Title: Neural basis of the crossmodal correspondence between auditory pseudowords and visual shapes.

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Abstract: Behavioral research has demonstrated systematic crossmodal correspondences for many perceptual domains, e.g., between pseudowords and visual shapes bearing protuberances varying from rounded to pointed: the pseudoword “kike” (pronounced kee-kay) is typically associated with pointedness and the pseudoword “lomo”, with roundedness. Such correspondences, termed “sound symbolic”, have been theorized to underlie the origins of human language. The neural mechanisms mediating these correspondences are unknown. Here we used functional magnetic resonance imaging (fMRI) to examine the neural basis of the sound symbolic crossmodal correspondence between auditory pseudowords (“kike”, “lomo”), and pointed/rounded visual shapes. Participants (n=19) were presented with audiovisual stimuli in a block design. Stimuli either congruent or incongruent with respect to the sound symbolic correspondence occurred in separate, interleaved blocks. Participants attended to either auditory or visual stimuli, performing a two-alternative forced-choice on the attended modality. Reaction times (RTs) were recorded (RTc: RT for congruent trials; RTi: RT for incongruent trials). A neural incongruency effect (IE), indexed by greater blood oxygenation level-dependent (BOLD) responses for incongruent trials relative to congruent trials in the attend-auditory condition alone, was observed bilaterally in regions implicated in attention or cognitive control, including the frontal eye fields (FEFs), middle and inferior frontal gyri (MFG, IFG), anterior insula, intraparietal sulcus (IPS), and cingulate cortex. Many of these regions had IEs correlating negatively across individuals with the behavioral IE: (RTi - RTc)/(Rti + RTc); the negative correlation indicates that people with smaller behavioral IEs had stronger BOLD IEs. Three localizers, run to test proposed explanations for crossmodal correspondences, showed, among voxels with IEs: about a quarter, located in the MFG and IPS bilaterally and the right anterior insula, were more active when audiovisual stimuli were asynchronous than synchronous; some foci, in the right FEF, IFG and IPS, were active during magnitude estimation; and a few left IFG foci were active during semantic processing. Our findings may reflect multiple neural processes during processing of incongruent sound symbolic stimuli, including deployment of attention and/or cognitive control, multisensory processes, magnitude estimation (e.g. of roundedness or pointedness), and only minimally, semantic mechanisms.