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Comparison of tactile sensation among blind and sighted individuals

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ABSTRACT

Background: Blindness is a highly limiting disability affecting tens of millions of individuals worldwide. One of the current challenges in sight restoration and sensory aids for blind pertains to the possible visual acuity and capacity which can be transmitted through various restoration approaches. Compensation for sensory handicap by blind individual has been a subject of study and debate. Objects can be recognized by using any of our sensory modalities. But, the inputs about physical characteristics of a particular object perceived by vision and touch are unique and complex. Hence, in a blind individual, development of exceptional compensatory abilities in remaining senses in distinction to becoming severely handicapped due to the lack of the calibrating visual modality may look like a distant theoretical possibility.
Aims: To compare tactile sensation among blind and sighted individuals.
Materials and Methods: 85 subjects in between age group of 18-27 years. Study Group-Consisted of total 21adventitiously(not congenitally blind) blind subjects. Control Group-Consisted of total 64 apparently healthy sighted subjects.
Statistical Analysis used: Results had been analysed using unpaired test by SPSS version 16.
Results: It was observed that mean values for two point discrimination on horizontal and longitudinal axes, mean values of the time taken for letter identification was significantly lower in the blind group than the sighted group.
Conclusions: Results of the present study showed that the non sighted group outperformed the performance of the sighted group.

1. Introduction

Blindness is a highly limiting disability affecting tens of millions of individuals worldwide.[1] One of the current challenges in sight restoration and sensory aids for blind pertains to the possible visual acuity and capacity which can be transmitted through various restoration approaches.[2] Objects can be recognized by using any of our sensory modalities. But, the inputs about physical characteristics of a particular object perceived by vision and touch are unique and complex.[3] Hence, in a blind individual, development of exceptional compensatory abilities in remaining senses in distinction to becoming severely handicapped due to the lack of the calibrating visual modality may look like a distant theoretical possibility. Throughout life, neurons in CNS show changes. These changes may be specific molecular, biochemical, electrophysiological and physical. Cotman et al.[4] stated that these changes in neurons and neuronal networks occur as a response to physical activity and behavior of the individuals. Is it possible that blindness results in enhanced acuity in the remaining

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senses? Occipital cortical areas that normally serve vision are activated in congenitally blind subjects performing auditory or tactile spatial discrimination tasks.[5] In the light of the available evidence, it would be reasonable to investigate for signs of exceptional compensatory sensory abilities in blind individuals.

2. Materials and Methods

The present study includes total number of 85 subjects in between age group of 18-27 years. The total subjects have been divided into study group and the control group.

2.1. Study group

Consisted of total 21adventitiously(not congenitally blind) blind subjects (12 male, 09 female) taken from blind school, in age group of 18-27 years.

2.2. Control group

Consisted of total 64 apparently healthy sighted subjects (37 males,27 females) obtained from large tertiary care teaching hospital in Pune. Age matching of the controls was done.

2.3. Inclusion criteria

1. To 27 year old apparently healthy male and female sighted controls.
2. To 27 year old adventitiously blind male and female subjects under study group.
3. Subjects whose dominant hand was only right hand.

2.4. Exclusion criteria

1. Subjects with any neurological illness.
2. Subjects with mental retardation.
3. Subjects with any hearing defects.
4. Subjects with any finger pad calluses.
5. Subjects with any problem in understanding the language.
6. Smoker and alcoholic subjects.

2.5. Material

Board with 5 letters of English alphabet embossed on it, Compass aesthesiometer, Measuring scale.

Institute Ethics committee clearance was obtained. Permission had been taken from principal of blind school from where the study group was obtained. Informed consent was taken from all the study participants. Detailed case history of all the subjects was taken. Visual acuity had been tested in each individual before the start of study to label them as blind or sighted individuals. Visual acuity of perception of light (P.L.) and projection of rays (P.R.) and below had been included under blind group. Individuals with visual acuity 6/9 and better were taken as controls i.e sighted group.

The following tests had been performed in all subjects-

1. (A)-Two point discrimination.
2. (B)-Letter test.

Each task had been tested in all subjects and score was noted at the end of each task. Every task was performed blind folded by all subjects. Trials were given for four times to all the subjects before recording of the actual data.

2.6. Experiment 1 'A' (Two Point Discrimination)[6]

In both blind and sighted individuals (with the eyes closed in sighted),using a compass aesthesiometer, distance for the two point discrimination in both the longitudinal and horizontal axes were measured on the distal phalanx of all the five fingers on the ventral side of their right hand. The axis in the long axis of the finger was considered as longitudinal axis and the axis perpendicular to it was taken as the horizontal axis. Thickness of the points of compass aesthesiometer was less than 0.25millimeter. The minimum distance is when the two points touch each other and the distance could be increased by using a screw on the side. Ruler was used to measure the distance between the two points. Initially, the distance between the 2 points of the compass aesthesiometer was increased. Subjects were asked to tell whether he felt one or two ends of the testing instrument. If he felt them as two separate points, the distance between the two points of the compass aesthesiometer was reduced until he was able to perceive touching of the two points as a single point. This particular distance between the two points of the compass aesthesiometer where subject could feel it as one although two points were touched on his finger was taken as distance for two point discrimination. Same procedure was done in both the axes of the fingers.

2.7. Experiment 2 'B' (Letter Task)[7]

Both blind and sighted individuals(with the blind folded in sighted) were presented with 3 dimensional structures of English alphabet H,Q,U,V,Y in capital case taken on wooden cardboard. Each subject was presented with only one letter at a time. They were asked to identify the letter by using only their right hand. Maximum time of 50 seconds was given for the identification of each letter. If the letter was identified correctly within this time, the time taken was documented. Subjects failing to identify the given letter within the mentioned time were considered as unable to do the test & were presented with next letter. Those subjects who could successfully identify the letter within the given time were also given next letter for the identification.

Actual data was recorded by taking help of any person who was blinded to study and results of previous research done. All results were recorded in a pre-specified format.

Table 1: Mean age distribution of the male and female sighted subjects as well as the blind subjects

Age in years	Male Mean±SD	Female Mean±SD	p value
Blind	22.91±4.05	21.33±2.23	0.306
Sighted	20.56±4.10	22.33±6.70	0.197
p value	0.091	0.66	

no statistical significance (p>0.05.)

Table 2: Comparison of Mean values of Two point discrimination (Horizontal axis) on all the finger tips among sighted and blind subjects

Test finger	Mean in sighted (in mm) ±SD	Mean in blind (in mm) ±SD	'p' value
A1 Thumb	3.16±0.80	1.97±0.59	0.000000016*
A2 Index	2.98±0.76	2.25±0.50	0.000092*
A3 Middle	3.05±0.80	2.21±0.44	0.000016*
A4 Ring	2.99±0.84	2.18±0.44	0.000062*
A5 Little	3.13±0.87	2.08±0.61	0.0000019*

statistically significant (* $p < 0.05$).

Table 3: Comparison of Mean values ofbTwo point discrimination (Longitudinal axis) on all the finger tips among sighted and blind subjects

Test finger	Mean in sighted (in mm) ±SD	Mean in blind (in mm) ±SD	'p' value
A1 Thumb	3.07± 0.75	1.94± 0.68	0.000000029*
A2 Index	3.09 ±0.84	1.87±0.55	0.000000019*
A3 Middle	3.05 ±0.87	2.07± 2.07	0.000011*
A4 Ring	3.21 ±0.87	1.94±0.59	0.00000023*
A5 Little	3.29 ±0.80	2.12± 0.75	0.000000075*

statistically significant (* $p < 0.05$).

Table 4: Comparison of mean time taken for completion of Letter task among sighted and blind subjects

Letter Test	Letter	Mean(in seconds) in sighted subjects±SD	Mean (in seconds) in blind subjects ±SD	'p' value
B1	H	15.15± 9.85	9.34±3.27	0.0097*
B2	Q	14.24±7.30	9.76±7.10	0.016*
B3	U	9.34±5.26	5.61±5.35	0.0062*
B4	V	10.39±4.79	7.20±3.98	0.00000073*
B5	Y	11.15±6.54	7.69±5.21	0.031*

statistically significant (* $p < 0.05$).

Data was tabulated. Results had been analysed using unpaired test by SPSS version 16.

3. Results

There is no statistical difference (p>0.05.) in the mean age distribution of the male and female sighted subjects as well as the blind subjects (Table 1). Mean values for two point discrimination on the horizontal axis in the blind ranges between 1.97 mm and 2.25 mm & it was observed that, this value was significantly lower in the blind group than the sighted group (Table 2). Mean values for two point discrimination on the longitudinal axis in the blind (non sighted) subjects ranges between 1.87 mm and 2.12 mm which was significantly lower in the blind subjects as compared to the sighted subjects (Table 3). The mean values of the time taken for letter identification in all the five tests from B1 to B5 was significantly lower (* $p < 0.05$) in the non sighted group than the sighted group (Table 4).

4. Discussion

There is increasing interest in the study of blindness and its effect on cognition and behaviour in recent years. Is it possible that blindness results in enhanced acuity in the remaining senses? Some areas of the brain mainly lateral occipital cortex are specialized for visual object recognition and can be activated by tactile stimuli. In the present study, it was found that distances for two point discrimination on both horizontal and longitudinal axes as well as time taken for Letter identification test were lower in the blind or non sighted group as compared to sighted individuals which is in line with acuity being found to be significantly superior in blind subjects independently of their degree of childhood vision, light perception level or Braille reading. Results argue against uni modal somato sensory plasticity as cause of acuity enhancement but leave open the possibility that cross modal plasticity plays a role.[5]

Results were found to be similar in both males and females. From this it can be inferred that number of tactile receptors encoding information remains same in both males & females.[8] The observations of this study are in line with study of Petkova et al. in 2012 which stated that not only blind people have an intact somato sensory system for which a perfectly reasonable argument could be that they perceive their own body just as sighted individuals 40 but also blind have superior capacity to detect relative timing of tactile stimuli delivered to two hands for example, 23ms in blind compared to 47ms in sighted individuals.[9] Not just blindness but, acuity on Braille trained finger was significantly enhanced by 5 day period of blind folding.[10]

However limitations of this method may be questionable because of uneven pressure, possible slight tilting resulting in non simultaneous application of points of instrument or subject himself may apply pressure against the instrument thereby causing overstimulation. To minimise subjective errors in the present study, two axes were chosen.Bliss I et al. in 2004 conducted a similar study and as expected blind participants outperformed the sighted ones statistically significantly in tactile raised letters n-back test.[11] These results demonstrate the degree to which everyday practice develops perceptual skills in persons with severe sensory loss (blindness & tactile environment).[12]

5. Conclusion

Results of the present study showed that the non sighted group outperformed the performance of the sighted group.

This study opens up many interesting questions for future research. A first set of questions concerns the extent to which the organization of visual cortex extends to non visual processing. If cortical plasticity alone is the cause of increased tactile acuity in the blind or is their recruitment of different physiology in them for better performance of tactile acuity.

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None.

Conflicts of Interest

None.

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