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A Study of Critical Flickering Fusion Frequency Rate in Media Players

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Abstract
Aim: This study investigated the effect of video games on Critical flickering fusion frequency rate (CFFFR).

Background: CFFFR is the rate of successive light flashes from a stationary light source at which the sensation of flicker disappears and the light becomes steady. CFFFR with higher values suggested that greater perceptual accuracy. This CFFFR has been used in the studies on physiology of vision, Stress, drug research.

Results: In the present study CFFFR was measured in two age-matched groups of healthy volunteers whose ages ranged from 18 – 45 years with 75 subjects in each group. Test group consists of Media players who were played video games since their childhood. Control group consists of Non-Media players who did not know how to play the video games. The scope of the present study is to know the effect of video games on CFFFR. The results in our study showed that CFFFR threshold increases significantly in media players when compared to non – media players ($p<0.001$).This study also showed that CFFFR significantly decreases as the age increases and high CFFFR threshold were recorded in media players who played puzzle and brain games than the action adventure and sports games. The gender effect on CFFFR was not significant but higher CFFR values were recorded for men than women.

Conclusion: This study proved that playing video games can develop cognitive skills, high level thinking skills, problem solving complex, concentration, logical thinking, imagination and creativity but on the other side teenagers who spend an ample amount of time playing games experience effects which are not so beneficial at all.

Keywords: Critical flickering fusion frequency rate, Media and Non-Media players, Visual processing

Introduction

The Critical Flickering Fusion frequency (CFFF) test measures the rate at which successively presented light stimuli appear to be steady and continuous. This rate, expressed in Hz, is commonly referred to as the “threshold frequency”. Because it provides a measure to distinguish discrete sensory events and also provides an index of central nervous system (CNS) activity or “cortical arousal”. The eye and brain act together to perceive flickering light. The activities in the retina and brain are synchronized as a part of the visual process. If the modulation i.e. flicker frequency is high enough, the visual system will perceive flickering light as a continuous steady light. The CFF is widely used in the study of human behavior, physiology of vision since it can be administered quickly, easily and relatively non-invasive[7]. Various factors that influence CFFF performance includes time of day, sleep deprivation, shift-work, work with visual display terminals i.e. video games, acute effects of substances like caffeine, alcohol, prescribed medication. CFFF performance can also be influenced by age, intelligence and gender. Though many factors influence the CFFF performance, in our study we concentrated more on the effect of video games on CFFFR[8].

In the 19th century, if you asked a teenage boy that what they did in their free time, they'd probably talk about assisting their parents on the work. You ask the same question to a teen in the mid 90’s, and you'll get an answer regarding baseball, cricket, chess, caroms etc. But now we are living in a new millennium, where 97% of children and teenagers would reply 'videogames' to that question[3]. Video games are the most popular and widespread form of entertainment at present. Many video game developing countries earn billions of dollars and constantly invest into research aimed to make virtual reality look like reality. Their games become more and more popular, and they attract a wide audience. The main target audiences of game developing companies are children and teenagers, who actively engaging in video games at such a young age can produce both beneficial and adverse effects[8].

With regards to the positive effects, children playing video games can develop cognitive skills, high level thinking skills, problem solving complex, concentration, logical thinking, imagination and creativity. Furthermore, it has been shown that computer simulation games can improve users' motor skills[10]. Though the Developers of video games claim that first-person shooters and real-time strategies put focus on reflexes, enhance concentration and muscle timing, in reality, teenagers who spend an ample amount of time playing games experience effects which are not so beneficial at all[10].

Negative effects includes that there is a possibility of the loss of sight and visual fatigue. Spending hours on the computer or in front of the TV and playing video games is one of the main causes of blurred vision within teenagers. It is also seen that neglecting healthy physical activities in favor of video gaming may become a risk factor for obesity. Mental health can also be affected by engaging in video games at an early age. This indicates addiction and out of mind behavior. It is a well-known fact that many gamers suffer from addiction, which is almost similar to narcomania or alcoholism. This out of mind behavior can be caused by violence in video games. Many research studies indicated that children and teenagers who play violent video games tend to be more aggressive[4].

With this knowledge, the present study was conducted with the following aims and objectives: 1) To assess the effects of video games on the Critical flickering fusion frequency rate in media players and compare the results with controls i.e. non-media players. 2) To assess the age and gender based alterations on CFFR. 3) To compare the CFFFR threshold values between Puzzle, brain games and action adventure sports games.

Materials & Methods

This study was undertaken by me on behalf of Department of Physiology, Narayana Medical College. The approval Medical ethics committee of Narayana Medical College, Nellore was taken for this "Study of Critical Flickering Fusion Frequency Rate in Media Players". Subjects were selected from Physiotherapy students, Medical lab technology students, teaching and non-teaching staff of Narayana medical college, aged between 18 to 45 years, who volunteered to take part in the study. The procedure was explained and written consent was obtained from the subjects. All the subjects are healthy volunteers and divided them into two groups i.e. media players and non-media players based on questionnaire regarding age, sex, spending time with video games in a day, watching length between the eyes and the television screen, subjective symptoms of eye strain, changes of visual acuity and video game playing for various categories of games (action, fighting, strategy, fantasy, and sports games). All subjects had normal vision or corrected vision and none of them had colour blindness[6].

CFFFR was measured with a standard electronic module designed by Dr.K.N.Maruthy Professor in Physiology Department, Narayana Medical College, Nellore. In this module, the system presents a series of Red light stimuli at different frequencies adjusted from 12 – 120 Hz with the help of SweepGen software. This red light stimuli was surrounded by a white background. After a short practice phase, each participant was seated in front of this module i.e. 80 cms from the stimulus in a semi-dark room with a single 40-w bulb fixed behind the participant. Once all the pre-requisites were done, the frequency of flicker was gradually increased from minimum threshold of 12 Hz till the participants reported that they perceived successively presented light stimuli to be "constant" or "fused" or "steady". Performance data was obtained automatically from SweepGen. Data corresponding to the output variable "last frequency presented" were analysed. This provides an indication of the "critical" frequency, i.e. the highest frequency at which participants are unable to perceive flickering.

SweepGen is a lightweight and portable application that turns a PC into an Audio Oscillator and Sweep Generator which can be used for testing audio or educational purposes. In conjunction with audio test instruments, you can make frequency response plots. SweepGen uses the sound card in your PC to produce sine waves that are mathematically correct almost to CD quality, indeed it's more likely that the quality of your PC sound card will be the limiting factor rather than the code in SweepGen[13].

Results

The results of the above tests were compared between the media and non-media players. Values are expressed as mean ± SEM in the tables. The comparison of results was also done between two groups according to the age, gender and Type of games

Table-1, CFFFR threshold values are high in Media players when compared to Non-media players and these values are highly significantly ($p<0.0001$).

According to Table-2, CFFFR threshold values gradually decreases as the age increases.

Table-3 shows that CFFFR threshold values are slightly higher in males when compared to females and these values are statistically not significant (p value - 0.176126)

Table-4 shows CFFFR threshold values are more in media players playing puzzle and education games than Action adventure sport games. These values are statistically significant with a p value of 0.0052.

Discussion

The Critical flicker fusion threshold is an interesting concept in the psychophysiology of vision. CFFF specified that the frequency at which an intermittent light stimulus appears to be completely steady[1]. Flicker fusion threshold is related to persistence of vision. It's an important phenomenon in daily routine surrounding us as many display and lighting technologies work by displaying very brief flashes of light several times a second. This includes the incandescent light bulb, fluorescent lights and cathode ray tubes (CRTs, the bulky glass tubes in old TVs). The critical fusion frequency depends on the luminance of the stimulus and its size. For a large high luminance stimulus, flicker fusion occurs at about 60 Hz[2].

The present study showed a statistically significant increase in critical flickering fusion frequency rate in media players when compared to non-media players. This increase in CFFF in media players indicates an increase in visual sensitivity. Some previous studies also showed some positive effects that the video game playing would shorten reaction time, develops motivation and enhance visual attention[5]. However, some negative effects were also reported. Negative effects include eye fatigue, mental stress etc. Furthermore, the interaction of video games in media players significantly increases the CFFF as shown in Table 1 and Figure 2. The effect of game type was significant in all the media players as shown in Table 4 which reveal that the change in CFF for playing the puzzle and educational games was almost higher than that of playing the action adventure and sports games. The intensive and exciting puzzle and educational games caused the subjects to

allocate more mental resources into visual attention and thus increased visual sensitivity which in turn increases the CFFFR. It seems that the exposure to the more dynamically changing images, numbers and moving objects while playing the intensive puzzle and educational games induced a higher level of cognition, concentration and visual attention. The prolonged attention and fast reaction required in playing the intensive and exciting puzzle and educational games resulted in a higher CFFF values. Additional, playing action adventure and sports games also showed good CFFFR threshold values[2].

We have shown that CFFFR can be significantly elevated in media players. These changes in CFFF co-occur with improvements of motion-direction sensitivity, which results from plasticity in visual areas. In addition, this plasticity is long lasting and is retained for years. Several research studies indicated that magnocellular ganglion cells of visual system show phasic activity that correspond well to heterochromatic flicker fusion thresholds of humans. On the other hand, the LGN (lateral geniculate body, a major nuclei in visual pathway through which optic radiation passes to visual cortex) can respond to flicker at rates approaching 100 Hz indicate that the retina is not rate limiting for luminance flicker fusion[3]. The specialized cells in magnocellular brain areas are also responsible for activating specific apparent movements react to inputs of high temporal frequencies. In addition, occipital lobe processing was also required to detect relatively high-frequency flickering stimuli.

In media players perceptual learning is the key concept in the elevated CFFFR values. The underlying mechanism of the perceptual learning is the plasticity. Some studies showed that sensory plasticity occurs through a strenghtening-learning signal. This learning signal is likely mediated by neurotransmitters such as acetylcholine and catecholamines like norepinephrine, dopamine which are widely released from subcortical brain areas in a task-specific manner and have been implicated in neuronal plasticity[5]. In media players, these reinforcement learning signal results in plasticity of neurons that are active for longer periods.

In our study we also focused on age and gender based alterations on CFFFR. There is a significant difference in the CFFFR values between young and old age (Table 2). According to our study as the age advances CFFF threshold values gradually decreases. The decrease in CFFF in old age is probably due to the degeneration of the optic nerve and cerebrum. Table 3 reveals that CFFFR threshold values are slightly higher in males than females and this gender effect on CFFF was not statistically significant[11]. Our study also indicated that males prefer to play the more intensive challenging games, and hence the engagement and participation tend to be higher when playing the boxing game. Obviously, females prefer the competitive but less exhaust games, and hence they have a more concern and participation in playing the tennis game. The findings in our study correlated with the study conducted by Aaron R. Seitz et al[1].

Tables and Figures

Table 1: Comparison of CFFFR threshold values in Media and Non-media players

Parameter	Media players (n=75)	Non – media players (n=75)	P value
CFFFR threshold values in Hz	48.71 ± 0.3432	42.10 ± 0.2617	< 0.0001***

Table 2: Comparison of CFFFR threshold values in different age groups

Age in Years	CFFFR threshold values in Hz
18 - 21 years	47.84
22 - 26 years	46.63
27 - 31 years	44.85
32 - 35 years	43.63
36 - 39 years	40.42
40 - 43 years	39.46
44 - 45 years	38.38

Table 3: Comparison of CFFFR threshold values in Males and Females

Parameter	Males	Females	P value
CFFFR threshold values in Hz	38.8	37.2	0.176126 NS

Table 4: Comparison of CFFFR threshold values in type of game

Parameter	Puzzle and Educational games	Action, Adventure and Sports games	P value
CFFFR threshold values in Hz	49.29 ± 0.1893	48.45 ± 0.2263	0.0052**

Figures

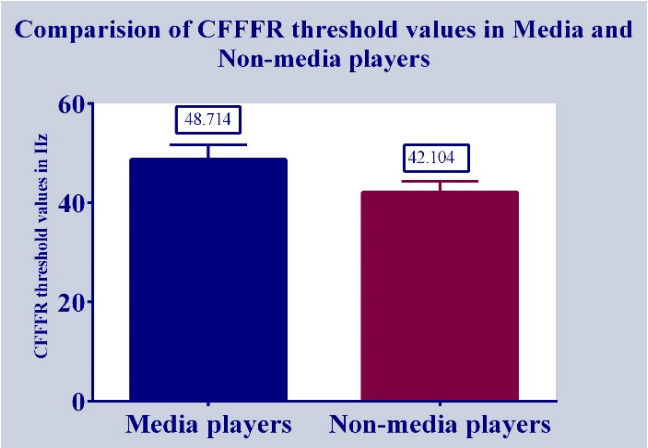

Fig 1: Comparison of CFFFR threshold values between Media and Non-media players

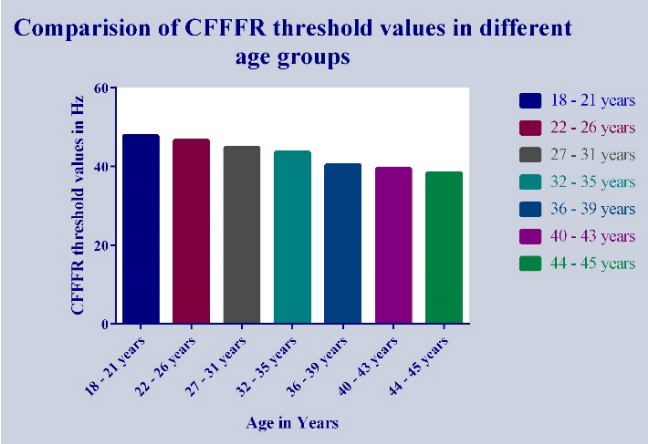

Fig 2: Comparison of CFFFR threshold values in different age groups

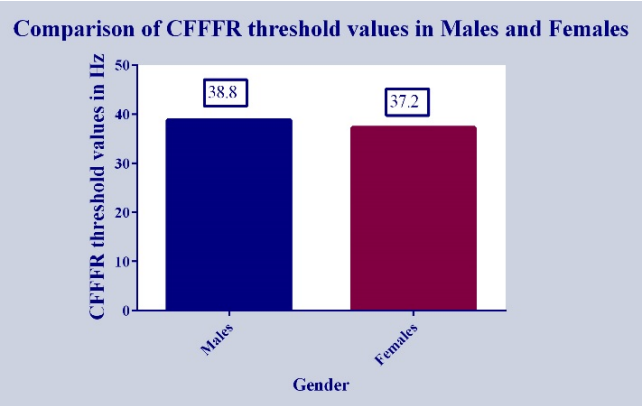

Fig 3: Comparison of CFFFR threshold values in males and females

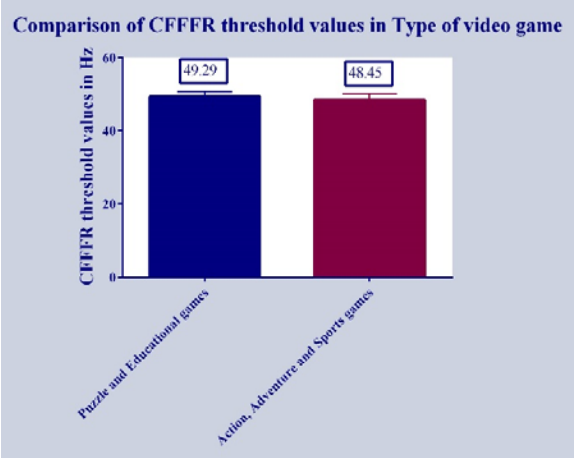

Fig 4: Comparison of CFFFR threshold values in type of video game

Conclusion

The primary contribution of this study is to gain more information regarding critical flicker fusion frequency (CFFF). CFFF is an easy quick and Non-invasive technique used as a general indicator of cortical processing, visual persistence and perceptual learning. Some findings from this study are as follows:

1. CFFFR threshold values are high in Media players when compared to Non-media players and these values are highly significantly ($p<0.0001$)
2. CFFFR threshold values are more in media players playing puzzle and education games than Action adventure sport games.
3. CFFFR threshold values gradually decreases as the age increases.
4. CFFFR threshold values are slightly higher in males when compared to females and these values are statistically not significant

Final conclusion - In media players, playing action video games improves acuity and contrast sensitivity, as well as enlarging the useful field of view, improving the number of moving objects that can be tracked simultaneously, and enhancing selective attention.

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Competing interests The Authors declare that they have no competing interests

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