

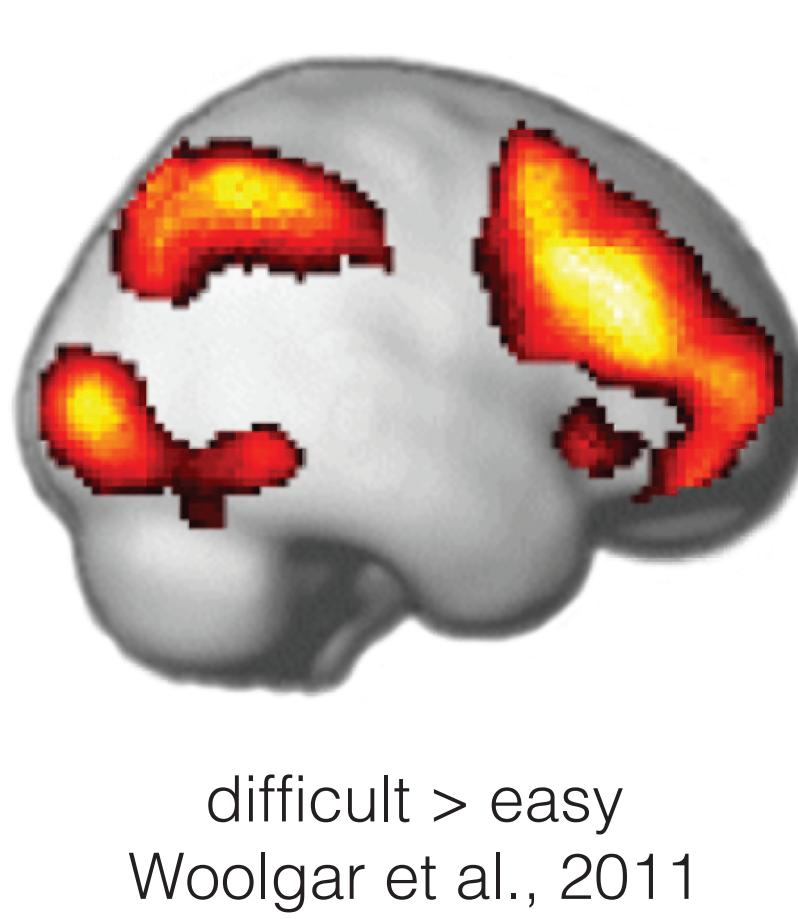
# Auditory- and visual-biased regions in multiple demand areas of human lateral frontal cortex

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Caudolateral frontal cortex, particularly along the precentral sulcus and inferior frontal sulcus, is part of the **multiple demand network** (Duncan 2010).

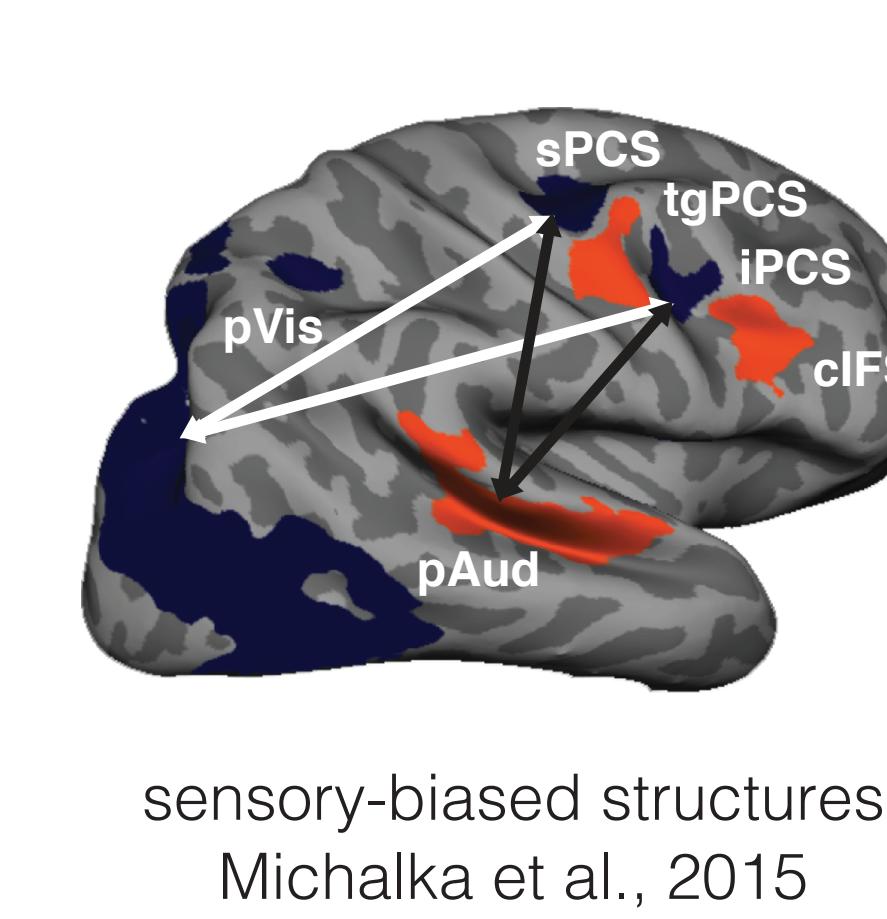


This network is characterized by  
 (1) Activation across many different task demands.  
 (2) Activation modulated by task difficulty.

Recently, we identified sensory-biased structures in lateral frontal cortex (LFC).

**Visual:** superior & inferior precentral sulcus, **sPCS & iPCS**  
**Auditory:** transverse gyrus bridging PCS, **tgPCS**, & caudal inferior frontal sulcus, **cIIFS**

Preferential functional connectivity to posterior visual & auditory regions confirms LFC's role in **sensory attention networks** (Michalka et al., *Neuron*, 2015).



Goals of this study:

- (1) Replicate finding of auditory- and visual-biased LFC structures in a fundamentally different task.
- (2) Reconcile conflicting sensory biased and multiple demand accounts of LFC organization.

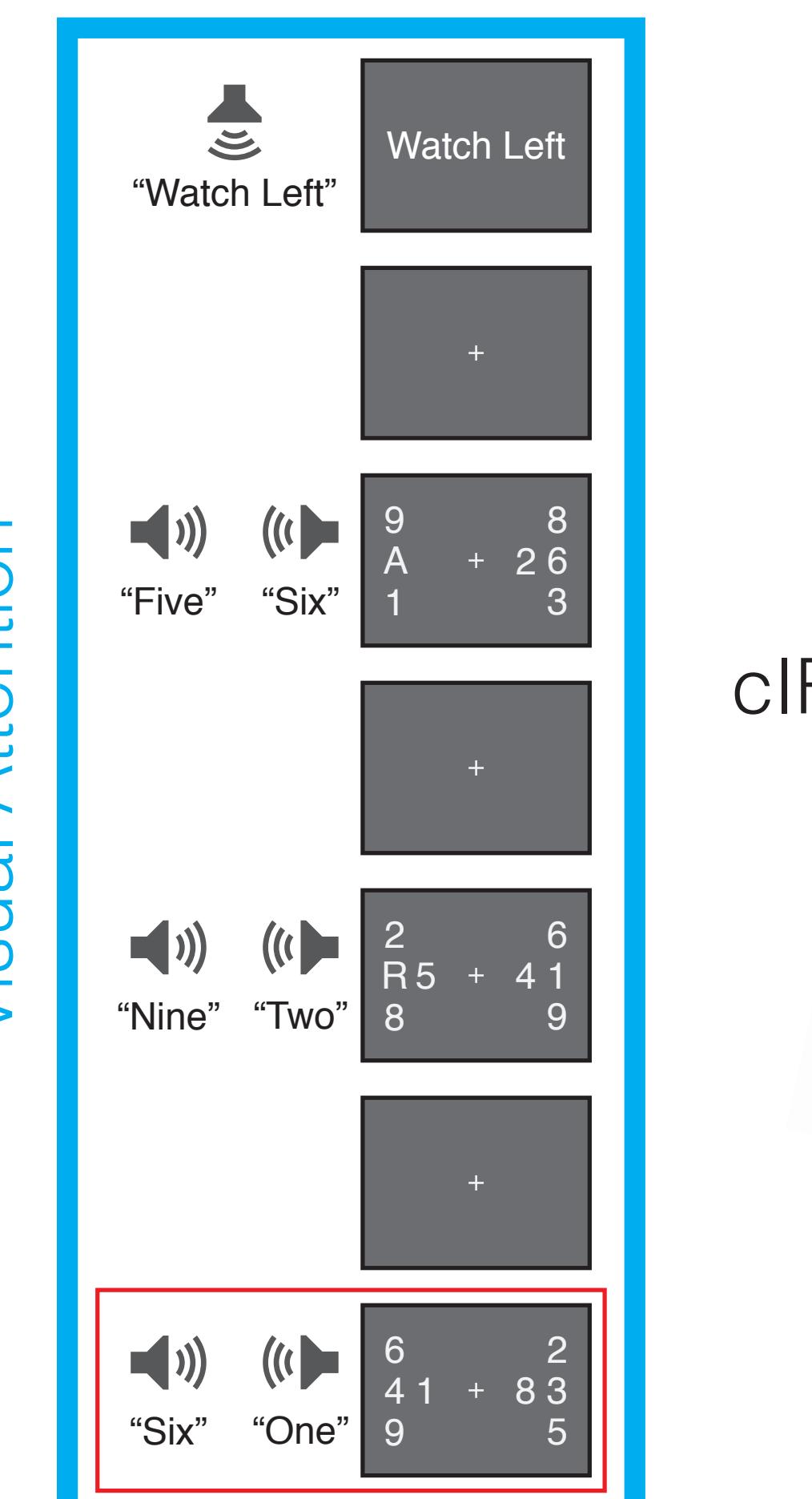
## Experiment 1 - Selective Spatial Attention

### Attention Task

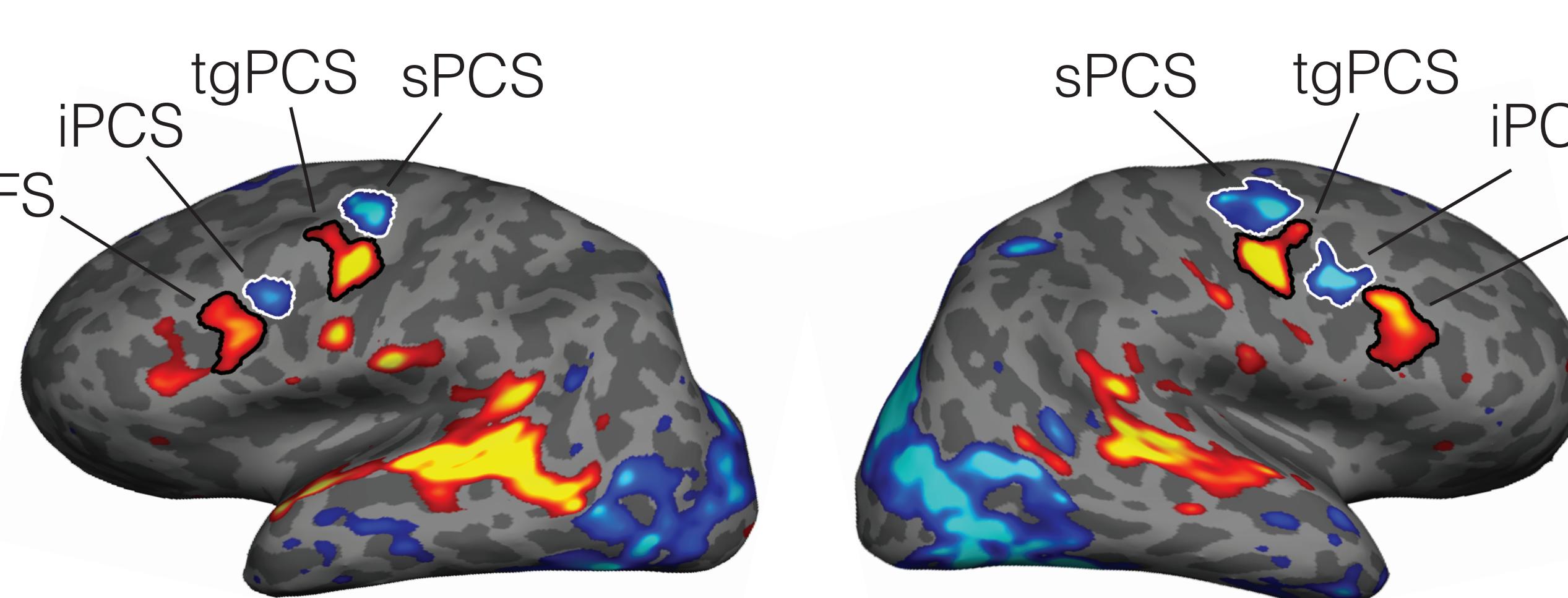
Subjects attended to 1 of 4 stimulus streams (2 auditory, 2 visual) and reported digits among letters (Michalka 2015).

Univariate contrast of **auditory** selective attention vs. **visual** selective attention identified four bilateral LFC structures that were consistently biased for one sensory modality.

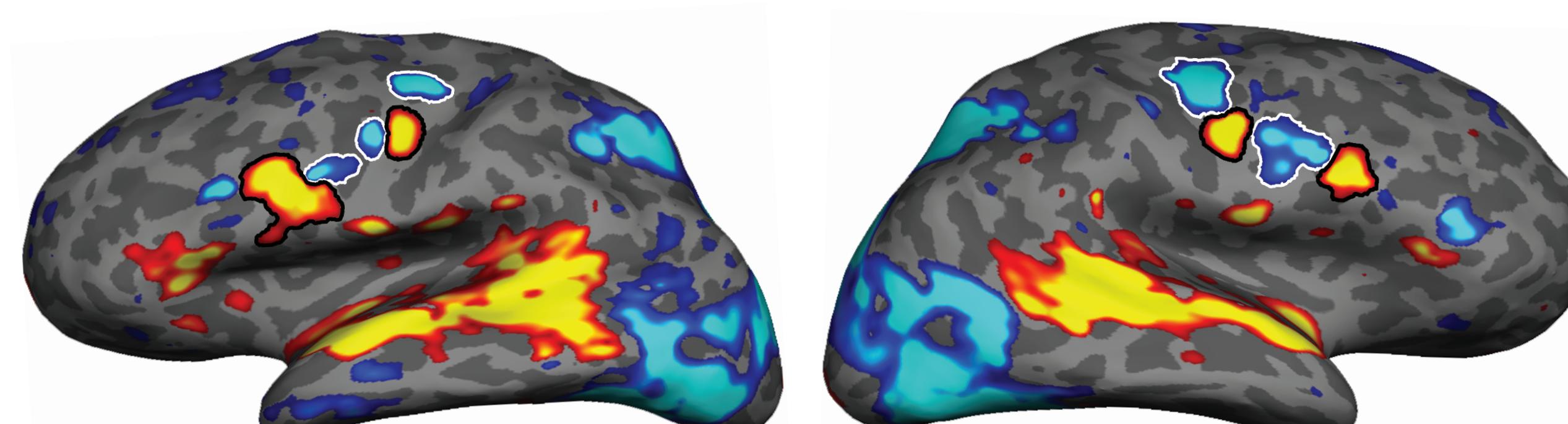
Visual Attention



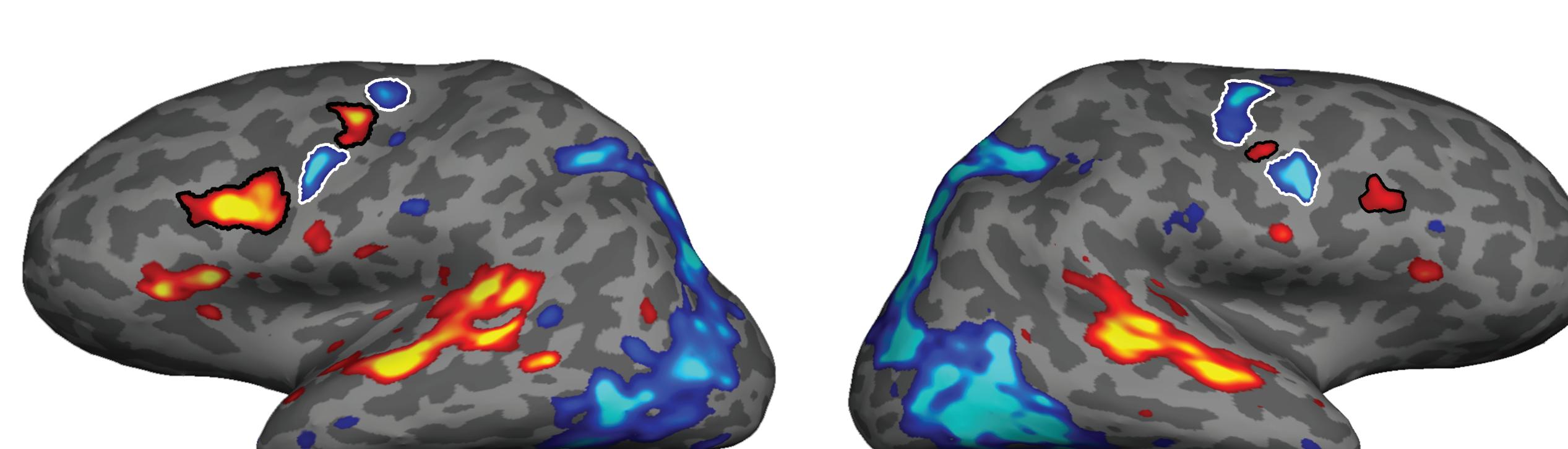
iPCS, tgPCS, sPCS, cIIFS



Subject 1



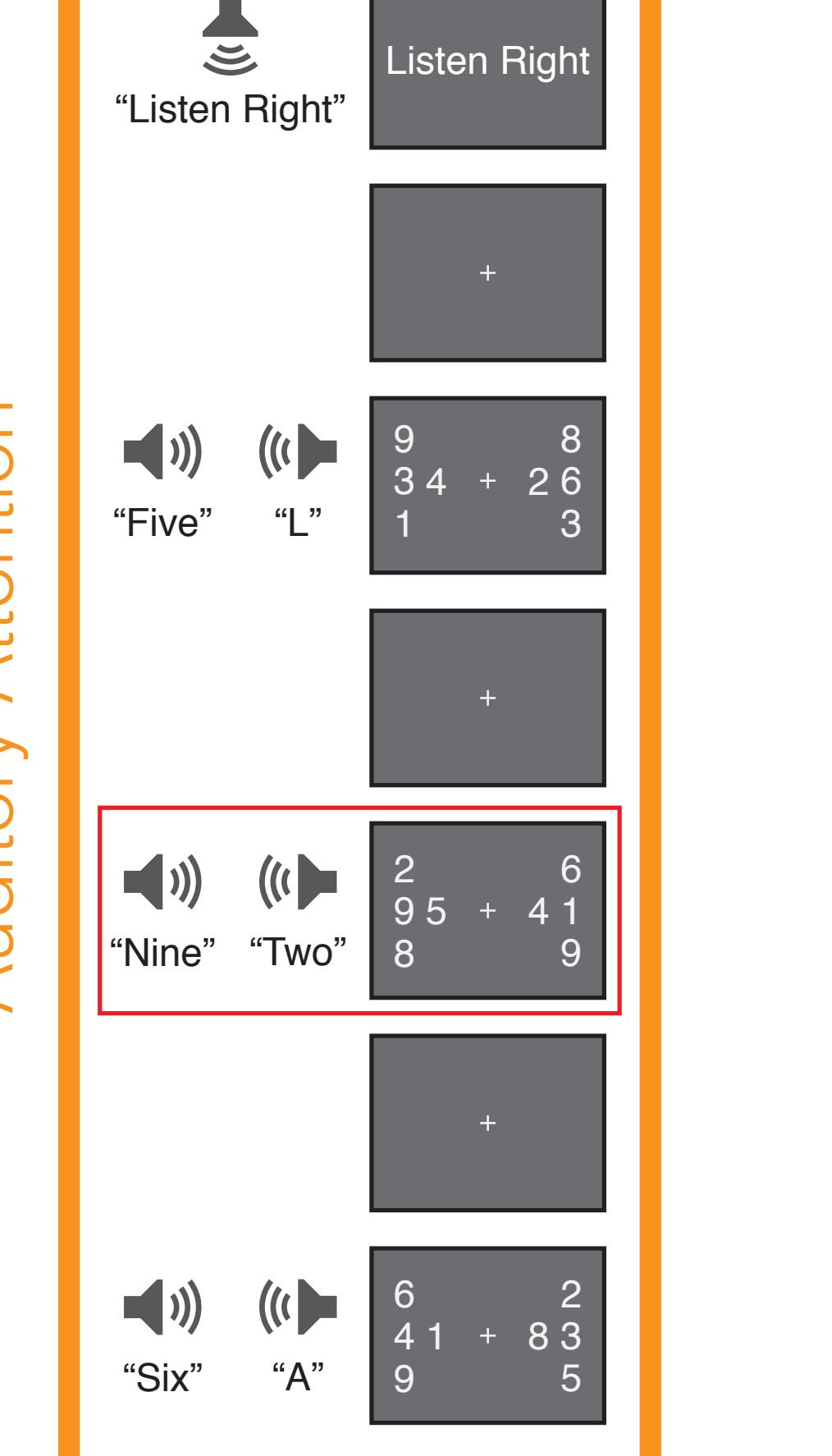
Subject 2



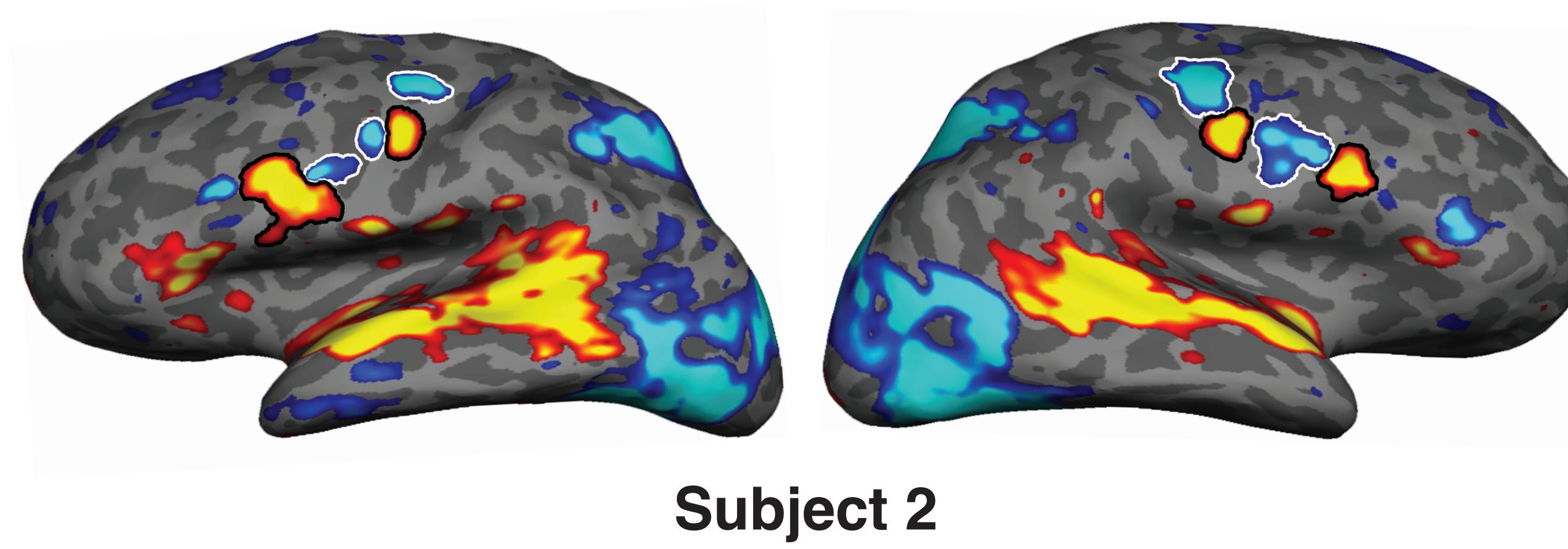
Subject 3

n = 10      Visual      -log(p)      Auditory

Auditory Attention



iPCS, tgPCS, sPCS, cIIFS

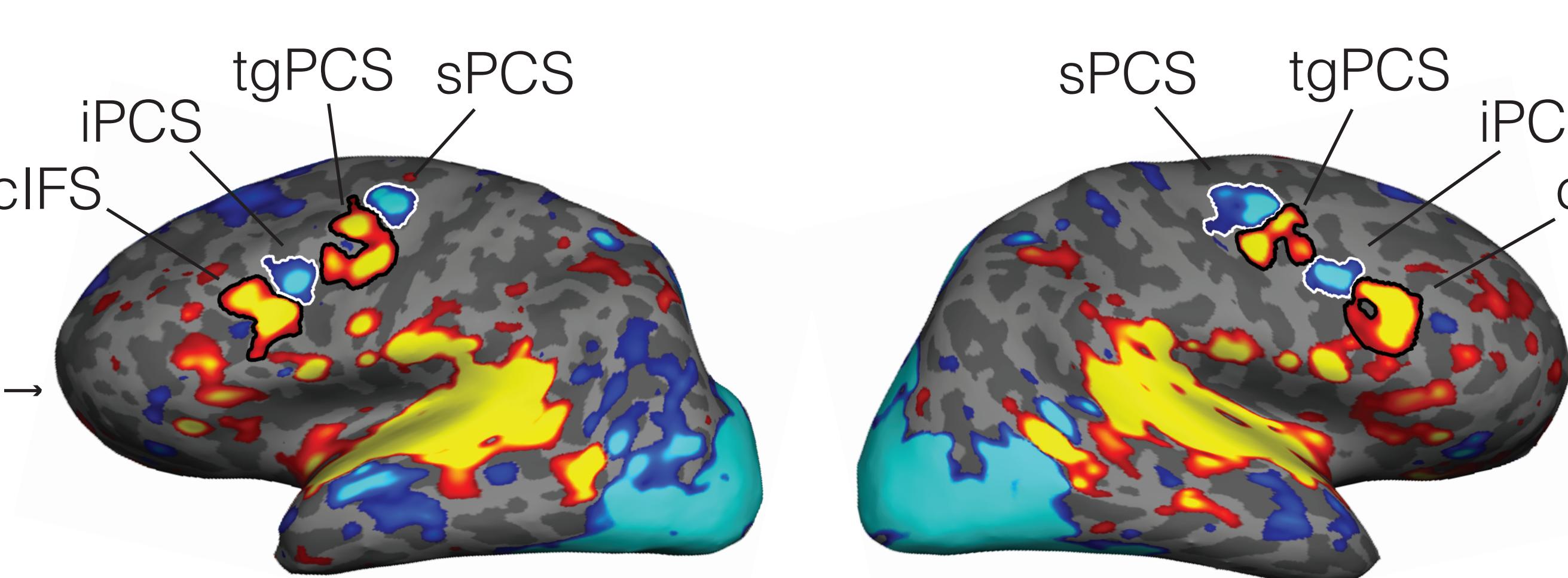


## Experiment 2 - Working Memory

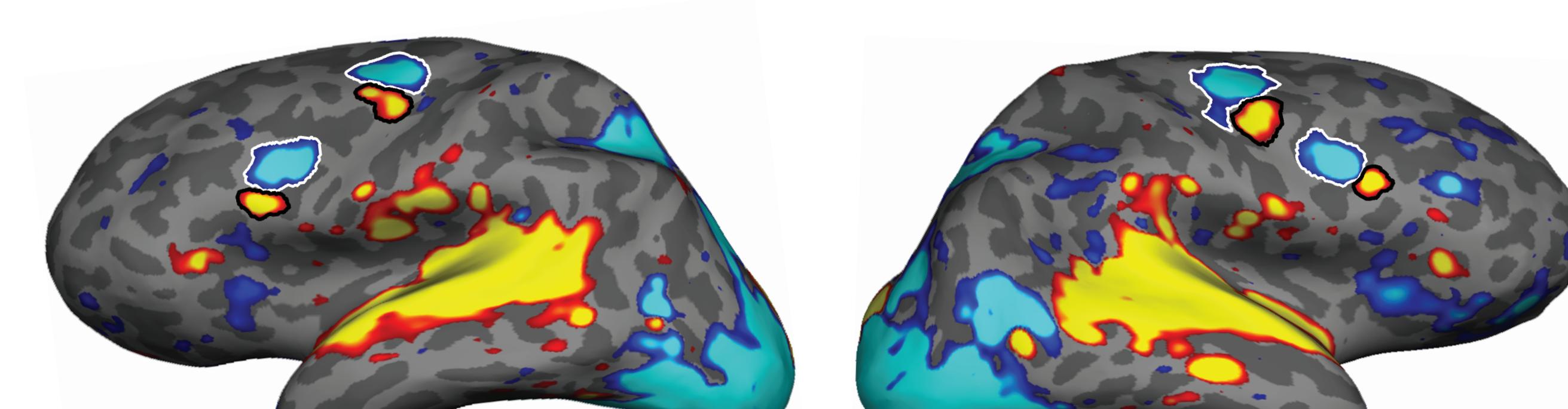
### Working Memory Task

Subjects monitored a single stream of either visual stimuli (faces) or auditory stimuli (cat and dog vocalizations) for 2-back repeats.

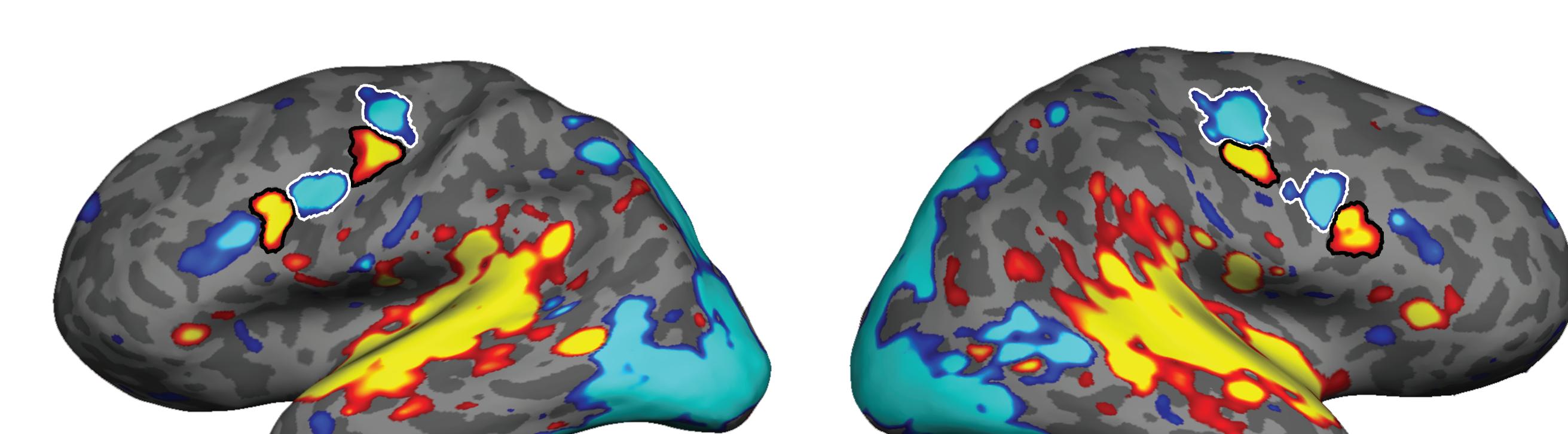
Univariate contrast of **auditory** working memory vs. **visual** working memory replicated sensory-biased LFC structures.



Subject 1

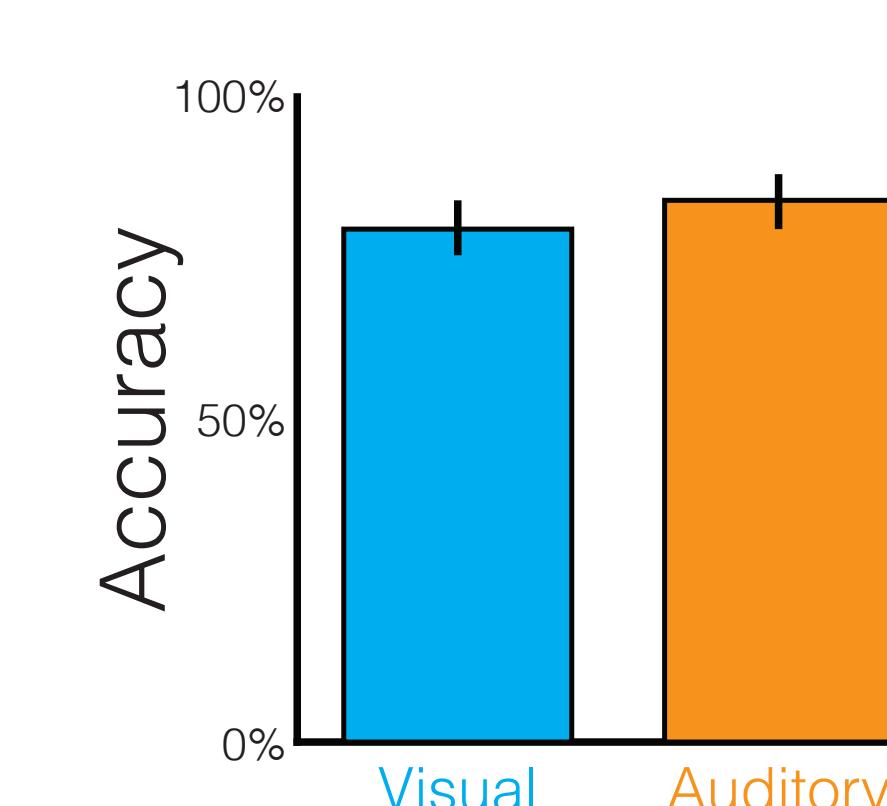
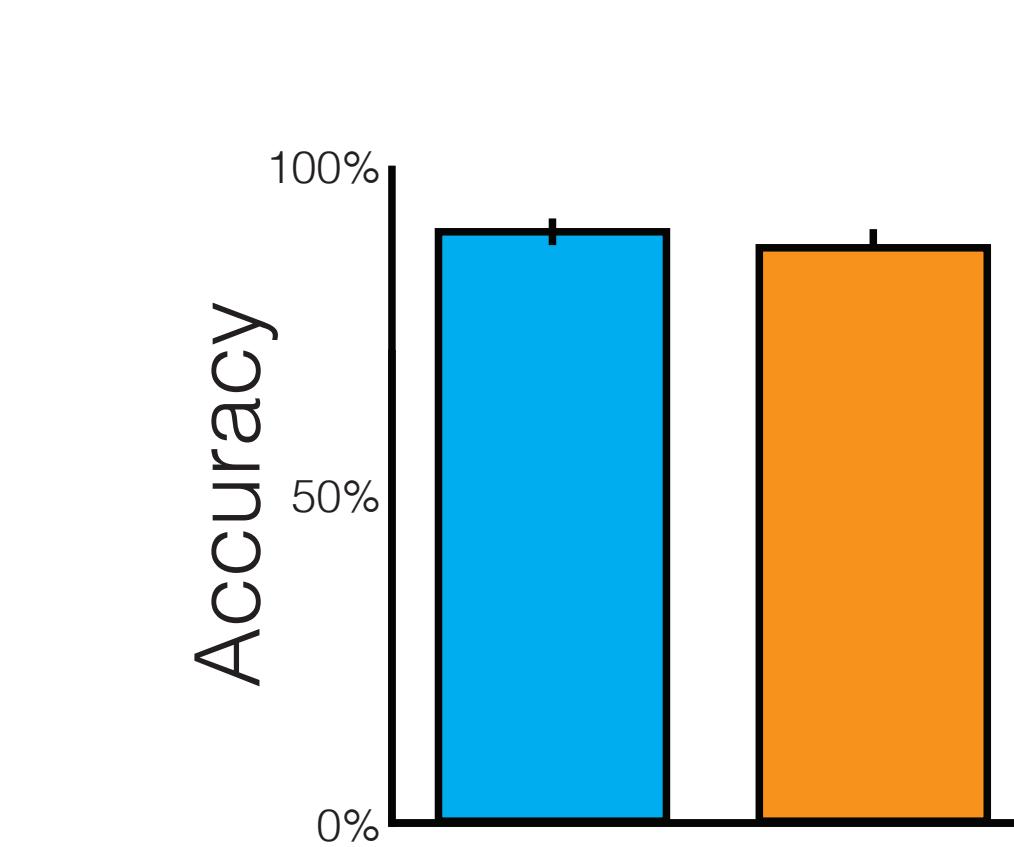


Subject 4



Subject 5

n = 16      Visual      -log(p)      Auditory



ROI identification rates

	Left	Right
<b>sPCS</b>	8/10	8/10
<b>tgPCS</b>	10/10	10/10
<b>iPCS</b>	9/10	9/10
<b>cIIFS</b>	9/10	9/10

Scan and stimulus parameters  
 3T Siemens Tim Trio, 32-channel matrix coil, TR = 2.6 s, TE = 30 ms, 42.3 mm slices, in-plane resolution 3.125 mm x 3.125 mm.  
 3-6 runs, w/ 4 blocks each of visual attention and auditory attention, & 2 of fixation and passive. 40 stimuli / 26 s per block.

### ROI identification rates

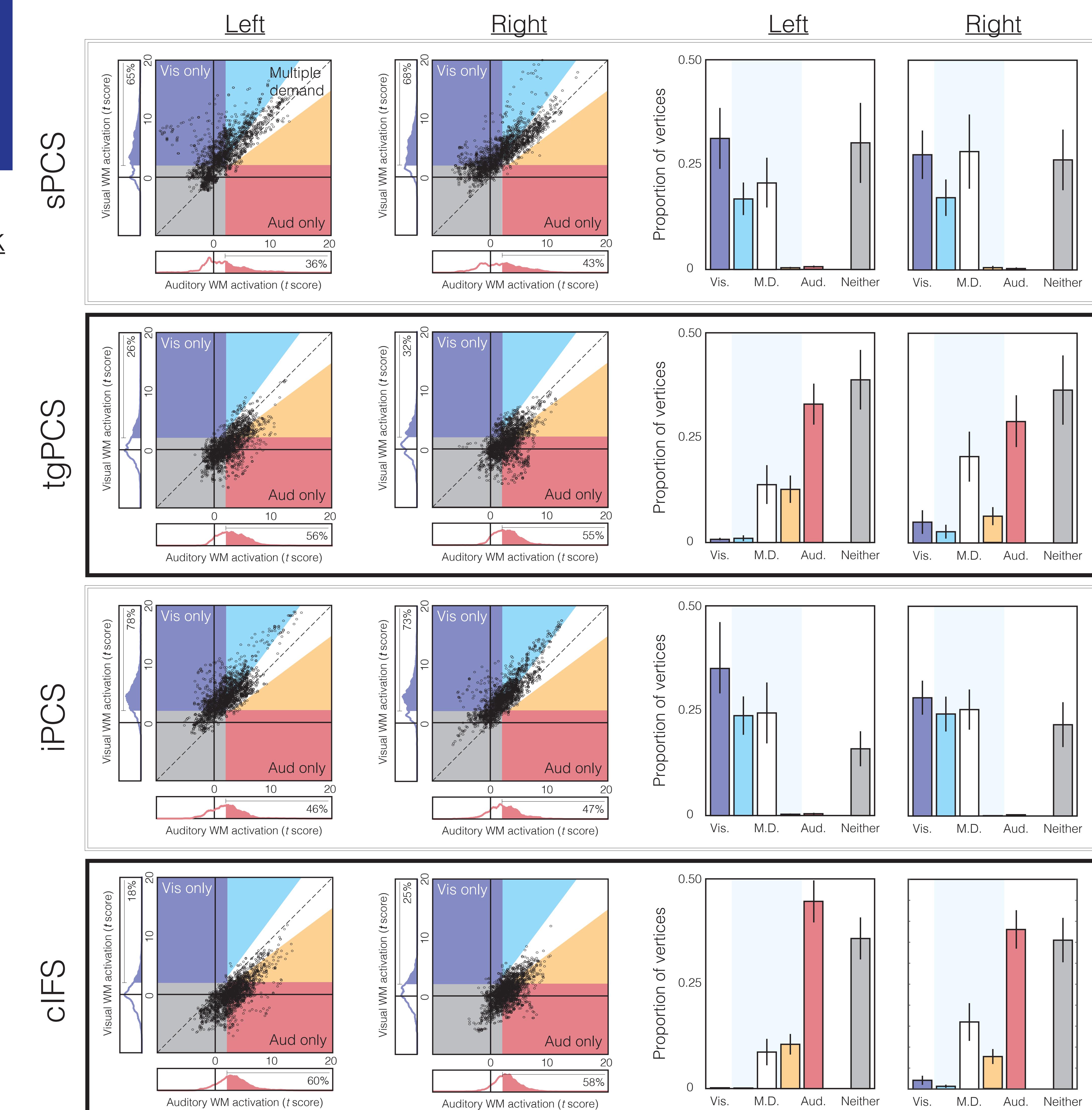
	Left	Right
<b>sPCS</b>	15/16	15/16
<b>tgPCS</b>	16/16	15/16
<b>iPCS</b>	16/16	16/16
<b>cIIFS</b>	15/16	16/16

### Scan & stimulus parameters

3T Siemens Tim Trio, 32-channel matrix coil, TR = 2.0 s, TE = 30 ms, 69.2 mm slices, in-plane resolution 2 mm x 2 mm.  
 8 runs, w/ 2 blocks each of visual 2-back, auditory 2-back, visual passive, auditory passive. 32 stimuli / 40 s per block.

## Multiple Demand Analysis

A second analysis of Experiment 2 tested for multiple demand behavior. We measured the degree of activation in each WM task vs. passive exposure to the same stimuli. Within each LFC structure, we determined the proportion of vertices with unimodal vs. multiple demand activation.

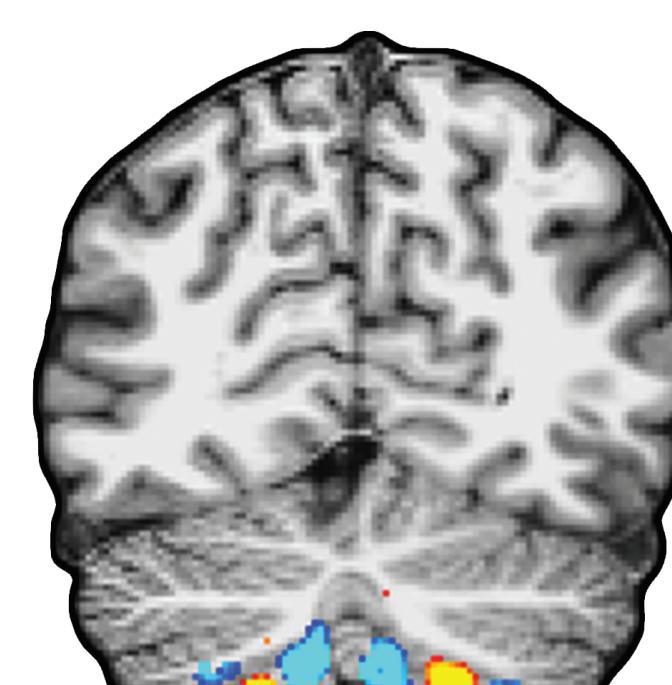


## Conclusions

Reliable, replicable identification of bilateral **sensory-biased** LFC structures.

**Visual-biased** sPCS & iPCS are also active in auditory tasks. This flexibility suggests visual cognitive substrates may support **multiple demand** processing.

**Auditory-biased** tgPICS and cIIFS are minimally active in visual cognitive tasks, and may comprise a more specialized cognitive network.



Sensory-biased attention networks extend to the cerebellum! See Emily Levin, poster board BB8.

Duncan (2010). *Trends in Cognitive Sciences*, 14.  
 Michalka et al. (2015). *Neuron*, 87.  
 Woolgar et al. (2011). *Journal of Cognitive Neuroscience*, 31.  
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