

A Comparative Study of Simple Auditory Reaction Time in Blind (Congenitally) and Sighted Subjects

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ABSTRACT

Background: Reaction time is the time interval between the application of a stimulus and the appearance of appropriate voluntary response by a subject. It involves stimulus processing, decision making, and response programming. Reaction time study has been popular due to their implication in sports physiology. Reaction time has been widely studied as its practical implications may be of great consequence e.g., a slower than normal reaction time while driving can have grave results. **Objective:** To study simple auditory reaction time in congenitally blind subjects and in age sex matched sighted subjects. To compare the simple auditory reaction time between congenitally blind subjects and healthy control subjects. **Materials and Methods:** Study had been carried out in two groups: The 1st of 50 congenitally blind subjects and 2nd group comprises of 50 healthy controls. It was carried out on Multiple Choice Reaction Time Apparatus, Inco Ambala Ltd. (Accuracy \pm 0.001 s) in a sitting position at Government Medical College and Hospital, Bhavnagar and at a Blind School, PNR campus, Bhavnagar, Gujarat, India. **Observations/Results:** Simple auditory reaction time response with four different type of sound (horn, bell, ring, and whistle) was recorded in both groups. According to our study, there is no significant different in reaction time between congenital blind and normal healthy persons. **Conclusion:** Blind individuals commonly utilize tactual and auditory cues for information and orientation and they reliance on touch and audition, together with more practice in using these modalities to guide behavior, is often reflected in better performance of blind relative to sighted participants in tactile or auditory discrimination tasks, but there is not any difference in reaction time between congenitally blind and sighted people.

Key words: Auditory reaction time, congenital blind, sighted subject

INTRODUCTION

Reaction time is the time interval between the application of a stimulus and the appearance of appropriate voluntary response by a subject as rapidly as possible.^[1] It is a measure of function of sensorimotor

association^[2] and performance of an individual.^[3] It involves stimulus processing, decision making, and response programming.

Reaction time has been widely studied as its practical implications may be of great consequence, e.g., a slower than normal reaction time while driving can have grave results. Many factors such as physiological, psychological, pharmacological etc., have been shown to affect reaction times. They are age,^[4] sex,^[4,5] gender,^[4,6] handedness,^[7,8] physical fitness,^[9,10] sleep,^[9] fatigue,^[9] distraction,^[9,11] alcohol,^[12] caffeine,^[13] diabetes,^[14] personality type and whether the stimulus is auditory or visual. Reaction time study has been popular due to their implication in sports physiology.^[6]

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The model for information flow within an organism can be represented in this way.^[15-17]

Stimulus → Receptors → Integrator → Effectors → Response

More specific in human, the information flow can be represented in this way.

Stimulus → Sensory neuron → Spinal Cord or Brain → Motor Neurone → Response.

Types of auditory reaction time

- Simple reaction time: One stimulus and one response (Shorter duration)
- Recognition reaction time: 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 correct response (Longer)
- Choice reaction time: There are multiple stimuli and multiple responses. The reaction must correspond to the correct stimulus (Longest duration).

Simple auditory reaction time^[15-18] is the time interval between the onset of the single stimulus and the initiation of the response under the condition that the subject has been instructed to respond as rapidly as possible.

- It evaluates the processing speed of central nervous system (CNS) and coordination between the sensory and motor systems. Reaction time measurement includes the latency in sensory neural code traversing peripheral and central pathways, perceptive and cognitive processing, and a motor signal traversing both central and peripheral neuronal structures and finally the latency in the end effectors activation (i.e., muscle activation)
- Due to its simplicity, it can be assessed in blind participants.^[19,20] Bernard *et al.* pointed out that the most important sensory modalities in the activities of the blind are touch (proprioception) and hearing. For this reason, the possibility that the blind possess a particular sensitivity with reference to touch and hearing is often assumed; it is therefore implied that the blind might be superior to the sighted in tasks in which touch and hearing are the most important performance elements. Bernard *et al.* showing there is no significant difference in reaction time between normal sighted groups and congenitally blind sighted group,^[19] whereas Kujala *et al.*, Neimyese *et al.*, Collignon *et al.* and Naveen *et al.* studies showing significant alteration in the reaction time. Many theories of Cross Modeling Sensory Reorganization or Properties of Plasticity in CNS had been postulated regarding

this superiority. Previous studies in the past on auditory reaction time in blind participants having contradictory findings.^[21]

JUSTIFICATION OF STUDY

Blindness is the functional disorders of sense organs may intensify the remaining senses. It is presumed that blind persons do not only hear better and have an intensified tactile sense but also have a stronger sense of smell. Better hearing ability was demonstrated by auditory evoked potentials, but the auditory reaction time is an ideal tool for measuring the level of sensory motor association.^[22,23]

OBJECTIVES OF STUDY

To study simple auditory reaction time in congenitally blind subjects. To compare the simple auditory reaction time between congenitally blind subjects and healthy control subjects.

MATERIALS AND METHODS

After obtaining ethical clearance certificate from Institutional Review Board, Government Medical College, Bhavnagar, Gujarat, India. We carried out this study in two groups: 1st group comprises of 50 congenital blind and the 2nd of 50 healthy controls. 1st group was containing 42 congenital blind male and 8 congenital blind females. Mean age was 23.56 ± 8.92 years. 2nd group was containing 43 healthy male and seven healthy female volunteers. Mean age was 19.56 ± 6.28 . Study was carried out in a sitting position after taking anthropometric data. It was carried out on Multiple Choice Reaction Time Apparatus, Inco Ambala Ltd. (Accuracy ± 0.001 s) at Government Medical College, Sir T. General hospital and Blind school, PNR campus, Bhavnagar.

Procedures done before obtaining simple reaction time

The detailed information of study to participants and informed written consent was taken before starting the reaction time. Proper preparation of participants was carried out and knowledge on precautions was given to them. The testing procedures were quite simple, non-invasive and harmless from subject's point of view. Subjects were explained and demonstrated about the procedure to be performed. A blindfold was given to participants (both congenital blind and controls) made up from dark black cotton cloth. Index finger of the dominant hand of participant was used on the key to get a response. Same instruction was given to both groups to press the key as soon as they hear a sound. Practice period of three trials with an instrument at

each key (horn, bell, ring, whistle) were given to all participants. They were allowed to do enough practice as reaction time depends on the subject making a maximal alertness. Three times simple auditory reaction time was taken, and out of them fastest response was used for this study. Full series of tests takes time of about 4-5 min. All tests were recorded in sitting comfortable and relaxed position in the chair on before lunch and with no any tight clothing which substantially restricts discomfort. Following precaution was taken during data collection:

- Temperature was maintain between 30°C and 35°C
- Keep kept complete silence and avoids unavoidable voice
- Never set the instrument near any kind of disturbances
- Keep kept proper comfort for study participants.

Statistical analysis

The data were put in Microsoft Excel sheets. The mean and SD were count with the help of Excel. The data between cases and controls were analyzed in graph pad software and by unpaired test with the demo version of Graph pad software.

RESULTS

The present study was undertaken on the sample size containing 50 blind subject and 50 healthy control subjects with applying necessary inclusion and exclusion criteria as mentioned earlier. The subjects of the study group (Congenital blind) were screened with proper taking of history with special reference to history blindness (questionnaire) and with the help of their class teachers at the blind school. They were subjected to clinical examination in detail. The control healthy participants were screen out by proper examination and history taking.

Simple auditory reaction time response with four different type of sound was recorded in both groups.

In this present study, the mean and SD of all four types of sound stimulus are assess. In congenital blind group, simple mean auditory reaction time are slower in horn sound stimulus and bell sound stimulus than control grouped whereas in ring sound stimulus and whistle sound stimulus, simple mean auditory reaction time are faster than the control group [Table 1].

Table 2 shows of simple auditory reaction time response with different type of sound stimulus like horn, bell, ring and whistle by both congenitally blind and normal sighted participants.

By using Graphpad Instat 3 software, unpaired *t*-test

applied for analysis of the data. The $P > 0.05$ for all four type of stimulus. These shows values are no statistically significantly difference between both groups.

Table 3 represents the relationship of body mass index (BMI) with simple auditory reaction time. These values come after statistical analysis. The $P > 0.05$ in all except < 20 BMI group in horn sound, (that is by chance) considered as there are not any significant relation between BMI, and simple auditory reaction time in both group (1st group is < 20 BMI and 2nd group is > 20 BMI).

DISCUSSION

Blind individuals commonly utilize tactual and auditory cues for information and orientation (e.g., auditory

Table 1: Comparison between case and control group

Parameters	Mean (case) n=50	SD (case)	Mean (control)	SD n=50 (control)
Age (years)	19.56	6.28	23.56	8.92
Ht (cm)	156.04	10.3	166.66	9.93
Wt (kg)	46.28	10.82	59.62	17.6
BMI	19.1	4.44	21.49	7.19
Horn (ms)	210.24	90.81	186.92	73.02
Bell (ms)	152.06	56.15	149.66	55.04
Ring (ms)	137.86	67.55	144.56	61.56
Whistle (ms)	151.42	52.57	155.54	54.41

BMI – Body mass index; SD – Standard deviation

Table 2: Comparison of simple auditory reaction time with 4 different types of stimulus

Type of stimulus	Cases (ms), n=50	Controls (ms), n=50	P value	Significant or not
Horn	210.24±90.812	186.92±73.017	0.1602	NS
Bell	152.06±56.148	149.06±54.044	0.8493	NS
Ring	137.86±67.148	148.52±58.496	0.4010	NS
Whistle	151.42±52.57	155.54±54.411	0.7010	NS

NS – Not significant

Table 3: Relation of simple auditory reaction time with BMI of both groups

BMI group	Congenital blind (ms)	Control (ms)	P value
Horn			
<20 (mean±SD)	228.22±80.76	179.5±98.98	0.0211
>20 (mean±SD)	189.13±98.57	191.87±85.95	0.916
Bell			
<20 (mean±SD)	165.89±62.99	146.2±46.70	0.223
>20 (mean±SD)	135.83±42.17	152.47±59.35	0.241
Ring			
<20 (mean±SD)	139.48±53.20	149.75±49.53	0.4691
>20 (mean±SD)	135.96±82.10	147.7±67.55	0.5821
Whistle			
<20 (mean±SD)	164.22±58.67	153.75±38.3	0.4634
>20 (mean±SD)	136.39±46.80	156.73±63.54	0.1637

BMI – Body mass index; SD – Standard deviation

pedestrian signals, tactual walking stones or Braille reading). Increased reliance on touch and audition, together with more practice in using these modalities to guide behavior, is often reflected in better performance of blind relative to sighted participants in tactile or auditory discrimination tasks.^[21]

As described by Röder and Neville that blinds participants have better auditory performance than sighted participants. Outcome of this present study stated that there is statistically significantly no difference in simple auditory reaction time between congenitally blind and healthy control group. This outcome is as related as a result come by study of Bernard, which was done in 10 blind and 10 normal showing there is no significant difference in reaction time in between group.^[19]

These values are further as comparable as study done by Borker and Pendnekar's.^[24] Their study in normal participants showed Simple Auditory Reaction Time was 188 ± 36 ms which is as near to simple auditory reaction time carried out in our study participants of both congenital blind and normal sighted subjects. In this study, a blind fold is given to both group of participants for given same environment to all. No any study mention on the blind fold given to both the congenitally blind group and control group.

Namita *et al.*, a comparative study of auditory and visual reaction time in males and females staff during shift duty in hospital showed auditory reaction time was 215.15 ± 47.52 .^[9] In our study, Auditory Reaction Time (ART) for horn sound is 210.24 ± 90 ms in congenital blind and 186.92 ± 73.017 ms in normal sighted participants.

Niruba and Murthy's study of auditory and visual reaction time in type 2 diabetes; A case control study, showed ART in control was 174.13 ± 30.7 ms, which is near to this study.^[25] Kujala *et al*, Neimyese *et al*, Collignon *et al* and Naveen *et al*. studies showing significant alteration in the reaction time in congenitally blind as compare to healthy participants.^[22,26-29] All above study was done in small groups and controversy in method the use.

In an early study in 1899 carried out by Galton a study of sound stimuli in teenagers (15-19); the result was mean ART was 158 ms for sound stimuli, which is accordance accordance with this study.^[30]

Our finding regarding on two group of BMI as 1st group having <20 BMI and 2nd group having >20 BMI, there are statistically significantly no any difference between them. This shows BMI has no any impact on the

participant's response to auditory stimuli. A study done by Nikam and Gadkari shows that there was significant positive correlation between BMI and reaction times (Visual Reaction Time (VRT) and ART) in both males and females by Pearson correlation analysis, but other factors such as age, sex, habit have also effect in the ART.^[4]

CONCLUSION

In this study, there is statistically no significant difference in reaction time between congenital blind and normal healthy persons with a different kind of sound such as horn, bell, ring, and whistle in their group. This reflected the perception and response toward external auditory stimulus among congenital blind and normal sighted individual are equal. Loss of one sense does not reflect on the overacting of other sense as it act normally as per its' perception and growth.

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