] [11]. Low levels of light, such as that of an overcast day (about 220 lux) are calming whereas bright lighting such as in a college classroom (five hundred lux) is alerting [9] [12]-[14]. Research findings have identified daytime alert and cognitive function with finding that morning exposure for complex academic/cognitive tasks was preferable for good performance [5]. Applied research on light levels and sleep recommends the use of residence hall design to optimize daylight exposure at awakening [4] [6]. In a study of nighttime television viewing, poorer sleep in participants was reported [2]. An alerting response has been reported (*i.e.*, reduction of EED activity theta-alpha frequency/power density 5 - 9 Hz) that correlated with the degree of melatonin suppression by light that co-occurred with reported subjective alertness [8].

Evening types characterized by a subject experience of peak activation in the evening corresponded to a later rating of mid-temperature lowering cycle which may account for the evening alertness and morning sleepiness may account for the evening alertness and morning sleepiness [11]. Measurement of dim light melatonin onset in sleep laboratories (corresponding to about 7 hours before temperature drop with the sleep cycle) cooccur in evening types [11] [12].

## 2. Aim of the Investigation

The aim of the current study was to identify sleep quality effects with varying light exposures. It was hypothesized that bright (450 lux) light conditions would be considered focusing and low light (220 lux) would be considered calming. We hypothesized that sleep quality will improve by 5% with the introduction of the calm light condition.

## 3. Method

### 3.1. Participants

Undergraduate students enrolled in psychology courses at a Midwestern University were invited to participate in the study in exchange for a gift card upon completion. Eight participants signed up, six completed the study and two dropped out due to disinterest. Two males and four females, aged 21 - 24 years, completed an informed consent following an explanation of the study. The study has IRB approval.

### 3.2. Measures/Instruments

All participants completed the following forms: sleep history, sleep hygiene, beliefs about my sleep, mood ratings. Each participant received instructions on the use of a Sleep score max (Sonar "nearable" to record sleep) and Lifx smart light bulb alone with the apps that manage their operation. All participants completed a light survey of the environments they stayed in and the type/amount of light in each setting.

### 3.3. Procedure

Each participant following the explanation and informed consent received instructions on the use of the Sleep score max and Lifx smart light bulb with the apps to manage each loaded to their personal cell phone. They were instructed to sit for twenty minutes with assigned lighting levels of focus lighting condition (440 lux) for twenty minutes in the morning and the calm lighting condition (22 lux) for twenty minutes during the afternoon using the app to manage the smart lightbulb setting. The participants tracked their sleep using the sleep score max for seven days and engaged in the lighting level assignments on days three, four and five. Thus, days one and two served as a baseline, days three, four and five as the intervention and days six and seven as the follow up in this ABA design applied to natural settings of the participant.

## 4. Results

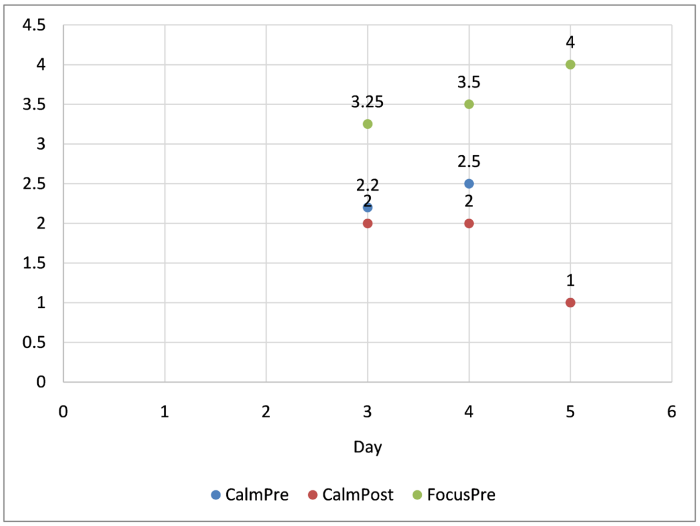
Summary statistics of all variables were conducted with the results listed in Table 1. The aim and hypothesis were supported in this study. The participants in the study were sleepy. Sleep hygiene knowledge was moderately high among the participants. Table 1 lists an average rating of 33% of participants time, on average,

involve a sensation of sleepiness. The participants, all young adults University student, spend an average of 61% of their time in bright lighting (*i.e.*, >550 lux classroom overhead lights), followed by 22% of the time, on average, in bright desk light lamp/residence room overhead light. The result and lighting in the participant' reporting was 17% natural lights each day. Participants ratings, on average, denote increased calmness after the calm lighting intervals and increased focus after the focus lighting intervals. This relationship is represented with Figure 1. Figure 1 depicts the elevation in ratings of calm and focus by the participants following the use of the a and a focus lighting level interval, respectively. Due to the small sample size, between condition analysis (*i.e.*, Nonparametric Chi Square) was used and yielded non-significant findings between intervention and baseline days of sleep quality rating and between pre to post ratings (*i.e.*, Nonparametric Autocorrelation). Visual analysis of Figure 2 indicates increases in sleep quality on days three, four, and five of the lighting intervention as compared to day two of the baseline.

Table 1. Summary statistics of participants.

| Light level variable | Average % |
|---|---|
| Daytime sleepiness felt | 33 |
| Sleep Hygiene knowledge | 66 |
| Amount of time in daytime | |
| Lighting >550 lux | 61 |
| Amount of time on task lamp | 22 |
| Amount of time in natural light | 17 |
| Morningness versus Eveningness | 30 |

Note: Morning condition (10am to 2pm interval for twenty minutes), 6500 K or 440 lux Afternoon condition (4pm to 8pm interval for twenty minutes).




Note: 1 = very much so, 2 = somewhat, 3 = neutral,4 = Not so much, 5 = not at all.

Figure 1. Ratings by day.

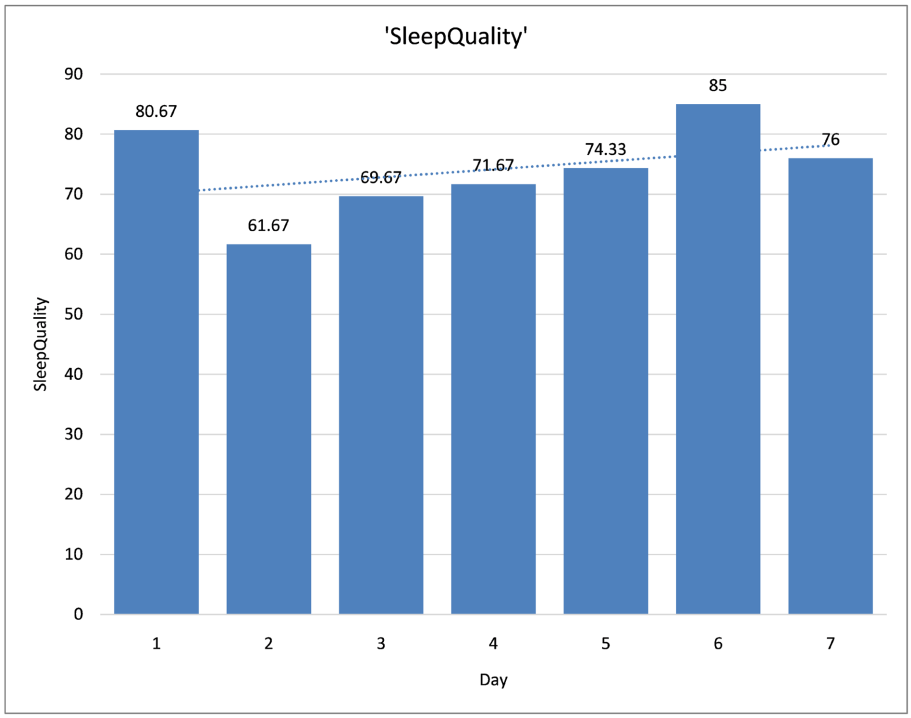



**Figure 2.** Average sleep quality by day.

## 5. Conclusion

We find that despite the small sample size and short sampling interval, a determination of favorability of the use of lighting levels by the participants was evident. The increased sleep quality substantiated the hypothesis as well. Sleep quality was improved sleep knowledgeable and sleepy sample of young adults. The participants' rating of increased calmness and increased focus following a lighting interval suggest the utility of light alteration to facilitate greater sleep quality. In future studies, specificity to lighting level that are optimal for inducing calmness and for increased focus will be explored. The participants reported a lifestyle, an average of excessively bright light for extended periods of time, seemingly from lecture halls, laboratories and overhead lighting in the residence hall rooms. Better vision care in terms of awareness and education will be included in future studies for all participants.

## 6. Recommendation

We have the following recommendations based on the findings in our study: (1) Future study with larger sample size and extended to one month of sleep log collection is planned to more thoroughly test the aim of the utility of varying light levels on sleep quality; (2) Additional exploration of lighting levels for both a focus and a calm condition, in addition to repeating the use of the levels used in this study is underway so as to provide further evidence of selected lighted levels; and (3) More exposure to natural light and less to LED lighting of high intensity of residence hall room overhead light, classroom and laboratories is recommended

as the surprisingly sparse amount of natural light that young adults reported was conducive to good sleep health.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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