The Role of Sensory Experience and Communication in the Neural Mechanisms Supporting Social Communicative Processes: An fNIRS Hyperscanning Study.

Introduction.

The neural networks for language processing have classically been considered as arising from modality-specific processes, until studies investigating signed languages demonstrated that these areas were responsible for carrying out linguistic functions regardless of language modality (i.e., functional specificity) (Nishimura, et al., 1999; Petitto et al., 2000; Cardin et al., 2016). In this study, we aim to broaden our understanding of the functional specificity of the high-level language processing neural networks by investigating the much less studied tactile language. We specifically test the extent of functional specificity of the left lateralized language network covering the inferior frontal gyrus (IFG) and superior temporal gyrus (STG) areas. If the language network is function specific rather than modality linked, we hypothesize that tactile signed languages perceived without sight or sound recruit the same canonical language regions as spoken and visual-based signed languages both for production, that is the IFG, and perception, that is the STG.

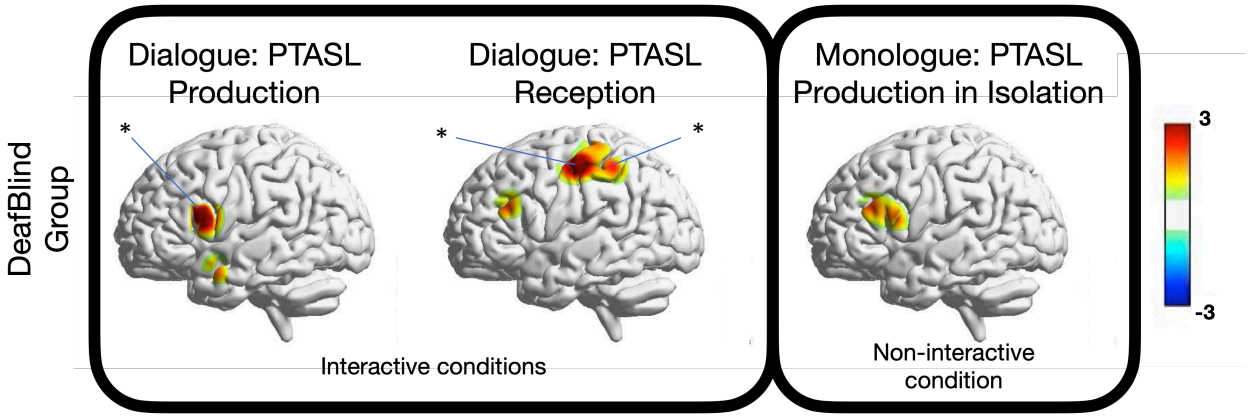
Method. We recruited 8 DeafBlind adults who use a tactile language: ProTactile ASL (PTASL). Neural activations were recorded with an fNIRS continuous-wave dual-brain imaging paradigm (i.e., hyperscanning), with time-locked recordings over the left hemispheres. This method has successfully been used for studying language processes, is portable and provides a greater ecological testing environment. Participants were divided in dyads and undertook a dialogue (production and perception) and a monologue (production only) task. For both tasks, participants were first given an object to explore before either naming and describing the object to themselves or before naming and describing the object to their partner. In the dialogue task, partners took turns in their roles: while one dyad member described an object, the other dyad member perceived the description.

Results. All contrasts were run against the baseline as statistical power was too low to compare two active tasks. The monologue task (production) showed activation in the left IFG (Figure 1). For the dialogue task, language production showed similar activation in the left IFG which is typically recruited in other language modalities. Language perception in the dialogue task showed activations in the somatosensory areas rather than the canonical left STG area.

Discussion.

Language production results support our hypothesis, and are consistent with research in visual languages, that PTASL shows functional specificity for high-level language processes and recruits the canonical left IFG. Language perception in the dialogue task shows novel and surprising results: perceiving language occurred in the somatosensory areas with no significant activations in Wernicke's area. This may be explained by several factors: First, language perception in PTASL requires a unique cooperative process where the listener's top-down anticipatory processing of linguistic utterances informs co-articulation of linguistic content. Interestingly, these somatosensory activations were found only in the listener role in the dialogue condition, and not the talker role, strengthening the idea that the somatosensory areas play a specific role related to tactile language perception. Second, the absence of activity in Wernicke's area (i.e., IFG) could be explained by low statistical power of our sample. However, activations for both production conditions (monologue and dialogue) resulted significant suggesting that we should have been able to detect activation in other language areas. Importantly, these results might be specific to our group of participants as none were native, from birth, PTASL users but varied in the time of acquisition of PTASL. It is possible that these activations resemble more those of second language learners who might show neural adaptation occurring later in life. Together, these findings are indicative of a functional specificity in the language *production* network, with novel adaptability of the human brain in order to perform the same language *perception* functions irrespective of modality differences.

Figure 1: Results for the contrasts against baseline showing IFG activation for the language production conditions and novel somatosensory recruitment for language perception. Due to the small power of our groups, maps are presented with a threshold of p<.01 to visualize the context in which peak activations occurred. Peaks at p< 0.05 are represented with *.



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