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Vision Sciences Society Annual Meeting Abstract | September 2019

Visual-biased frontal structures are preferentially connected to multisensory working memory regions.

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Journal of Vision September 2019, Vol.19, 245c. doi:https://doi.org/10.1167/19.10.245c

Abstract

Lateral frontal cortex contains discrete regions that are recruited for working memory (WM) in sensory-specific ways. We collected block-design fMRI (TE=30 ms, TR = 2000 ms, 1 mm iso) while 15 subjects performed 2-back WM for visual (face photographs) and auditory (cat/dog vocalizations) stimuli. Sensorimotor

control blocks were also collected. In addition, we collected 2–3 runs (180 TRs each) of eyes-open resting-state fMRI for each subject. Directly contrasting visual WM task activation with auditory WM revealed 6 bilateral sensory-biased structures along the precentral sulcus and inferior frontal sulcus of individual subjects. Visual-biased structures in the superior and inferior precentral sulcus (sPCS and iPCS) and mid inferior frontal sulcus (midIFS) are interleaved with auditory-biased structures in the transverse gyrus intersecting precentral sulcus (tgPCS), caudal inferior frontal sulcus (cIFS), and frontal operculum (FO). Each individual subject's visual- and auditory-biased frontal regions served as seeds in a seed-to-whole-brain resting-state functional connectivity analysis. After thresholding the resulting maps to remove negative correlations, we computed the difference in connectivity to the visual- and auditory-biased regions for each cortical vertex (Tobyne 2017). This differential connectivity analysis revealed subdivisions within areas we had previously identified as candidate multi-sensory WM regions (Noyce 2017). Anterior insula (AIC) contains a caudal portion with preferential connectivity to frontal auditory structures, and a more rostral portion with preferential connectivity to frontal visual structures. Similarly, pre-supplementary motor area (preSMA) contains a region with preferential visual connectivity, flanked above and below by regions with preferential auditory connectivity. Assessing task activation in these regions showed that the visual-connected portions of preSMA and AIC are significantly and equally recruited in both WM tasks, while the auditory-connected portions are not recruited in either task. These results provide further evidence that human cortical mechanisms for visual cognition participate flexibly in a wide range of tasks.