

# Study of Sensory, Pain Thresholds and Pain Tolerance in Persons with Visual Impairment

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**Abstract:** *Aim and Introduction: It is often assumed that persons with visual impairment have a better sensory perception this ability helps them to perceive the environment better. To objectively study this assumption we carried out a study on sensory, pain thresholds and pain tolerance in persons with visual impairment. Materials and Methods: An electrodiagnostic stimulator was used to assess the sensory threshold, pain threshold and pain tolerance using a standard procedure. Result: The sensory and pain threshold, and the pain tolerance in persons with visual impairment was found  $3.66 \pm 4$ ,  $8.35 \pm 4.14$ ,  $13.19 \pm 4.93$  respectively as compared to  $9.96 \pm 2.7$ ,  $13.13 \pm 2.62$ ,  $15.41 \pm 2.88$ , respectively in subjects with normal vision. On statistical analysis these results were found to be statistically significant ( $p < 0.05$ ). Conclusions: The sensory and pain threshold and the pain tolerance in persons with visual impairment were found to be lower in persons with visual impairment.*

**Keywords:** Sensory perception, Sensory threshold, Pain threshold, Pain tolerance, Persons with Visual Impairment.

## 1. Introduction

The WHO states that blindness is the inability to see. The WHO Statistics show that, 285 million people are estimated to be affected with visual impairment worldwide and about 90% of the world's persons with visual impairment live in developing countries [1].

### 1.1 Challenges faced by the persons with visual impairment

In persons with visual impairment there is an evident loss of visual exploration and play as a result they are unable to visually perceive their environment. This would further hinder their ability to cognitively approach a given situation in the environment hence, leaving them baffled and helpless. Visual deprivation in the developmental periods adversely affects the functional organization of the occipital cortex [2]. However, despite the organic causes of visual impairment, most affected subjects are able to carry out their activities (basic, instrumental and even economically productive) through compensatory role of their non-visual modalities. This is amply evident through the usage of Braille, wherein simple tactile information is converted into meaningful patterns that have lexical and semantic properties [3, 4] mediated by the somatosensory system [4]. Hence, we proposed to carry out this research to objectively study the sensory pain thresholds and the pain tolerance in the persons with visual impairment as compared to those with normal vision.

## 2. Review of Literature

1. R.W. Van Boven, et al in their study on tactile spatial resolution in blind Braille readers, found that **blind people have heightened tactile spatial acuity probably** owing to expanded cortical representation of fingers used in Braille reading [5].
2. Bonino D in their study on **Tactile spatial working memory activates the dorsal extrastriate cortical pathway in congenitally blind individuals** found that recruitment of the dorsal cortical pathway in

response to the tactile spatial working memory task is not mediated by visually-based imagery and that visual experience is not a prerequisite for the development of a more abstract functional organization of the dorsal stream [6].

3. Golledge, Klatzky et al in their study, Cognitive mapping and way finding by adults without vision found that Exploration of unknown spaces is essential for the development of efficient orientation and mobility skills [7].
4. O Lahav and D Mioduser in their study on Multisensory virtual environment for supporting blind persons' acquisition of spatial cognitive mapping, orientation, and mobility skills found that at **the perceptual level, the deficiency in the visual channel should be compensated with information perceived via alternative channels.** Touch and hearing become powerful information suppliers about known as well as unknown environments [8].

## 3. Methodology

**Study Design:** Crosssection

**Study Settings:** The study was done in two blind institutes. The study was done Smt.Kumudben Dwarka Das Vora, Industrial Home for Women, Andheri (West), Mumbai and Mancherji Banaji Industrial Home For Blind, Jogeshwari (West), Mumbai.

**Sample Size:** 100

**Study Subjects. :**Inclusion criteria: 50 Visually Impaired who are trained Braille readers or are obtaining training for the same and 50 age matched subjects with normal vision.

Exclusion criteria: The subject suffering from any known pathology which could hinder their perception or psychological problems altering their response.

**Materials Used:** Electrodiagnostic stimulator, pen electrode, carbon electrode

**Ethical Clearance:** Ethical Clearance for the study was taken from the Ethics Committee of Pad Dr DY Patil University.

**Procedure:** This study was conducted in the above mentioned blind institutes where subjects who complied

with the inclusion criteria and gave a written informed consent were randomly selected. Standard procedures were followed for assessment of sensory, pain, and pain tolerance using a diagnostic electrical stimulator. Three readings were taken. The average of the three readings was calculated and the result was considered.

**Sensory threshold:** The lowest intensity of sensory stimulus experienced by the subject at the first instance of testing.

**Pain threshold:** The lowest intensity of noxious stimulus experienced by the subject [9].

**Pain tolerance level:** The extreme intensity of noxious stimulus that a subject can withstand with respect to the subjects individual capacity [9].

**Electrodiagnostic stimulator:** An instrument used to assess the sensory, pain thresholds and pain tolerance by using direct current.

**Statistical Analysis:** Data were collected on standardized forms and encoded for computerized analysis using GraphPad Instat Version3.10, 32 for Windows. Tables were made using Microsoft word and figures were plotted using Microsoft Office Excel 2007. Continuous variables were summarized by mean (range) or number (percent). Associations denoted as statistically significant were those that yielded a *p* value < 0.05, assuming a 2-sided alternative hypothesis.

**Demographics:**

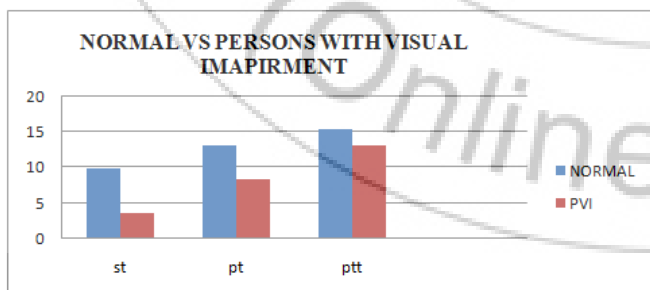
**Age:** The average age of persons with visual impairment was estimated to be 25.6 years. The average age of persons with vision was estimated to be 21.8 years. The two groups are homogenous with respect to age.

**Gender wise Percentage:** Persons with visual impairment: Males %: 58 Females %:42%. Persons with vision: Males %:14%, Females%:86%.

**Educational Qualification:** Persons with visual impairment: All subjects (100 %) had undergone vocational training. The subjects learnt were Braille reading, Acupuncture, Massage therapy, Stitching, Jute making. Persons with vision: (100%) Under Graduate level students.

**Occupations:** Vocational trainees who were Braille readers, Acupuncture therapists, Massage therapists, tailoring work that included stitching and Jute making.

**4. Analytical Statistics**

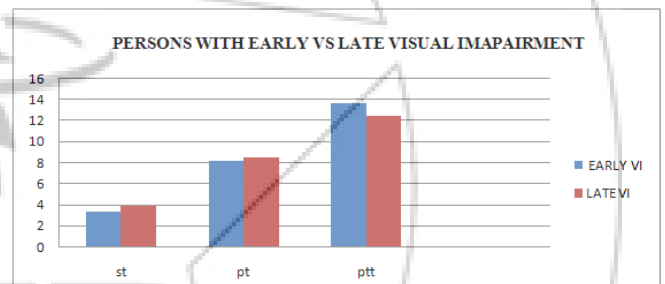


**Graph 1:** Comparison of Sensory, Pain Thresholds & Pain Tolerance in Normal's Vs Persons with Visual Impairment

**Table 1**

	NOR MAL	(PVI)	*p VA LU E	LO WE R 95% FOR (N)	LO WE R 95% CI FOR (PVI )	UP PE R 95 % CI FO R (N)	UP PE R 95 % CI FO R (PVI)	Stats signifi cance
S T	9.96 ± 2.7	3.66 ± 4	<0.0 5	9.18 0	2.51 0	10.7 48	4.81 0	Signif icant
P T	13.13 ± 2.62	8.35 ± 4.14	<0.0 001	12.3 83	7.17 3	13.8 77	9.52 8	Extre mely signifi cant
P T T	15.41 ± 2.88	13.19 ± 4.93	0.00 13	14.5 96	11.7 91	16.2 36	14.6 01	Very signifi cant.

\*Statistical data analysis, Performed unpaired, non parametric test, 2 tail p value, Man Whitney U test. N = Normals, PVI=Persons with Visual Impairment  
**Inference:** The sensory and pain thresholds and pain tolerance were lower in persons with visually impairment when compared with the normal subjects. The data was considered significant.



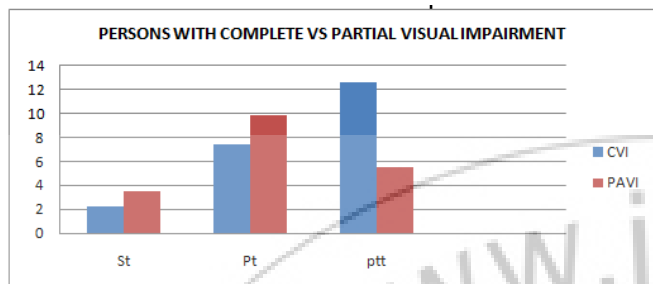
**Graph 2:** Comparison of Sensory, Pain Thresholds & Pain Tolerance in Persons with Early Vs Late Visual Impairment

**Table 2**

	PWE VI	PW LVI	p valu e*	LOW ER 95% CI PWE VI	LOW ER 95% CI PWL VI	UPP ER 95% CI PWE VI	UPP ER 95% CI PW LVI	Stats Signific ance
St	3.41 ± 4.10	3.99 ± 4.03	0.53 31	1.858	2.159	4.97 7	5.83 2	Not signifi cant
Pt	8.19 ± 4.2	8.57 ± 4.13	0.76 03	6.589	6.690	9.79 2	10.4 53	Not signifi cant
**P TT	13.71 ± 5.75	12.4 7 ± 3.53	0.31 71	11.52 9	10.86 8	15.9 06	14.0 84	Not signifi cant.

\*Statistical data analysis. Performed unpaired, on parametric. Man whitney u test. \*\*performed t paired test. PWEVI: Persons with Early Visual Impairment. PWLVI: Persons with Late Visual Impairment.

**Inference:** The sensory, pain thresholds are lower in persons with early visual impairment. The pain tolerance is higher in persons with early visual impairment than in late visual impairment. The data was not considered significant.



**Graph 3:** Comparison of Sensory, Pain Thresholds & Pain Tolerance in Complete Vs Persons with Partial Visual Impairment

**Table 3**

	PW CV I	PW PVI	*p value	LOWE R95%CI PWCVI	LOWE R 95% CI PWPVI	UPPER 95% CI PWCVI	UPPER 95% CI PWPVI	Stat significance
St	2.29 ± 2.33	3.45 ± 3.58	0.1050	1.440	1.731	3.154	5.184	Not significant.
Pt	7.39 ± 3.73	9.90 ± 4.38	0.0299	6.027	7.790	8.768	12.021	Considered significant.
Ptt	12.65 ± 5.58	5.51 ± 6.35	0.1525	10.612	12.322	14.705	15.826	Not significant

\*Statistical data analysis. Performed unpaired, on parametric. Man whitney u test. **PWCVI:** Persons with Complete Visual Impairment, **PWPVI:** Persons with Partial Visual Impairment. **Inference:** The persons with complete visual impairment have a reduced sensory and pain threshold when compared with persons with partial visual impairment. The pain tolerance was noted to be increased compared with persons with partial visual impairment.

## 5. Discussion

### 5.1 Persons with Visual Impairment Vs Normal's

The persons with visual impairment had lower sensory, pain thresholds and pain tolerance as compared to the normals (control group) and data analysis found this to be statistically significant ( $p < 0.05$ ). Neuroplasticity explains that the brain undergoes anatomically and functionally altered changes when undergoing new experiences which are repeated over a period of time resulting into formation of multiple neural pathways [10]. Crossmodal plasticity is responsible for enhancing the tactile acuity. A study showed that the brain MRI had certain changes where

there was tactile activation observed in the cortical areas of persons with visual impairment [11]. Our findings were corroborated by a study by Fiehler et al stating that the, “functional MRI data showed overlapping activation patterns in the dorsal stream for kinesthetically guided hand movements in congenitally blind and sighted people [12,13]. Similar findings were also seen by Kravitz et al. 2011 in a study showed that “activations in the parahippocampus and visual cortex during tactile navigation were reported in blind but not in blindfolded-sighted subjects and were restored for sighted subjects when the blindfold was removed [12,14]. Similar physiological changes [5] happened in braille readers regarding “cortical plasticity and enhanced spatial acuity where the, “cortical representation of the reading fingers of blind Braille readers is expanded compared to that of fingers of sighted subject [5]”. Then it was hypothesized that the expanded cortical representation of fingers used in Braille reading may reflect an, “enhanced fidelity in the neural transmission of spatial details of a stimulus [5]. The above studies support the point that increased sensory, tactile perceptions were highly evident in persons with visual impairment.

### 5.2 Persons with Early Vs Late Visual Impairment

The sensory, pain thresholds and pain tolerance were lower in persons with early visual impairment. ( $p$  value  $> 0.05$ ) Increased sensitivity was attributed to, the somatosensory cortex which recruits the visual cortex to assist with tactile sensation [15]. Furthermore, the somatosensory cortex is the centre of neural networking for the persons with early visual impairment [15]. A strong cross-modal networking results in increased number of neural pathways to work with, hence in persons with early visual impairment a better speed and acuity to react to tactile stimuli is observed [15]. A study by Bonino et al (2008), shows that dorsal visual stream is recruited by the somatosensory cortex [6]. The dorsal stream is used by the sighted to identify spatial information visually, but the persons with early visual impairment use it during, “tactile sensation of three dimensional objects [6, 16]”. Persons with delayed visual impairment who already oriented with vision in the initial stages of development and somatosensory perception had higher thresholds and tolerance than persons with early visual impairment. A study by Päivi Nevalainen et al explained that during the early neurodevelopmental period there is simultaneous formation of visual and the somatosensory centers in the brain [17]. As with time when loss of vision occurs leading to an absence of visual stimuli, the somatosensory perception centre alters gradually, since there are already developed pathways for sensation that have still not adapted to the visual loss in the brain. This will also mean that they do not have a great extent of plasticity, also proved by a study that stated the same [18]. They still have to unlearn the old changes in the brain and then relearn the new changes in order to adapt to the onset of loss of vision which will probably take a good amount of time to adapt to the new sequence of learning.

### 5.3 Persons with Complete Vs Partial Visual Impairment

The persons with complete visual impairment have lower sensory, pain thresholds and pain tolerance when compared to persons with partial visual impairment. The p value ( $> 0.005$ ). The persons with complete visual impairment have had no visual input at all. Thus, if they are blind since birth they would have somatosensory changes in the somatosensory region that would have stronger interconnectivities and a more sensitive perception to different sensations [3]. This is in comparison to the persons with partial visual impairment who do not have total loss of vision implying that the visual afferents were present through of poor quality hence inhibiting the role of cross modal plasticity in these subjects.

### 6. Conclusion

**Clinical Implication:** Persons with visual impairment are more sensitive perceptually and have a good tactile acuity. This distinct trait should be harnessed in day to day activity making them confident independent and economically productive individuals. Occupation should be carefully chosen where their heightened tactile sensation is tapped to their advantage. Examples of such occupations, acupressure therapists, massage therapists, sculpting, print media where exclusive use of Braille occurs or even playing an instrument like table, guitar where the enhanced tactile functions are utilized to the optimum.

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