Evaluation of auditory processing in blind people: a comparison of semantic and auditory perception

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Introduction: Sensory and cognitive levels of information processing in the auditory sensory modality suggest hemispheric reorganization in blind individuals [3]. Auditory processing comprises the successive processes whereby subjects carry out cognitive analyses of sounds. In general, blind persons and listeners require good quality temporal processing not only to locate themselves in space but to learn and comprehend language [1].

Materials and Methods: Six right handed female blind subjects (table 1), were recruited from a school after clinical evaluation from the Ophthalmological clinics of our institute. Standard diagnostic and exclusion criteria were followed. Functional MRI scans were conducted after ethical approval on standard clinical 3T MR scanner (Achieva 3.0T TX, Philips Netherlands) with the subject in supine position. The head was supported and immobilized using vendor provided foam-pads within the circularly polarized 32 channel head coil. An object holding platform was positioned at arm's length to the subjects. On this perspex platform, rotating sheets with a many small object-holders were inserted for tactile perception. For the Spatial perception, rotating sheets with object holders at different positions were inserted during the course of the experiment. For the Phonological session, MR compatible headphones (Philips) were provided to the subject inside the scanner, and the paradigm is presented to the subject using E-prime software. Single-shot echo planar imaging (EPI) sequence was used for the functional MRI studies to study the Blood oxygen level dependent (BOLD) effects in the whole brain. The parameters are: number of slices: 30, slice thickness 4.5 mm; TR: 2000 ms, TE: 30 ms, FOV: 230 mm, flip angle: 90^{o}, number of dynamics: 160 (for perception) and 210(for auditory session), resolution: 64x 64, were used for the BOLD sessions. Pre and postprocessing were carried out using SPM8 (Wellcome Department of Cognitive Neurology, UK). The BOLD clusters were converted from mni template to the Talairach and Tornoux coordinates, for estimation of anatomical areas. Two sample t-test ($p<0.001$, cluster threshold 10) were used for group analysis.

Table 1.Details of subjects

Subject	Sex	Age (years)	Aetiology	Age of onset (years)	Vision
LB1	F	14	Atrophic bulbi	3	none
LB2	F	12	Corneal ulcer	4	low
LB3	F	13	Nystagmus	3	low
LB4	F	13	Nystagmus	3	low
LB5	F	12	Accident	5	none
LB6	F	16	Pthysis bulbi	3	none
Mean Age ± SD		13.3± 1.5			

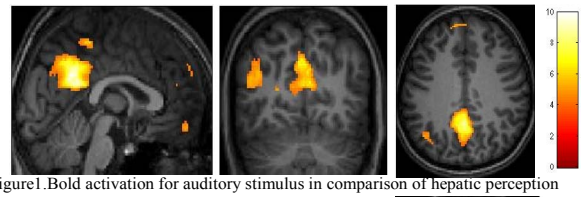

Figure1.Bold activation for auditory stimulus in comparison of hepatic perception

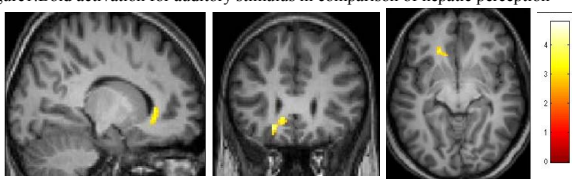

Figure2. Bold activation for tactile perception in comparison of auditory

Results and Discussion: The analysis of one way ANOVAs showed significantly more BOLD activation in cingulate gyrus of left hemisphere (no. Of clusters = 1818) and middle temporal gyrus (with cluster count 304), suggesting that auditory processing and perception were consistent in the left cerebrum. In group analysis, the contrast {auditory conditions *vs*. perception} showed the activation in cingulate gyrus, middle temporal gyrus, post central gyrus, middle temporal gyrus, superior frontal gyrus, anterior cingulate, and precentral gyrus. Bilateral activation is observed in medial frontal gyrus. Lentiform nucleus (cluster value 124) in left hemisphere is observed for perception than auditory. The BOLD cluster in primary auditory cortex suggests the prioritised attention / awareness of sound perception than tactile perception. Medial frontal gyrus and middle frontal gyrus were involved in the secondary cortical area to process information regarding perception activity. Enhanced BOLD responses to auditory stimuli in the primary visual cortex of blind volunteers are mediated by corticocortical connections from the primary auditory cortex Long-term blindness hypothetically enhance not only processing of a sensory stimulus in the auditory modality but that it also results in enhanced sensitivity for overcoming different phonetic stimulus input a stimulus related to speech sound perception.

Table 2. Activation clusters for different BOLD activation areas in the Blind subjects (Auditory vs. Perception)

Clusters	Z-Score	mni	Hemi-sphere	Area	Brodmann area
1818	5.08	0 -56 30	Left	Cingulate Gyrus	BA 31
304	4.44	-48 -70 28	Left	Middle Temporal Gyrus	BA 39
162	3.66	14 -42 70	Right	Postcentral Gyrus	BA 7
137	4.04	-48 2 -30	Left	Middle Temporal Gyrus	BA 21
82	3.86	-10 40 52	Left	Superior Frontal Gyrus	BA 6
65	3.89	-2 54 -12	Left	Anterior Cingulate	BA10
29	4.13	-8 38 28	Left	Medial Frontal Gyrus	BA 9
22	3.43	4 44 24	Right	Medial Frontal Gyrus	BA 9
13	3.35	-46 6 46	Left	Precentral Gyrus	BA 6

References:

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