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RESEARCH ARTICLE

COMPARISON OF HAND AND FOOT REACTION TIMES AMONG FEMALES- A METHODOLOGICAL STUDY USING RECOGNITION AUDITORY REACTION TIME

***,[1]Dr. Grrishma, B., [2]Dr. Gaur, G.S., [2]Dr. Velkumary, S., [3]Dr. Gurunandan, U., [1]Dr. Aswini Dutt and [4]Dr. Dinesh, T.**

[1]Department of Physiology, Yenepoya Medical College, [Affiliated to Yenepoya University], Mangalore, India
[2]Department of Physiology, Jawaharlal Institute of Post Graduate Medical education and Research, [Affiliated to Institute of National importance under the Ministry of Health and Family Welfare], Puducherry, India
[3]Department of Surgery, Yenepoya Medical College, [Affiliated to Yenepoya University], Mangalore, India
[4]Vinayaka Mission's Medical College, Karaikal, [Affiliated to Dr. MGR University], Tamil nadu, India

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ABSTRACT

Reaction time is a simple means of determing the sensorimotor performance of an individual. It has been more widely used as an objective method in experimental procedure in field of data processing. Auditory recognition reaction time is a type of reaction time and it plays a very important role while driving vehicles. Previous studies were mainly on simple and choice reaction time and there are very less studies on recognition reaction time. The aim of our study was to compare the dominant hand recognition reaction time with that of foot. The present study was conducted in department of Physiology, JIPMER, Puducherry on 60 healthy female volunteers. After giving adequate practice, hand and foot recognition auditory reaction time were recorded using Reaction Time Machine (RTM 608, Medcaid, Chandighar). The result showed auditory recognition reaction time was significantly more for foot when compared with hand. This could be because of difference in nerve conduction velocity and movement time of the hand when compared with that of foot.

INTRODUCTION

The problem of the reaction time of man appeared in the science in the forties of the last century. The first researches were by Herman Hemlholtz who worked on determining the speed of impulse conducting through the nerve fiber, which is a component of reaction time. He offered a method for determination of that speed. In the well-known experiments of his, Helmholtz stimulated first one point of the nerve near to the muscle, and then another point far from the muscle. The difference between the time intervals from the stimulation to the muscle contraction in those two situations is the time needed for the conduction of the nerve impulse from the first to the second point. Later further experiments were done to study the time taken for a specific response and were called reaction time (Obrenović *et al*., 1996). Reaction time also named response time or response latency is a simple and probably the most widely used measure of response in time units (usually in milliseconds). It is the time interval from the stimulus or the complex of the stimulus presentation to the moment of giving the motor response. It reflects the speed of the flow of neurophysiological, cognitive and information processes which are created by the action of stimulus on the person's sensory system. The receipt of information, its processing, decision making and giving the response - execution of the motor act are the processes which follow one another and make what we call the reaction time. Reaction time involves stimulus processing, decision making and response programming and execution (Madan *et al*., 1984; Malathi *et al*., 1990; Baayen and Milin, 2010). Reaction time provides an indirect index of the processing capability and biological efficacy of the central nervous system. Reaction time is a simple means of determining sensorimotor performance of an individual (Das *et al*., 1997; Bottwinick *et al*., 1996). Reaction time has been widely studied, as its practical implications and may be of great consequence. Slow reaction or an increased reaction time while driving can have grave results. Reaction time has been more and more used as an objective method in the experimental procedure in the field of data processing (Obrenović *et al*., 1996). Many factors have been shown to affect reaction times, including age, gender, physical fitness, level of fatigue, distraction, alcohol, personality type, limb used for test, biological rhythm, health and whether the stimulus is auditory or visual (Baayen and

Corresponding author: Dr. Grrishma, B.,
Department of Physiology, Yenepoya Medical College, [Affiliated to Yenepoya University], Mangalore, India

Milin, 2010). Reaction time is independent of social-cultural influences. Slowed performance is usually accompanied by prolonged simple reaction time (Shah *et al*., 2010). There are 3 different types of reaction time experiments, simple, recognition and choice reaction time experiments. In addition, there are many others reaction time which can be obtained by combining three basic reaction time experiments. In simple reaction time experiments, there is only one stimulus and one response. In choice reaction time experiments, there are multiple stimuli and multiple responses, the user must give a response that corresponds to the stimulus. In recognition reaction time experiments, there are some stimuli that should be responded to (the 'memory set'), and others that should get no response (the 'distracter set'). There is still only one stimulus and one correct response (Miller and Low, 2010; Kosinski, 2013). It was reported that the time for motor preparation (e.g., tensing muscles) and motor response was the same in all three types of reaction time tests, implying that the differences in reaction time are due to processing time (Baayen and Milin, 2010; Miller and Low, 2010).

The recognition reaction time can be studied by using visual inputs or by using auditory inputs. When studied using auditory inputs it is called as auditory recognition reaction time. The components of auditory recognition reaction time are 1) Mental Processing Time- which includes sensation (the time it takes to detect the sensory input from an object), perception/recognition of sensation, memory scanning response selection and programming, 2) nerve conduction time, 3) movement time and 4) device response time (Green, 2000; Gordon *et al*., 2004; Kirsner and Kim, 1972). Reaction time is faster when the dominant limbs both hand and foot are used when compared with the opposite side (Misra *et al*., 1985). Auditory recognition reaction time using the dominant limbs was studied. Reaction time is faster in men compared with women (Misra *et al*., 1985; Seashore *et al*., 1941). For uniformity, we had analysed the auditory recognition reaction time on 60 female subjects. Most of the studies were based on simple and choice reaction times and there are not many studies comparing the auditory recognition reaction time of hand with foot.

Aim of The Study

To compare the recognition auditory reaction of the dominant hand with that of foot of 60 healthy undergraduate female subjects.

MATERIALS AND METHODS

The study was conducted in department of Physiology, JIPMER, Puducherry. Prior to commencement of study approval of JIPMER scientific advisory committee and ethics committee was obtained. Sixty normal healthy female volunteers without hearing defects were recruited for the study. Auditory recognition reaction time of hand and foot were compared. All tests were carried out in Autonomic function testing laboratory in the department of Physiology, JIPMER between 3.00 pm to 5.00 pm. The laboratory environment was quite, the temperature maintained between 22-25^{0}C and lighting subdued. The participants were explained in detail about study protocol and written informed consent was obtained from them. The subjects were advised to have lunch at 1.00 pm and come for tests at least two hours after lunch with empty bowel and bladder. The subjects were instructed to avoid caffeine and nicotine 12 hours before, sympathomimetics and parasympathomimetic agents 48 hours prior to study, psychotropic drugs (sedatives, hypnotics and tranquillers) and antihistamines prior to the study. The parameters were recorded 5-8 days after menstruation. The anthropometric measurements were taken. Subject's height was measured to the nearest millimeter by a wall mounted stadiometer. Weight was measured with an electronic weighing scale (Microgene, New Delhi) with LCD with accuracy of ± 0.1 kg. BMI was calculated by Quetelet's index that is weight / [height] ^{2}; weight in kg and height in meters. Auditory reaction time were done in subjects using reaction time machine (RTM-608, Medcaid systems, Chandigarh) with resolution of 0.001 sec, accuracy ±1 digit and has 3 different light red, green and yellow and 3 different sound-high, medium and low pitch sounds. The subjects were instructed about the procedure and after adequate practice the subjects were asked to keep their index finger of the dominant hand on the centre button for hand reaction time followed by right foot on the leg peddle for foot reaction time. Three different sounds of high, medium and low pitch were produced and the subjects were asked to respond to medium pitch sound and the reaction values were directly read from digital display.

Statistical analysis

Ten values of auditory reaction time were recorded, two lowest and two highest values were deleted and the average for the middle six values were calculated. The data was summarized by using descriptive statistics such as mean and standard deviation. The student's paired t-test was used for analysis. P<0.05 was considered statistically significant.

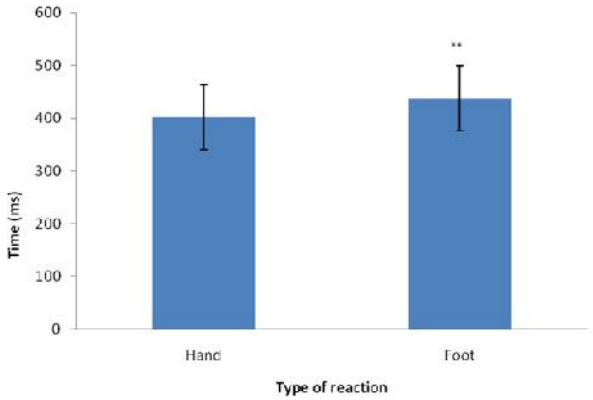
RESULTS

Sixty female subjects with the mean age group of 19.23±0.86 yrs, with average weight 52.24±9.09 kg. Their mean BMI was 21.4±3.57kg/ m^2 (Table 1).

Table 1. Age and anthropometeric measurements of the subjects

Parameters	Study group (n=60)
Age (years)	19.23±0.86
Weight (kg)	52.24±9.09
Height (cms)	156.81± 4.37
BMI (kg/m^2)	21.40±3.57

Values are expressed as Mean±SD. BMI: Body Mass Index



Values are expressed as Mean±SD, analysis was done by Student 's paired *t* test. ms: milliseconds, * P< 0.05 ; ** P< 0.01 ; *** P< 0.001.

Figure 1. Comparison of hand auditory recognition reaction time with foot auditory recognition reaction time

When the hand and foot recognition auditory reaction times were compared, it showed recognition auditory reaction time for hand 402.26±61.6 milliseconds was significantly less than foot 438.34 ± 97.48 milliseconds with p value 0.0002. (Figure 1).

DISCUSSION

Recognition reaction time is the time between application of stimulus (memory set) and the response to the stimulus. Recognition reaction time is very important in driving vehicles. Most of the time people drive their vehicles based on the conditioned reflexes, learned through experience but sometimes when unexpected situation arises, like sudden horn from another vehicle from front, whether to apply break or not is an example of auditory recognition reaction time (Dhavalikar *et al*., 2009). The purpose of our study was to compare the recognition auditory reaction of the dominant hand with foot of 60 healthy female undergraduate student volunteers. The finding of our study has revealed that auditory recognition reaction time for foot was significantly more than hand. Auditory recognition reaction time is the sum of mental processing time (which includes sensation, perception/recognition of sensation, memory scanning response selection and programming), nerve conduction time, movement time and device response time (Green, 2000; Gordon, 2004; Kirsner and Kim, 1972). Since the perception of stimuli, response selection and programming and device response time are equal for foot and hand reaction time, the difference could be in nerve conduction time and movement time.

Nerve conduction velocity is speed of impulse conducting through the nerve fiber. Nerve conduction velocity is more in upper limb than lower limb. This could be because of abrupt distal axonal tapering in lower limbs, shorter internodal distance in lower limbs, progressive reduction in axonal diameter in lower limbs and lower temperature in feet when compared to hands (Dhavalikar *et al*., 2009; Pal and Pal, 2010). Also the distance travelled by the motor impulse via nerves from CNS to hand is less than to foot. Once a response is selected, the responder must perform the required muscle movement. The time taken for movement is called movement time (Green, 2000). It was found that execution time for foot movements is generally about twice as long as that for the equivalent arm movement (Hoffmann, 1991). Faster the movement time for hand could contribute to decreased recognition reaction time of hand when compared to foot. So both decreased conduction velocity in lower limb nerves and difference in movement time could have resulted in increased auditory recognition reaction time for foot when compared with hand. We could not separately measure the nerve conduction velocity and movement time to strengthen our findings. In addition to auditory recognition reaction time, the visual recognition reaction time could also be recorded which forms the future scope of our study.

Conclusion

The study results indicated auditory recognition reaction time for foot was significantly more than hand as shown by Student's paired *t* test which could be because of difference in nerve conduction velocity and movement time in both the limbs.

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