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Original Article

Blindness Enhances Texture Perception: Role of Haptic Sense

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Abstract

In congenitally blind subjects, visual experience and visual imaginary is lacking which in turn forces them to be dependent on haptic system for tactile discriminative task. Many studies suggest that visual experience facilitate the haptic processing of surrounding information making sighted and late blind more efficient in haptic perception compared to congenitally blinds. When it comes to texture identification, the role of visual imaginary is not clear. In the view of this,the present study want to investigate the role of visual experience in haptic processing in congenitally blinds, when they are compared with blindfolded sighted subjects for texture discriminative task. Method: This study was done on 30 congenitally blind Braille subjects & 30 age & gender matched sighted subjects who were blindfolded during the texture discriminative task. Participants were instructed to arrange the sandpapers of different grit size from rough to smooth grading and performance was evaluated in terms of speed & accuracy. Result: Congenitally blind subjects outperformed blindfolded sighted subjects, both in terms of speed & accuracy. Conclusion: Congenitally blind subjects appear to get the benefit of their haptic sense in texture discriminative task resulting into faster & more accurate perception.

Introduction

While extracting information from external world, both visual and somatosensory information is necessary for which touch emphasize on material properties and vision emphasize on spatial or geometric properties (1). During haptic exploration, blindfolded sighted individuals may get the benefit of past visual experience while congenitally blinds have to rely on their haptic sense.

Lederman et al. suggested that visual imaginary and visual experience is needed for interpretation of 2-dimensional patterns while haptic sense is important for perception of solid forms of substances like texture, hardness and thermal perception (2). Very few studies have been done on haptic texture perception and there is no Indian data published on it so far. In the view of this, present study has attempted to explore the role of haptic experience in texture discriminative task in congenitally blind

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individuals in whom visual experience and visual imaginary is lacking.

Methodology

The study was conducted at residential blind training centre for girls. Approval from ethical committee of the institute was obtained prior to study. Study participants were 30 congenitally blind girls of age group 18-27 years and 30 normally sighted female subjects of same age group. All participants were randomly selected for the study.

Participants with known sensorimotor deficit of hands like leprosy, neuropathy or neuritis were excluded from the study. An informed consent was obtained from each study participant. Visual acuity of all sighted subjects was checked and it was assured that they had normal vision. The sighted subjects were blindfolded for all tests for texture recognition to exclude vision as a source of information.

Test procedure was explained to all subjects in detail and one practice session was given to each of them to make them familiarize with the study procedure. The practice session used different set of sand papers from the ones used for actual testing of the subjects.

The study protocol was based on the procedure described by Heller et al. (3). Aluminum oxide abrasive sandpapers of different grit size were used. The grit value designates number of sharp particles per square inch of sandpaper. Sandpapers were mounted on square shaped cardboard of size 8 cm x 8 cm and divided into 2 sets. Set I contains coarse sandpapers while set II contains smoother sandpapers. Each set consists of random arrangement of sandpapers.

Set I grades 60, 80, 100, 120, 140

Set II grades 200, 240, 360, 400, 600

Test procedure

Each subject was administered with two sets of sandpapers in random order and instructed to arrange them from rough to smooth grade with tip of index finger. The blind subjects used the index finger of the hand used by them to read Braille while the sighted subjects used index finger of their dominant hand. Subjects were instructed to arrange sandpapers as quickly and correctly as possible. The number of sandpapers arranged correctly within 30 seconds was expressed as percentage accuracy of haptic texture discriminative task. Subjects were allowed to continue haptic manual exploration at the end of 30 seconds and time required to arrange sandpapers in set I and set II from rough to smooth gradation was measured and taken as speed of haptic texture discriminative task.

The data collected from all the subjects was recorded on an MS Excel sheet and subjected to statistical analysis. An unpaired t-test was applied to analyze the data by using SPSS software (Version 15).

Result

Time taken by blind and blindfolded sighted subjects to arrange sandpapers from rough to smooth grade is shown in Table I. Blind subjects were able to arrange sandpapers on an average 30 to 31 seconds faster than blindfolded sighted subjects. This difference was consistent for both the sets of

TABLE I: Comparison of Time (in seconds) required for Texture Identification in blind and control groups.

Variable	*Groups*				*Unpaired t-test applied*	
	Blind		*Control*			
	Mean (sec)	*S.D.*	*Mean (sec)*	*S.D.*	*p-value*	*Difference*
Time required for Texture Identification – Set I	12.50	2.60	42.08	12.72	0.0000000000	Significant
Time required for Texture Identification – Set II	16.44	8.20	47.71	10.19	0.0000000000	Significant

TABLE II: Comparison of percentage accuracy of texture identification between Blind and Control Groups.

Variable	Groups				Unpaired t-test applied	
	Blind		Control			
	Mean (%)	S.D.	Mean (%)	S.D.	p-value	Difference
Texture Identification – Set I	98±8	0.08	77±16	0.16	0.0000000175	Significant
Texture Identification – Set II	93±14	0.14	72±17	0.17	0.0000043882	Significant

sandpapers tasted and was statistically significant.

Blind subjects also showed significantly higher accuracy for arrangement of sandpapers compared to blindfolded sighted subjects. This difference, again, was consistent for both the sets of sandpapers (Table II).

Discussion

For texture discrimination, congenitally blind participants significantly outperformed blindfolded sighted participants both in terms of speed and accuracy suggesting that congenitally blind get the benefit of haptic experience. Precise reason for this specific advantage of haptic experience is not clear probably the practice and habit of using touch as a main navigation for active exploration of surrounding environment might have helped.

Lederman et al. proposed two models for haptic processing of information. Direct apprehension model suggests that haptic system has unique representation of objects, independent of any visual representation. While according to image mediation model, haptic system translates tactile information into visual image, which is then perceived by visual system (4, 5). Thus perception of surrounding environment is highly integrated and requires sensory representation from different modalities, mainly visual and haptic sense for blinds. However contribution of one sense over another has long been debated and found to be dependent upon the nature of the work (6). Touch perceives roughness of texture more appropriately while vision is helpful for differentiating boundaries of texture (7).

In a comparison for texture perception among sighted, late blind and early blind, similar performance was observed, suggesting that there was no extra advantage of visual experience and visual coding of tactile stimuli is not necessary as touch itself is advantageous for detection of smoothness of surfaces (3).

When blind individuals were compared with sighted subjects in 3 different tactile discriminative tasks, it was found that blind subjects were more superior in tactile discriminative task. For grating oriented threshold and vibrotactile frequency discrimination threshold, similar performance was found between them. All blinds were fluent Braille readers and possibly the similarity between raised dot surface and Braille characters had resulted into superior performance in them (8).

A tactile image recognition study done on early blind children using different techniques and materials showed that early blind children were better at recognizing textured images than other illustrations. The study also showed that adequate exposure and practice is a key factor for improvement (9).

Our finding that congenitally blind subjects are significantly better than blindfolded sighted subjects both in speed and accuracy in haptic texture discriminative task suggests that haptic sense is very well developed in congenitally blinds and they need not depend upon visual experience for texture perception. Tactile sensitivity and awareness are necessary for performing higher haptic task. With the help of previous tactile experiences and memory, congenitally blinds develop their own spatial skills by using body centered cues and active tactile exploration (10, 11). So proper training and adequate exposure to the surrounding environment in critical age is at most necessary for development of these

special skills (12). Congenitally blind participants of present study were living in residential blind training school and were exposed to different sorts of academic, social and cultural environment and were trained in Braille reading from young age. This might have helped them to develop a strong haptic special sense and succeed in texture discriminative task.

We hope that our finding regarding superiority of congenitally blinds in texture discriminative task and importance of early exposure to tactile training will be useful for developing various tactile devices and strategies.

We would like to do extensive research on late blinds also to know their encoding patterns during haptic exploration, which in turn may help us to train them to develop strategies to use their haptic sense.

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