A COMPARATIVE STUDY OF SIMPLE AUDITORY REACTION TIME BETWEEN MALE CONGENITAL FULL BLIND AND SIGHTED CONTROL

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ABSTRACT:
Introduction:
Huge amount of interest has been created regarding compensatory increase in other sensory modalities in blind due to loss of vision by so called Cross Modal Plasticity theory. In order to review its impact on auditory compensation in blind we attempted to study simple auditory reaction time in male congenital blind and compared with male sighted control’s simple auditory reaction time.

Methods:
25 male congenital full blind and 25 male sighted control full filling inclusion criteria were presented with 3000 Hz single tone sound via headphone randomly for 20 times and were instructed to press spacebar as soon as they hear sound. Time interval between sound presentation and pressing of spacebar was recorded by computer using Direct RT software. Other preliminary data were inquired before starting the test.

Results:
Male congenital full blind were having faster reaction time compared to sighted control in significant proportions (p<0.05). Right handed individuals (irrespective of blind or sighted) were having faster reaction time compared to left handed though it was not of significant
magnitude. Negative correlation was found between BMI and reaction time i.e. Higher BMI Less simple auditory reaction time

Conclusion:
Faster reaction time in congenital blind is proposed to be due to use of occipital cortex for auditory processing due to compensatory reorganization of neuronal circuitry in brain. Though further evaluation of other facets of auditory modality can give clearer picture of this cross modal plasticity.

KEYWORDS:
Cross modal plasticity, Handedness, BMI, Auditory reaction time

INTRODUCTION:
In 2007, many newspapers all over the world reported that the Belgian police was recruiting blind people as detectives because of their superior auditory skills. One of their jobs has been to analyse tapes of telephone calls; in particular, blind detectives segregated individual voices when listening to a large mixture of sounds and voices of a number of people very precisely. Thus, the blind detectives were better able to infer where a specific suspect was talking or to recognize his/her dialect [1]. When vision is unavailable or insufficient for perception, other sensory modalities often take precedence in sampling the environment. In the case of echolocation used, for example, by many bats and some marine mammals as a mechanism for navigation, object perception, hunting, and social communication [2]. Thus this kind of compensatory neuronal reorganization to enhance remaining sensory modalities is called cross modal plasticity [3].

The reaction time is time interval between application of stimulus and onset of response. Reaction time can be broken down into three parts. The first is perception time: the time for the application and perception of the stimulus and giving the necessary reaction to it. The second is comprehension time for understanding type, duration and direction of stimulus application. The third is motor time, which is the time for compliance to the order received [4, 5]. There are two types of reaction time: auditory and visual. Auditory Reaction time can be described into three types: (1) Simple auditory reaction time - here there is one stimulus and one response. (2) Recognition auditory reaction time - here there are some stimulus that should be responded to and other that should not get response. (3) Choice auditory reaction time - here there are multiple stimulus and multiple responses [6, 7]. John Bernard (1979) described two sensory modalities namely hearing and touch being superior in blind person than sighted. So he carried out research using simple auditory reaction time to compare hearing abilities between blind and sighted individuals [8].

So attempt was made to assess the hearing sensitivities by measuring simple auditory reaction time between blind and sighted persons.

MATERIALS AND METHODS:
The study was conducted in Shri Guru Gobind Singh Hospital (tertiary care hospital), Jamnagar, and Gujarat, India. 50 subjects including 25 male congenital full blind and 25 male sighted subjects were included in the study. Prior institutional ethics committee (IEC) approval was taken before conducting the study. The inclusion criteria were: Age and sex matched subjects
from 10 to 50 years old, literate subjects and those who's themselves and/or guardians have given consent were included. Illiterate subjects, person not willing to give consent have been excluded. Subject was either patients, their relatives or visitors to Shri Guru Gobind Singh Hospital, Jamnagar. Subjects were invited for participating in study on voluntary basis. Written consent was taken for participating in study. Auditory tests in form of pure tone audiometry were performed to analyse auditory status of subject. Also reflexes of subject were screened for motor status of subject. A Performa in form of questionnaire contains information about factors affecting reaction time were filled by investigator after interviewing the subject. Reaction time was noted by software Direct RT [9] in milliseconds. Subjects were first explained the procedure. It was carried out in room with adequate light and in silent atmosphere. A 3000 Hz of 90 db was presented randomly through headset provided to them. As soon as person hears the sound he/she has to immediately press the spacebar. Time taken between hearing of sound and pressing of spacebar was recorded in data files. 20 times this exercise was repeated out of which initial 10 reaction time were provided for practice and last 10 reaction times records were included in study. In that 10 reaction time records, minimum and mean simple auditory reaction time records were included. Analysis was done by SPSS version 20.0.0 software. Number of factors thought to be influencing reaction time were analyzed in present study.

RESULTS:
There were 50 subjects included in the study out of which 25 were male congenital full blind and 25 healthy sighted individuals. In present study age matched male subjects were included in the study in which mean age in male congenital blind is 23.16 ± 10.16 years and sighted is 23.32 ± 8.66 years.

Table No. - I
Mean ART for Blind and Sighted

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean (mSec)</th>
<th>Std. Deviation (mSec)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blind</td>
<td>25</td>
<td>324.52</td>
<td>63.044</td>
<td>0.043</td>
</tr>
<tr>
<td>Sighted</td>
<td>25</td>
<td>367.40</td>
<td>236.241</td>
<td></td>
</tr>
</tbody>
</table>

Table-I shows in present study mean auditory reaction time for congenital full blind was 324.52 ± 63.04 milliseconds while for healthy sighted control it was 367.40 ± 236.24 milliseconds revealing that congenital full blind had faster reaction time than sighted control with data showing significant value p<0.05.

Table No. - II
Minimum ART for Blind and Sighted

<table>
<thead>
<tr>
<th>Groups: Mini</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory: Blind</td>
<td>25</td>
<td>261.16</td>
<td>47.522</td>
<td>0.022</td>
</tr>
<tr>
<td>Auditory: Sighted</td>
<td>25</td>
<td>333.16</td>
<td>148.940</td>
<td></td>
</tr>
</tbody>
</table>
Considering minimum ART as the fastest response given by an individual, Table-II shows that Minimum ART of congenital blind was faster (261.16 ± 47.52) than sighted (333.16 ± 148.94) with significant value p<0.05.

<table>
<thead>
<tr>
<th>Hand</th>
<th>N</th>
<th>Mean (mSec)</th>
<th>Std. Deviation (mSec)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blind</td>
<td>41</td>
<td>341.54</td>
<td>182.296</td>
<td>0.636</td>
</tr>
<tr>
<td>Sighted</td>
<td>8</td>
<td>374.25</td>
<td>130.551</td>
<td></td>
</tr>
</tbody>
</table>

Table-III shows that out of 50 subjects 41 were right handed individuals and 8 were left handed individuals while 1 person was able to perform various tasks by both hands. Mean auditory reaction time for right handed persons was shorter (341.54 ± 182.3) compared to left handed persons (374.25 ± 130.6). Though results were found to be insignificant despite difference in mean ART (p>0.05).

Considering Body Mass Index (BMI) of study group, mean BMI of study group was 19.28 ± 4.99. Correlation coefficient study for observing effect of BMI on mean ART showed negative (-0.284) correlation i.e. MORE BMI LESS MEAN ART with $R^2=0.081$. See Graph-I.

**GRAPH NO. - I**: Correlation of BMI with mean ART BMI= sq.m/kg, Final mean ART= millisecond

**DISCUSSION:**
Study conducted by Collignon O et al [10] shows that blind have exceptional abilities in auditory processing due to recruitment of occipital areas for auditory processing. Another study done by Kirsten Hotting et al [1] showed that increase use of auditory system results in compensatory behavior having better perceptual auditory tasks. Mario Liotti et al [11] group showed that reaction times for attend ear intensity deviant targets were markedly faster (91msec faster) for blind compare to sighted individuals. While O. Despres et al [12] group results were showing
that early blind subjects exhibited shorter reaction time than sighted when sound sources were placed at far lateral locations. Thus supporting results of present study that simple ART of congenital full blind is faster (43 msec faster) than sighted (See Table-I). Though study done by John Bernard [7] showed insignificant reaction time results between blind and sighted individuals. Different activation patterns in the visual cortex of late and congenitally blind subjects was also shown by Christian Buchel et al [13]. Animals and humans that grow up blind use their auditory modality for localization in far space. Areas in parietal and occipital cortex that are ordinarily used for vision become activated by hearing input. This leads to an expansion of auditory areas in the dorsal stream into visual area and to a simultaneous sharpening of auditory spatial tuning in these neurons. Together, this massive cross-modal reorganization leads to superior performance of blind as compared to sighted individuals in auditory spatial tasks. [14]

The right hemisphere controls the left hand, and the left hemisphere controls the right hand. Sathiamoorthy A et al [15] study showed that left handed volunteers were having faster reaction time compare to right handed volunteers. Contrary to that in present study right handed individuals were having faster reaction time compare to left handed individuals using dominant hand. Study conducted by Lalita H Nakim and Jayshree V. Gadkari [16] showed that there is positive correlation of BMI with reaction time which is contradictory to this study.

CONCLUSION:
Considering the ability of brain neurons to reorganize among themselves to enhance the residual sensory modalities can be utilized in increasing brain performance by reversible induced suppression of one specific sensory modality. So we conclude that in present study congenital full blind have faster ART compare to sighted control. Though further evaluation of various aspects of sensory modalities in blind along with elaborate research on factors affecting them can enlighten mechanism underlying neuronal reorganization in blind subjects.

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CONFLICT OF INTEREST: None declared

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(9) Website: [http://www.empirisoft.com/directrt.aspx as sited on 21/03/2013](http://www.empirisoft.com/directrt.aspx)


