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# COMPARATIVE STUDY OF VISUAL REACTION TIME AND FIELD OF VISION IN DEAF CHILDREN WITH NORMAL CHILDREN

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**ABSTRACT** With auditory deprivation the visual senses are enhanced in the deaf children. The visual reaction time is measured by response analyzer and the field of vision is tested by Priestly-Smith's perimeter in the deaf children and compared with the normal hearing children in the age group of 8-16 years. The results showed significant increase in the VRT and field of vision in the deaf children as compared to the normal children. Early deafness is responsible for processing the visual stimuli in auditory cortex due to plasticity of neuronal cells in the auditory cortex. The deaf depend on the visual stimuli to judge three dimensional objects as well as to moving stimuli in the periphery. The deaf children show faster VRT and widening of field of vision due to continuous training by sign language. Visual experiences to the deaf children improve the neuronal circuitry involved thus providing evidence of auditory plasticity.

**KEYWORDS :** Visual reaction time, field of vision, response analyzer, plasticity

## INTRODUCTION

Similar to blind individuals, the deaf persons have to adapt to other sensations like visual or tactile senses due to the auditory depletion, in order to communicate themselves with others.

According to Neville & Lawson research studies done in deaf subjects concerning visual perception have been reported to show enhanced visual perception skills. Early auditory deprivation leads to enhanced responsiveness of primary auditory cortex to visual stimuli in deaf. (1'2)

Deaf people are more proficient in redirecting attention from one spatial location to another. It is been interesting to test the peripheral field of vision in deaf and compare it with normal hearing children. The visual reaction also is better and faster which is tested with the help of response analyzer and the field of vision is mapped by Priestly-Smith's perimeter. (3)

Tarun have reported that the compressive strength of rubberized concrete can be improve when fine aggregate was fully replaced by fine crumb rubber. He also indicated that if the rubberParticles have rougher surface or given a pretreatment, the better and improved bonding may develop with the surrounding matrix, and that may result in higher compressive strength.

## METHOD

The deaf children (n=50) selected for this study were between the age group of 8 — 16 yrs and they belonged to Dr.R.V.Bhide Mukbadhir Shala, Miraj. Detailed history regarding past and present disease was taken and no illness was found. General and systemic examination was carried to rule out any cardiovascular, respiratory and central nervous system diseases. Congenital deaf children who had profound loss of more than 90 db were taken as deaf subjects. Visual acuity tests were done to identify any refractive errors. No visual defects were found and colour vision was also found to be normal.

Similarly the normal hearing children (n=50) were screened as above taken from Dr. Anandrao Gaikwad High School and Camran Marathi School, Miraj and additionally hearing tests were done to rule out hearing defects. No hearing defects were found.

## PROCEDURE

Response analyzer (Yantrashilpa's response analyzer) is an advanced instrument, which is used to test the visual reaction time in both deaf and normal children.

The stimuli used for visual reaction time were different colours like red, yellow, green light with fixed intensity. All the readings of visual reaction time were recorded in normal hearing and deaf children. .

The instrument was kept on table. The subject was made to sit comfortably on a chair opposite the instrument. The examiner was sitting on the other side of the instrument facing towards the subject. The visual stimulus box was kept on the basic unit. The subject was asked to press the switch off as soon as he saw the glow of different coloured lights and the visual reaction time (VRT) was recorded. The display of reaction time was in milliseconds. In this way the visual reaction time was recorded in right and left hand. Initially the person was made familiar and then three readings were recorded. The lowermost reading was taken as visual reaction time.

Besides recording VRT perimetry was done to detect the field of vision. Perimetry is a procedure to map the field of vision of each eye separately. The instrument used was Priestly — Smith's perimeter. It has the following parts.

a) Vertical stand
b) Metallic arc.
c) Adjustable chin rest and detachable leveling bar.
d) Circular ring to fix the perimeter chart at the back of the disc.
e) Perimeter chart.

The metallic arc is placed in the horizontal position on the right of subject (90 —degree meridian). The chart paper is then fixed at the back of the perimeter so that its center corresponds with the visual axis. The chart paper is adjusted so that the 90- degree meridian on it corresponds with the metallic arc. There has to be adequate illumination. Make the subject comfortably seated in front of the apparatus and ask to rest one's chin on the appropriate chin rest. The leveling bar is used to bring the eye in line with the fixation point. The other eye is covered by placing the hand on it and subject fixes his gaze of test eye on central fixation object. The subject is instructed not to shift his gaze from the point. The field of vision is tested with a white object (10 x 10 mm). Put the target object at the farthest point on the arc and gradually bring it forward by means of rod. Instruct the subject to indicate the point at which he first sees the object; the reading in degree on the arc is marked on the perimetric chart for that particular meridian. Repeat the whole procedure at 15 degree interval (12 meridians) till the field of vision is marked in 4 quadrants. All the points in different meridians are joined together to give the limit of field of vision for that eye. This is monocular field of vision. The field of vision is also mapped similarly for different colours like blue, green and red. (3)

**Table 1 Comparison Of Visual Reaction Time (milliseconds) Between Normal (n= 50) And Deaf (n= 50) Children**

| | Right hand | | Left hand | |
|---|---|---|---|---|
| | Normal | Deaf | Normal | Deaf |
| VRT (msec) | 248.81 ± 56.64 | 209.6 ± 45.95 | 259.05±41.01 | 215.82±61.45 |

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**Table 2 Comparison Of Field Of Vision For Different Colours (white, Blue, Green, Red) Between Normal (n=50) And Deaf Children (n=50)**

| | INFERIOR | | | | TEMPORAL | | | | SUPERIOR | | | | NASAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RE | | LE | | RE | | LE | | RE | | LE | | RE | | LE | |
| | N | D | N | D | N | D | N | D | N | D | N | D | N | D | N | D |
| White | 56.4±8.0 | 63.3±9.5 | 57.8±6.0 | 63.0±8.5 | 64.4 4.7 | 76.1 ± 6.3 | 63.8±5.7 | 71.3±6.2 | 50.36±4.97 | 54.86±6.49 | 51.14±6.06 | 56.68±6.17 | 52.94±4.2 | 60.2 ± 3.4 | 52.6±5.6 | 57.8±4.4 |
| Blue | 54.9±6.6 | 58.7±8.9 | 51.6±7.2 | 58.8±7.1 | 62.4±5.4 | 66.8±8.9 | 62.3±7.8 | 69.5 ± 8.8 | 47.7±5.5 | 53.04±6.5 | 46.9±6.3 | 55.1±5.4 | 51.3±7.02 | 57.6±7.2 | 49.4±6.4 | 57.1±5.6 |
| Green | 47.7±6.5 | 53.2±8.5 | 47.9±7.2 | 56.6±6.9 | 56.7±6.9 | 61.8±9.5 | 56.9±9.0 | 65.1±10 | 43.9±6.6 | 50.4±8.5 | 44.2±6.4 | 53.1±5.9 | 47.8±6.9 | 53.3±8.6 | 45.8±6.9 | 52.4±6.1 |
| Red | 45.1±7.3 | 51.9±8.5 | 41.3±7.5 | 49.8 6.4 | 51.2±6.6 | 58.8±8.7 | 48.8±7.3 | 57.1±6.2 | 41.1±6.9 | 50.2±9.8 | 39.4±6.9 | 48±6.1 | 43.1±6.9 | 52.8±9.2 | 43.7±7.2 | 50.7±5.6 |

N : Normal
D: Deaf
RE: Right Eye
LE: Left Eye

## RESULT

Thus it is seen that the visual reaction time is better in the deaf children as compared to the normal heating children. The difference of mean values for both the hands is statistically highly significant (P<0.01). This is in accordance with studies by K.Alho et al and Finney EM et al. (2'4) The mean values of inferior, temporal, superior and nasal field of vision for the white, blue, green and red colour of both eyes of both the normal hearing and deaf children is stated in the table no. 2. The difference is statistically significant (P<0.01) and is in accordance with studies done by Neville HJ et al.

## DISCUSSION

The visual reaction time of right hand and left hand of the deaf children is much more faster than that of normal hearing children. The field of vision for white, blue, green, and red is also wider in case of deaf children as compared to normal children. This may be due to deprivation of auditory senses to the auditory cortex causing increased input of visual signals to the not used auditory cortex, owing to the reason of plasticity of neuronal cells in the auditory cortex specialized to receive and interpret the visual impulses. This is responsible for faster visual reaction time in deaf children. Early deafness results in processing of visual stimuli in auditory cortex due to cross modal plasticity. Continuous visual stimuli and training of the deaf to interpret these visual signals enable the deaf children to react faster to any visual impulses. Visual experiences to the deaf children improve the neuronal circuitry involved thus providing evidence of auditory plasticity. (6'7'8)

Plasticity and habituation of visual input may be helpful and justifies the faster visual response time and the increase in field of vision. The auditory cortex of the deaf is depleted of any reception of sound thus making the deaf dependent on visual stimuli from the surrounding. These visual signals increase the field of vision making the deaf more capable in judging the three dimensional objects or any people coming within the deaf persons field of vision. The normal hearing individuals rely on both the visual and auditory senses but the deaf have to concentrate more on the visual input which is improved. Deaf individuals respond faster and more accurately than normal individuals to moving stimuli in the visual periphery. This is due to plasticity of auditory cortex and a continuous heavy visual input to the deaf children widening the field of vision. (9-13)

According to Parson, the field of vision decreases for colours. White color shows wider field of vision but other colors like blue, green, red are weak stimulus hence the field of vision decreases for these colors. In this study along with the field of vision for white color the field of vision for other colors like blue, green, red was also checked in the normal hearing as well as in deaf children. (14)

It is seen that the field of vision decreases from white to blue to green to red colour. This may be because white light is perceived when there is equal stimulation of all the red green and blue cones. White is combination of all the wavelengths of spectrum whereas red colour is perceived only when red cones are stimulated. Similarly blue and green colour is appreciated when the respective cones are stimulated. (15) This is according to Young-Helhmholtz theory of colour vision in humans which postulates the existence of three kinds of cones, each containing a different photo-pigment and maximally sensitive to one of the three primary colours (red, blue, green). (16)

The ability to detect movement is better in peripheral vision than in foveal vision but colour discrimination is markedly worse. The deterioration of colour vision is attributed to reduced colour specificity in cells of midget, parvocellular (PC) visual pathway in the peripheral retina. (17) Thus the field of vision is better in deaf as compared to normal for white, blue, green and red colour but the field of vision for different colours, especially (blue, green, red) in this order goes on decreasing in deaf and the same pattern is also seen in the normal.

From the following study it is seen that the visual reaction time is faster in deaf children and the field of vision is increased in deaf children as compared to the normal hearing children.

The visual sense ensures visuo-motor coordination to maintain and improve the lifestyle of deaf children. This betterment of visual responses helps in the understanding of sign language i.e movement of fingers, lips during the sign language. According to Brass M et al, imitating a movement is an easier task than responding to verbal instructions thus providing a basis for deaf children to learn sign language. Since the continuous visual input of finger movement may enhance the visual areas of deaf children to receive these signals and learn language on the basis of signs.(8)

**Special note to kindly consider:**

The above study was done during the year 2001-2002 at Government Medical College , Miraj and is an unpublished data. We are always grateful to this college for allowing us to conduct this study.

Similar studies were done in forthcoming years (19-22) but this existing study was done in congenitally deaf children in between the age of 8-16 years and field of vision was an additional parameter tested and found remarkably significant.

## REFERENCES

1) Rettenbach R, Diller G, Sireteanu R; Do deaf people see better? Texture segmentation and visual search compensate in adult but not in juvenile subjects. Ear Hear 1997 Dec; 18(6): 502-12
2) K. Alho, T.Kujala, P.Paavilainen; Auditory processing in the visual brain areas of the early blind: Evidence from event related potentials, Electroencephalogyaphy and Clinical Neurophysiology 1993, 86: 418-427
3) A.K.Jain; Manual of practical physiology. Perimetry; Mapping out of the visual field: 223-226
4) Finney EM et al;Visual stimuli activate auditory cortex in the deaf. Nat Neurosci 2001 Dec; 4(12): 113-17.
5) Neville HJ, Lawson D ; Attention to central and peripheral visual space in a movement detection task: an event related potential and behaviouraal study. Brain Res 1987 Mar 10; 405(2): 268-283.
6) Schaffer K et al; Auditory cortical response in hearing subjects and unilateral deaf patients as detected by functional magnetic imaging. Cereb Cortex 1998 Mar; 8(2): 156-63
7) Ponton CW et al; Plasticity in the adult human control auditory system: evidence from late onset profound unilateral deafness. Hear Res 2001 Apr; 154(1-2): 32-44
8) Manjunath NK et al; Shorter latencies of components of middle latency auditory evoked potentials in the congenitally blind compared to normal sighted subjects. Int J Neurosci 1998 Sept; 95(3-4): 173-81
9) Whim F Ganong; Review of medical physiology. 21st edition. Cutaneous, deep and visceral sensation; Cortical plasticity: 134-35
10) Bavelier D et al; Visual attention to the periphery is enhanced in congenitally deaf individuals. J Neurosci 2000 Sept 1; 20(17): RC 93
11) Savelsbergh GJ et al; Auditory perception and control of spatially coordinated action of deaf and hearing children. J Child Psycho! Psychiatry 1991 Mar; 32(2): 489-500
12) Kral A, Hartmann R, Klinke R; Congenital auditory deprivation reduces synaptic activity within the auditory cortex in a layer specific manner. Cereb Cortex 2000 July; 10(7): 714-26.
13) Weigersma PH, Vander Velde; Motor development of deaf children. Psychiatry 1983 Jan; 24(1): 103-11
14) Stephen JH.Miller; Parson's diseases of eye 18th edition; Examination of retinal function.109-110. The causes and prevention of blindness Pg. No. 413
15) A.C.Guyton: Textbook of Medical Physiology 10th edition. The Eye II, Receptor and neural function of the retina: Photochemistry of colour vision 582-84
16) William.F.Ganong: 21st edition: Colour vision 166-167
17) Martin PR et al; Chromatic sensitivity of ganglion cells in the peripheral primate retina. Nature 2001 Apr 19; 140(6831): 886-7

18) Brass M et al; Compatibility between observed and executed finger movements comparing symbolic, spatial and imitative cues. Brain 2000 Nov; 44(2): 124-43
19) Douglas Sladen, Anne Tharpe, Daniel H Ashmead; Visual attention in deaf & normal hearing adults: Effects of Stimulus compatibility.Journal of Speech, Language & Hearing Research. December 2005 vol 48. 1529-15237.
20) Nandini C, C.Hema Sankar , B.C. Vastrad: Comparative study of visual reaction time in congenital deaf & normal children. Biomedicine2014;34(4): 510-513
21) Charlotte J Codina, Oliver Pascalis, Heidi A Baseler; Peripheral visual reaction time is faster in deaf adults & British language interpretes than in hearing adults. Frontiers in Psychology 2017:8-50
22) Ali Tatlici, Evrim Cakmakci : Comparison of visual reaction values of elite deaf wrestlers & elite normally hearing wrestlers. Turkish Journal of Sports & Exercise 2018, vol 20, issue 2, pages 63-66