Cerebral dominance of phonological awareness in developmental dyslexia

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Introduction: Developmental dyslexia is primarily reading problem, despite normal intelligence, opportunity and in absence of any sensory, neurological or psychiatric disorder [1]. A core deficit is phonemic awareness that supports decoding of text and it persists during adulthood [1-4]. Rhyme detection task identifies the neural circuitry associated with phonological processing one of the earliest skills that children master [1-3].

Methodology: The study was carried out after IEC approval. Sample comprised of two groups- dyslexic group (n=16; DSM-IV) and control group (n=15 age and gender matched normal healthy). Inclusion criteria were: 8 to 16 years of age, right handedness, school going, given written consent by the immediate care giver. Exclusion criteria were IQ ≤ 70 and any neurological problems. Study was carried out on 1.5 Tesla MRI scanner with 12 channel head coil (Avanto, M/s Siemens). Single-shot EPI acquisitions were performed with slice thickness 4 mm, number of slices = 29, TR = 2 s, flip angle = 90°, FOV = 240 mm. Dynamic measurements of 122, 288, 214 measurements (volumes) were acquired for auditory, non-meaningful phonological and rhyming tasks respectively. The stimuli were presented using SuperLab (version 4.2, Cedrus inc, USA) and MR compatible headphones and the verbal output recorded with microphone (NordicNeuroLab, Norway). The phonological task comprised of 16 rhyming events in Hindi language where each event was of 10 sec duration with gap of 20 sec between the stimuli. The paradigm included sequence baseline of 20 sec (i.e. background noise with black screen display), then non-phonemic meaningful sound clip of 40 sec, followed by rhyming clip of 440 sec. The response was verbal repetition of the heard stimulus during the gap of 20 sec

Results: During the auditory perception when non phonemic noises were compared with background noise, in dyslexics with respect to controls BOLD activation were observed in right cingulate, right superior temporal gyrus, right parahippocampal and right insular cortex. In controls compared to dyslexic during rhyming task vs. meaningless phonological stimulus, BOLD activation was observed in left fusiform gyrus (Table; Fig1) and in dyslexics on comparison with respect to controls BOLD activation was observed in right superior temporal gyrus (Fig2).

Discussion: The phonological processing in healthy readers was observed to be left cerebral dominant and in dyslexics as right cerebral dominant, hypoactivation of left cerebral areas and activation in complementary areas. It was concordant with other studies quoting hypoactivation of the left posterior language system [4], left temporo-parietal cortex [3-6], superior temporal gyrus [3-6] and inferior occipito-temporal cortex [6,7].

Conclusion: The present findings evidence the existence of modified phonological processing in developmental dyslexia observed by bilateral BOLD activation with dominance of right superior temporal gyrus vs. left cerebral dominance in controls.

Table1: BOLD activation in Intergroup comparison during meaningless phonological stimulus with respect to rhyming task (p<0.005)

	Z-Score	MNI	Area	Brodmann area
Control v/s patient	2.95	-40 -54 -14	Left Fusiform Gyrus	BA 37
Patient v/s control	4.34	58 -48 20	Right Superior Temporal Gyrus	BA 13

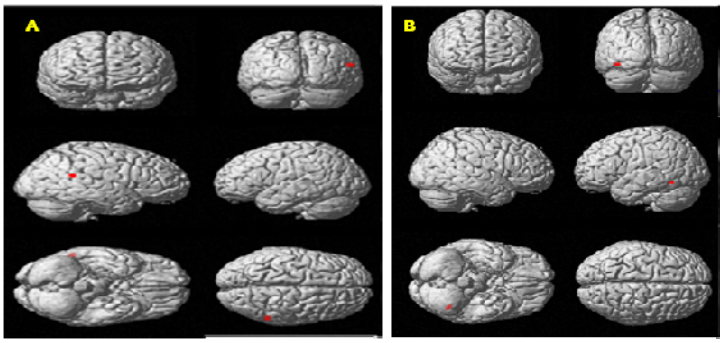

Figure1. BOLD activation in patient vs control (A) and control v/s patient (B) during meaningless phonological stimulus with respect to rhyming task (p<0.005)

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