

## Functional connectivity for visual language processing

*Presentation will be conducted in English*

As researchers try to determine the impact of using primarily a sign language instead of a spoken language, various parts of the brain have been explored for changes resulting from both hearing loss and visual language usage. A key concept for understanding these studies is ‘functional connectivity’, essentially the correlations between spatially remote neurophysiological events. Prior studies investigating functional connectivity in Deaf signers suggest that life-long experience with sign language and/or auditory deprivation may alter connectivity of brain regions; specifically, functional and imaging evidence points to changes in superior temporal cortex function for processing of non-auditory inputs (Li et al., 2012; Malaia et al., 2011). The present study investigates functional connectivity among regions associated with temporal cortex in Deaf signers and hearing non-signers for network-based adaptations to visual language processing.

Participants (13 Deaf native ASL signers, 12 hearing sign-naïve participants) were presented with video stimuli in a block paradigm. During half of the blocks the participants carried out an active Task associated with watching short signed video clips, while the other half required only passive viewing (no-Task; task negative (TNN)).

fMRI demonstrated TNN activations in posterior cingulate (PCC), anterior cingulate (ACC), bilateral dorsomedial prefrontal cortex (dMPFC), and posterior Inferior Parietal lobe (pIPL) in both groups (Table 1). However, bilateral posterior superior temporal gyrus (STG) was only activated in hearing subjects. The absence of STG activation in the Deaf signers likely reflects re-wiring of these temporal regions, possibly for participation in a sign language processing network. This possibility is supported by presence of STG activation in Deaf signers in the Task-related condition .

We continue to analyze functional connectivity between regions activated differently in the default network of Deaf and hearing participants using partial correlation based on ICA after global signal regression. Seed ROIs (spheres with 5-mm radius) are centered in peak task-negative activation coordinates for the Deaf (PCC [4 -44 16], ACC [-8 40 8], left dMPFC [-26 22 46], right dMPFC [16 32 48], left pIPL [-28 -92 26], right pIPL [24 -78 48]) and hearing participants (PCC [12 -54 20], ACC [-6 30 0], left dMPFC [-24 32 54], right dMPFC [26 24 44], left pIPL [-44 -78 34], right pIPL [50 -74 32], left STG [-52 -8 -26], right STG [56 -6 -8]). This enables us to compare TNNs in using node strength metrics.

The significance of these differential activations in task-negative networks in Deaf signers and hearing non-signers is that brain regions are not selectively specified for the type of input. Instead, experience-based neuroplasticity results in self-organizing processing networks for dealing with systematic linguistic input.

## References:

- Emmorey K, Xu J, Gannon P, Goldin-Meadow S, Braun A (2009) CNS activation and regional connectivity during pantomime observation: No engagement of mirror neuron system for deaf signers. *Neuroimage* 49: 994–1005
- Li Y, Ding G, Booth JR, Huang R, Lv Y, Zhang Y, He Y, Peng D (2012) Sensitive period for white-matter connectivity of superior temporal cortex in deaf people. *Human brain mapping* 33: 349-359.
- Malaia E, Ranaweera R, Wilbur RB, Talavage TM (2012) Event segmentation in a visual language: Neural bases of processing American Sign Language predicates. *Neuroimage* 59: 4094–4101.

**Table 1. Cortical areas in no task > task in deaf (N=13) and hearing (N=12) participants**

Anatomical region (and their equivalent nodes in default network)	cluster size	Side	BA	Peak t value	Peak voxel coordinates	Cluster p-values, uncorrected	Cluster p-values, FDR-corrected
<b>Deaf</b>							
Posterior cingulate cortex (PCC)	1837	midline	31	4.93	4 -44 46	0.000	0.032
Anterior cingulate (vMPFC)	514	midline	24/32	4.94	-8 40 8	0.000	0.003
Middle/superior FG (dMPFC)	108	R	8	3.94	16 32 48	0.012	0.006
Insula	32	L	13	4.15	-40 -10 10	0.137	0.004
Parietal lobe (posterior IPL)	22	L	39	4.10	-28 -92 26	0.213	0.005
MFG (dMPFC)	22	L	8	3.39	-26 22 46	0.213	0.019
Parietal lobe (pIPL)	11	R	39	3.58	24 -78 48	0.378	0.013
<b>Hearing</b>							
Posterior cingulate cortex (PCC)	1244	midline	7/19/31	4.12	12 -54 20	0.000	0.018
Anterior cingulate (vMPFC)	668	midline	10/24/32	4.57	-6 34 0	0.000	0.013
Parahippocampal cortex (PHC)	326			4.82	-24 -38 -18	0.000	0.012
Angular Gyrus (pIPL)	178	R	39	5.08	50 -74 32	0.001	0.011
Medial FG (aMPFC)	173	midline	9	3.67	8 52 20	0.001	0.030
Middle/superior FG (dMPFC)	158	L	8	3.85	-24 32 54	0.002	0.026
Inferior/middle temporal gyrus (LTC)	130	R	20/21	4.06	56 -6 -8	0.004	0.020
Parahippocampal/Fusiform gyri (HF+)	130	R	37	3.81	28 -44 -10	0.004	0.027
MFG (dMPFC)	102	R	8	4.08	26 24 44	0.009	0.020
Occipito-parietal junction (pIPL)	38	L	19/39	3.58	-44 -78 34	0.089	0.031
Inferior/middle temporal gyrus (LTC)	32	L	20/21	3.67	-54 -8 -26	0.116	0.030
Occipital lobe	22	L	19	3.38	-18 -92 28	0.187	0.031
Lingual Gyrus	15	R		3.35	14 -82 -2	0.272	0.031
Angular Gyrus (posterior IPL)	15	L	39	3.35	-48 -68 30	0.272	0.031
STG (LTC)	14	R	22	3.25	60 -16 2	0.289	0.033
Lingual Gyrus	12	L		3.28	-10 -80 -6	0.326	0.032

For each cluster, the peak location is given in MNI coordinates, accompanied by location in terms of Brodmann's area and sulcal/gyral locus. T values represent the peak voxel activation within each cluster.