

# A Comparative Study of Cognitive Functions among Male and Female Medical Students in a Teaching Hospital of South Kerala

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## Abstract

**Background:** Reaction time (RT) is a measure of the response to a stimulus. RT plays a very important role in our lives as its practical implications may be of great consequences. Factors that can affect the average human RT include age, sex, left or right hand, central versus peripheral vision, practice, fatigue, fasting, breathing cycle, personality types, exercise, and intelligence of the subject.

The Critical Flicker Fusion frequency (CFFF) test provides an index of central nervous system activity or cortical arousal which measures mental arousal and alertness. It is used as an indicator of physical human fatigue, mental work load and cognitive function as well.

**Aim:** The aim was to compare visual reaction time (VRT), auditory reaction time (ART) and critical flicker fusion frequency on the basis of gender.

**Materials and Method:** The present comparative study was conducted on 100 healthy medical students in age group of 18–24 years. PC 1000Hz reaction timer was used to measure auditory and visual reaction time. The task was to press the key as soon as the stimulus is presented. Three readings of each stimulus were taken, and their average of three RT's for each stimuli were recorded. Statistical analysis was done using independent sample t test. CFFF was measured by indigenous apparatus. Both ascending and descending frequencies are recorded and average of two is taken as CFFF.

**Results:** In both the sexes' RT to the auditory stimulus was significantly less ( $P < 0.001$ ) as compared to the visual stimulus. Significant difference was found between RT of male and female medical students ( $P < 0.001$ ) and males have quicker reaction time than females. Males have higher CFFF than females, but statistically not significant.

**Keywords:** Reaction time, Auditory reaction time, Visual reaction time, Critical flicker fusion frequency.

## Introduction

Reaction time (RT) is a measure of the quickness with which an organism responds to some sort of stimulus. RT is defined as the interval of time between the presentation of the stimulus and appearance of appropriate voluntary response in the subject<sup>(1)</sup>

Reaction time (RT) testing is one of the oldest diagnostic method used in modern psychology, and is known as simple and sensitive cognitive function test<sup>(2)</sup>.

Reaction time has physiological significance and is a simple and non - invasive test for peripheral as well as central neural structures<sup>1</sup>. Reaction time measurement is an indirect index of processing capability of central nervous system. Reaction time measurement helps in determining sensory motor association and performance of an individual. It determines the alertness of a person because how quickly a person responds to a stimulus depends on his reaction time<sup>(3)</sup>

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Out of these various factors, in this study we have studied the time taken between application of visual stimulus and auditory stimulus and response obtained and comparison of the response in boys and girls volunteer.

Reaction time involves three phases as follows: a) processing of the stimulus, b) making decision about it and c) programming a response. Therefore, RT measurement includes: 1- The sensory neural code latency traversing both in central and peripheral pathways, 2- Both cognitive and Perceptive processing, 3- A motor signal traversing both peripheral and central neuronal structures 4- And eventually the latency in the end effectors activation such as muscle activation<sup>2</sup>

Human RT works by having a nervous system recognize the stimulus. The neurons then relay the message to the brain. The message then travels from the brain to the spinal cord, which then reaches person's hands and fingers. The motor neurons directs the hands and fingers how to react. RT in response to a situation can significantly influence our lives due its practical implications. Fast RTs can produce rewards (e.g. in sports) whereas slow RT can produce grave consequences (e.g. driving and road safety matters).<sup>(1)</sup>

In the literature very few studies can be found determining RTs in medical students. Thus, this study was conducted to scientifically contribute to the field of RT, the difference if any to RTs between the two sexes.

Critical flicker fusion frequency (CFFF) is the frequency at which an intermittent light stimulus appears to be completely steady to the observer (As defined by Encyclopedia of psychopharmacology). It is the frequency at which the lowest level of continuous flicker is perceived as steady source of light. The flickering light will reach the retina based on temporal processing of visual stimulus. Temporal resolution of flickering stimulus is often limited by brain, so CFFF is used to assess the Cognitive function, CNS arousal in neurology & pharmacology. Normal CFFF value is 35-40 Hz. If the frequency at which frames are displayed in a film falls below the CFFF, the image will be perceived as jerky. Sub threshold intermittent light is perceived as flicker, if the flicker frequency is increased the flickering gradually becomes less distinct until it is no longer perceived as flickering but as steady source of light.<sup>(4)</sup>

So the present study aims to compare the reaction time and CFFF between male and female medical students.

## Material and Method

**Study design:** observational study.

**Sample size:** 50 male and 50 female (Total -100) MBBS students were randomly selected from their respective batch register.

**Sampling method:** Simple Random sampling

**Intervention:** Nil

A brief explanation regarding the purpose of study and cognitive tests was given to the subjects. They were explained in detail about the procedure to be performed in their vernacular language. Informed consent was taken from all the participants. Complete history is obtained and clinical examination was done. Auditory and visual screening was carried out on the subjects to rule out any auditory or visual impairment

**Cognitive function tests:** Audio visual reaction time, Critical flicker fusion frequency.

The auditory and visual reaction time is measured among males and female medical students in a quiet secluded room, whose ambient temperature is about 27°C, using the PC1000Hz reaction timer with their right upper limb, from 10am -12 noon for the subjects.

**Study tool:** Indigenously built reaction timer device, CFFF apparatus and a personal computer with Audacity software.

Device used – Indigenously built reaction timer device and a personal computer is used to measure audio visual reaction time.

**Reaction Timer:** The device is a PC1000 reaction timer<sup>6,7</sup> to measure Auditory and visual reaction time. PC1000 is a 1000 hertz square wave oscillator which has a soft key for 'start' and 'stop' function. This instrument has two components (A&B) connected to each other. Component (A) has a start button and it will be handled by the examiner only, second component (B) has a stop button which will be handled by the subject which is small red LED since Red light persists for a long time in retina & head phone (1000Hz tone) which receives the Visual & Auditory stimulus respectively. These two components are connected to a Personal computer which has audacity software installed in it. Audacity software records the reaction time in 0.001sec accuracy in wave format.

**Visual Reaction Time(VRT) Measurement:** when the examiner press the ‘start’ button in the component (A) which will be out of the view of the subject and the subject was instructed to press the ‘Stop’ button in component (B) with the right index finger first as soon as he/she sees the red light in the instrument. Reaction time was recorded in audacity software.

**Auditory Reaction Time (ART) Measurement:** When the examiner pressed the ‘start’ button which will be out of the view of the subject and the subject was instructed to press the stop button with the right index finger first as soon as he hears the sound (1000 hertz’s tone) through the head phone connected to it. Reaction time was recorded in Audacity software.<sup>(3)(9)</sup>

Minimum three trials were given for both VRT and ART measurement. Average of three recordings was calculated as final VRT and ART.

**Recording of CFFF**

**Instrument:** CFFF measuring instrument is a Portable device,<sup>(10)</sup> in-house built LED based instrument. Monochromatic red LED light of wave length 630nm, fixed on white back ground is used as flickering light source. Frequency adjustment done by software based variable frequency square wave oscillator (10-50 Hz). Frequency measured from the recorded data using audacity software.<sup>(4)</sup>

**Procedure:** Subject was asked to relax and tested in a minimally illuminated room, with the CFFF measuring device kept at a distance of 30cm. Subjects were properly instructed, asked to respond by lifting the hand

and tested by increasing and decreasing the frequencies. When the frequency is increased, at one point the flickering stops and light is perceived as a steady source. If the frequency is decreased from higher levels at one point flickering appears. Both ascending and descending frequencies were recorded and the mean of the two is taken as CFFF<sup>4,6</sup>.

**Results**

**Table 1: Comparison of mean VRT(ms) between Male and Female Medical students**

Gender	N	Mean	SD	t value	p value
Male	50	206.318	6.1411	5.487	0.001*
Female	50	217.923	13.6358		

\*Statistically significant p<0.05

**Table 2: Comparison of mean ART(ms) between Male and Female Medical students**

Gender	N	Mean	SD	t value	p value
Male	50	161.998	7.1273	4.217	0.001*
Female	50	169.624	10.6170		

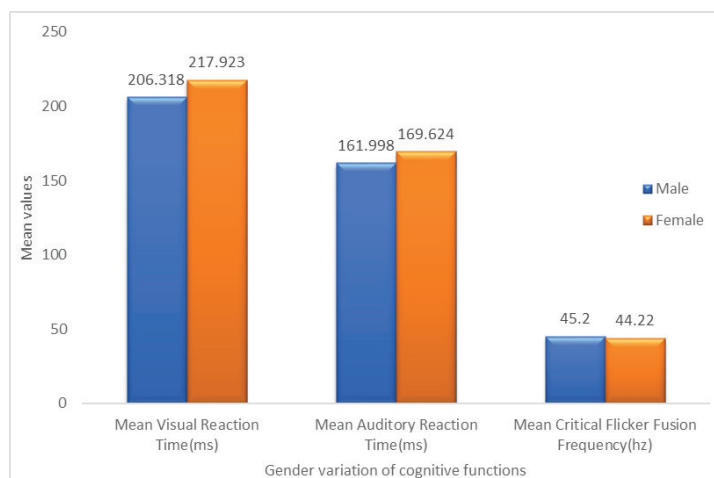
\*Statistically significant p<0.05

**Table 3: Comparison of mean CFFF(Hz) between Male and Female Medical students**

Gender	N	Mean	SD	t value	p value
Male	50	45.2000	2.14999	1.887	0.062
Female	50	44.2200	2.97637		

\*Statistically not significant p>0.05

**Independent Sample t test**



**Graph 1**

## Discussion

The study was conducted among 100 healthy medical students to study the VRT and ART and how do they vary on the basis of gender, and sedentary and regularly exercising healthy students.

Table 1 and Table 2 shows that both VRT and ART are less in males as compared to females and found to be statistically significant.

Table 3 reveals that CFFF values are slightly higher in males than females and this was not statistically significant<sup>(4)(6)(7)</sup>.

A review of the literature on the influence of gender on RT shows that in almost every age group, males have faster RTs as compared to females. Researches done by Misra *et al* also showed that males responded faster than females<sup>(2)</sup>. Study done by Shelton and Kumar<sup>(12)</sup> Nikam and Gadkari also reported similar findings to support females have longer RTs than males<sup>(13)</sup>. The results of our study agree with these studies and indicate that male medical students have faster RTs when compared to female medical students for both auditory, as well as visual stimuli.

The male-female difference is due to the lag between the presentation of the stimulus and the beginning of muscle contraction. It is documented in the literature that the muscle contraction time is the same for males and females and motor responses in males are comparatively stronger than females, this explains why males have faster simple RTs for both auditory as well as visual stimuli. Now a days the male advantage is getting smaller, possibly because more women are participating in driving and fast-action. Longer reaction times in females could be attributed to fluid and salt retention due to female sex hormones affecting sensorimotor coordination.<sup>(1)</sup>

Our observations are consistent with the observations of the other workers who observed that females had a longer reaction time when compared to males.<sup>(10)(11)</sup>. Bruce and Russel (1962) explained it on the basis of varying level of sex steroids during different phases of menstrual cycle which have sodium and water retaining effect<sup>(5)(8)(1)</sup>. This retention of salt and water could modify the axonal conduction. It is also suggested to alter the availability of the neurotransmitter at the synaptic level. This modulation of neurotransmitter coupled with altered rate of impulse transmission due to

fluctuation in the levels of hormones affect the sensory motor association with the processing speed at the Central Nervous System<sup>(1)(8)(11)</sup>

## Conclusion

Males have faster reaction time when compared to females due to strong motor responses. Females have long reaction time when compare to males due to salt and water retention affecting sensory motor coordination. CFFF is higher in males than compared to females but statistically not significant.

**Conflict of Interest:** No

**Source of Support:** Self support

**Ethical Clearance:** Ethical clearance has been taken from institutional ethical clearance committee.

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