Evidence for a Causal Contribution of Macaque Vestibular, But Not Intraparietal, Cortex to Heading Perception

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Multisensory convergence of visual and vestibular signals has been observed within a network of cortical areas that are involved in representing heading. Vestibular-dominant heading tuning has been found in the macaque parieto-insular vestibular cortex (PIVC) and adjacent visual posterior sylvian area (VPS), whereas relatively balanced visual/vestibular tuning was encountered in the ventral intraparietal (VIP) area and visual-dominant tuning was found in the dorsal medial superior temporal (MSTd) area. Although the respective functional roles of these areas remain unclear, perceptual deficits in heading discrimination following reversible chemical inactivation of area MSTd suggested that areas with vestibular-dominant heading tuning also contribute to behavior. To explore the roles of other areas in heading perception, muscimol injections were used to reversibly inactivate either macaque PIVC or VIP bilaterally. Inactivation of anterior PIVC increased psychophysical thresholds when heading judgments were based on either optic flow or vestibular cues, although effects were stronger for vestibular stimuli. All behavioral deficits recovered within 36 hours. Visual deficits were larger following inactivation of the posterior portion of PIVC, likely because these injections encroached upon VPS, which contains neurons with optic flow tuning (unlike PIVC). In stark contrast, VIP inactivation led to no behavioral deficits, despite the fact that VIP neurons show much stronger choice-related activity than MSTd neurons. These results suggest that area VIP either provides a parallel and partially redundant pathway for this task, or does not participate in heading discrimination. In contrast, PIVC/VPS, along with MSTd, make causal contributions to heading perception based on either vestibular or visual signals.