Neurolinguistic response to semi-syllabic scripts in tri-linguals using functional MRI

U. Sreekumar¹, S. S. Kumaran², S. Khushu³, R. P. Tripathi²

¹Institute of Nuclear Medicine and Allied Sciences, Timarpur, DELHI, India, ²David Geffen School of Medicine at UCLA, Radiological Sciences, Los Angeles, CA, United States

Synopsis
Functional MRI studies were carried out in six tri-lingual subjects in block paradigms for visual inputs (words vs 1 and sentences vs 1) using LED goggles in a 1.5T whole body MR system. The post-processing was carried out using SPM99. Activation was seen in the posterior, inferior frontal cortex, parietotemporal cortex, angular and supramarginal gyrus, other than prefrontal and occipital lobes. Increasing levels of complexity in the language pattern (from spoken language to mother tongue to rarely used language) demonstrated increased activation in the Broca’s area (BA 44/45), prefrontal cortex and cerebellum.

Introduction
Language association while it is read and processed involves orthographic, phonological and semantic processing (1). When familiar and unfamiliar languages are presented, the visualization and processing might differ. We used semi-syllabic languages as compared to semi-orthographic languages, to associate the complexity of the reading pattern in multi lingual subjects with reading tasks.

Material and Methods
Whole brain imaging was performed using multi-slice single shot gradient echo - EPI, on a 1.5 T whole body MR imaging system (Siemens Magnetom Vision, Erlangen, Germany). BOLD Functional imaging series consisting of 72 sequential images with 6 cycles of active and resting paradigms, with six measurements each during the two phases. The languages chosen for the study are English and Indian languages, Punjabi, Hindi being Aryan languages and Malayalam being a Dravidian language.

Two groups of subjects, each of 6 right-handed healthy, trilingual volunteers (24-30yrs age group), one group proficient in the lingual combinations of Punjabi (mother tongue), Hindi (language at work) and English (used less frequently) and other group in Malayalam (mother tongue), Hindi (language at work) and English (used less frequently) were recruited. Proficiency levels were graded using a school language proficiency test. The age of acquisition of second (Hindi) and third (English) languages were 2 and 4yrs in all the subjects. The Hindi words were chosen considering the academic background of the volunteers (2).

Visual inputs (word/ sentences) were given through non-magnetic LED goggles at the rate of 15 cues/ min. Within each language, the activation phase consisted of a (i) lexico- semantic processing task involving semantically unrelated words (3-5 letter strings) and (ii) syntactic processing of sentences (statements and questions), balanced across processing complexities. During baseline, the subject was instructed to think randomly while viewing a numeral one on the screen. The post-processing of datasets was performed with Statistical Parametric Mapping (SPM99) on a SUN Ultra Spare workstation.

Results
Results show that processing tasks carried out were characterized by predominantly left-lateralized neuronal networks for the processing of the orthographic, semantic, and syntactic attributes of the input stimuli. Clusters of activations were observed in the language centres that included the posterior, inferior frontal cortex (Broca’s Area BA44,45), parietotemporal cortex (Wernicke’s Area BA21,22), Angular and Supramarginal Gyrus (BA39,40) and in other diverse regions in the pre-frontal cortex (BA9,10,11), occipital lobe (BA17,18,19).

Discussion
Increasing levels of complexities demonstrated increased activation in the Broca’s Area (BA44/45), pre-frontal areas and posterior inferior temporal lobe (1). This could be either as a result of the lower proficiency levels (for across language studies) or due to increasing cognitive load (for within language studies). Recruited cerebral regions did not show any language specific variations or hemispheric specialization with processing in all languages being seemingly mediated by a common neural system (3). Mother tongue was used mainly as spoken language, so the subjects had difficulty in reading and associated perception as compared to Hindi. But since they could not understand the words in English, it was mainly the attention and reading centres that were active. Though familiar words are supposed to activate the semantic reading route and novel words the non-semantic route (1), the reading of the familiar words and novel words in different languages were more dependent on the fluency level in that language (rather than the complexity of the words or sentences).

References