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A Study of Critical Flicker Fusion Frequency among Individuals Exposed to Artificial Light from Electronic Gadgets

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Abstract

Background: The critical flicker fusion frequency (CFF) is the frequency at which a flickering stimulus is perceived to be steady, with higher values suggesting greater perceptual accuracy. Measurement CFF has been used to evaluate the processing speed of central nerves system and the coordination between the sensory and the motor systems. Exposure to LED light from smart phones causes sleep disorders. Lack of sleep affects alertness, concentration, memory leading to later developing anxiety disorders, depressive illness, and substance abuse. Hence the current study is designed to estimate CFF exposed to artificial light from electronics.

Materials & Method: Fifty young healthy subjects not exposed to the artificial light from electronic gadgets (group I) & fifty age and sex matched subjects exposed to the artificial light from electronic gadgets (group II) in the age group of 18 -38 years were included for the study. Informed consent was taken from the participants. Critical fusion frequency was recorded. Sleep quality, pattern & daytime sleepiness were assessed by questionnaire.

Results: CFF in group I (38.33 ± 0.98) Hz was significantly higher at 95% confidence interval than higher than in group II (36.65 ± 0.71) Hz, $p < 0.001$. CFF was positively and significantly correlated with the duration of electronic gadget usage.

Conclusion: CFF was higher in not exposed to the artificial light from electronic gadgets than subjects exposed to artificial light.

Keywords: *Artificial light, CFF, Sleep, Electronic gadgets.*

Introduction

Global warming and industrialization has affected public health. Modern world has explored a popularity of hand-held digital devices. The advent of electronic devices has significantly impacted on the sleep-wake patterns because of the LED light. Melatonin, which is a hormone produced during dark, helps to regulate & promote sleep. People who do not have enough melatonin of the hormone take longer to fall asleep. Sleep at night is essential for good health. Lack of sleep can affect alertness concentration memory leading to problems at study/work place. Exposure to artificial light from electronics disrupts sleep pattern, causes decreased melatonin and difficulty falling asleep.

The critical fusion frequency (CFF) is the frequency at which a flickering stimulus is perceived to be steady, with higher values suggesting greater perceptual

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accuracy. Measure of CFF has been used to evaluate the processing speed of central nerves system and the coordination between the sensory and the motor systems. So CFF measurement is useful in studying the cognitive function, neurological deficit and also in psychological illness.[1-3] Hence the current study was designed to record CFF among individuals exposed to artificial light from electronics and not exposed individuals.

Materials & Method

The study was conducted in a sample of fifty young healthy subjects exposed to artificial light from electronic gadgets of both sex and fifty young healthy subjects not exposed to artificial light in the age group of 18-38 years. Informed consent was taken from all the participants who volunteered for the study. The study was approved by Institutional Ethical Committee.

Inclusion criteria [Group 1]:

1. Fifty normal healthy subjects of either sex between 18 and 38 years not exposed to artificial light from electronics.

Inclusion criteria [Group 2]:

1. Fifty normal healthy subjects of either sex between 18 and 38 years exposed to artificial light from electronics for more than 2-3hrs a day.

Exclusion criteria [Group 1 & Group 2]:

1. History of consumption of alcohol/smoking.
2. History of depressive disorders in the past.
3. History of sleep disorders
4. Hypertension
5. Diabetes mellitus
6. History of consumption of drugs acting on CNS

Experimental design: The subjects were selected by a detailed history & thorough physical examination. ***CFF*** was measured by delivering gradually increasing frequency of stimuli. The frequency at which stimuli appear continuous was noted. Also gradually decreasing the frequency of the stimulation, the point at which flickers felt was noted. Mean of such six frequencies was considered as CFF.

CFF was measured using an in house built device. This device can lit a Red light emitting diode (5mm) at different frequencies in the range of 10Hz to 60 Hz (Square wave) with the help of software called as 'Sweepgen'. The subject will be seated in front of the module at near vision distance of 25-30 centimeters in a semi dark room. To begin with the test the Red light is made to flicker at low frequency of 10Hz and the subject is asked to prompt when the flickering stops. Now the frequency is gradually increased in steps of 1Hz. The frequency at which the subject is no longer able to discriminate individual flickers and he starts perceiving it as a single stimulus is recorded & reported as CFF. We can try the same in the decrement order of frequency to identify at what frequency he perceives the flicker.[4]

Statistical Analysis:

The results were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered statistically significant. Statistical analysis was performed using the statistical package for social & sciences. Pearson's correlation analysis was carried out between CFF & artificial light.

Results

The present cross sectional study included Fifty normal healthy subjects in the age group of 18-38 and 50 (24.46 ± 3.89) years, who were not exposed to artificial light from electronic devices (Group I) and fifty normal healthy subjects in the age group of 18-38 (24.78 ± 4.01) years who were exposed to artificial light from electronic devices(Group II). CFF was recorded in both the groups. CFF in group I (38.33 ± 0.98) Hz was significantly higher at 95% confidence interval than higher than in group II (36.65 ± 0.71) Hz, $p < 0.001$.

Discussion

Smart mobile phones are a major cause of distraction in adolescents which deranges psychomotor performance and alertness. Light emitting diode (LED) technology is also increasing in popularity in smart phones and has a high flicker index. Our study evaluates the effect of cellular mobile phone use on hand-eye coordination. Critical Flicker Fusion (CFF) measurement is non-invasive and of good reliability in assessing cortical arousal and a good marker of cortical alteration to physical workload.[5] Flickering light has been shown to have detrimental effects in humans. The

advent of electronic devices has significantly impacted on the sleep-wake patterns because of the LED light.

Normal values of CFF range between 35-40Hz.[6] The higher values of CFF suggest greater perceptual accuracy.[7] Previous studies have included CFF as an integral aspect of hazard perception skill which affects psychomotor abilities and therefore predicts risky behavior.[8-9]

Melatonin, which is a hormone produced during dark, helps to regulate & promote sleep. People who do not have enough melatonin of the hormone take longer to fall asleep. The extent of the response of the circadian clock will depend on how bright the light is and how far the device is from the eyes as well as what color of light are being emitted. Sleep at night is essential for good health. Lack of sleep can affect alertness concentration memory leading to problems at study/work place. Exposure to artificial light from electronics disrupts sleep pattern, causes decreased melatonin and difficulty falling asleep.[10]

Conclusion

CFF was higher in not exposed to the artificial light from electronic gadgets than subjects exposed to artificial light. The use of smart mobile phone has detrimental effects on psychomotor skills. The distraction caused by the use of mobile phones is the main reason for the impairment of psychomotor skills while performing any task.

Conflict of Interest: Nil

Source of Funding: Self

Ethical Clearance: Institutional Ethical Committee

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