Cortical Representation of Optic Flow as a Cue to Self-motion and the White-matter Tract Supporting the Process

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Representation and processing of visual cues from self-motion have been associated with the visual, multisensory and vestibular areas (Cardin & Smith, 2010; 2011). Using functional magnetic resonance imaging (fMRI), we assessed whether optic flow is encoded differently according to presence or absence of a visually-induced sensation of self-motion (vection). Areas including MT+, V6, VIP and PIVC exhibited greater BOLD responses to optic-flow stimulation during self-reported states of vection, which may indicate that activation in MT+, V6, VIP and PIVC reflects vection. Results also suggest that VIP plays a crucial role in integration of optic-flow information and vestibular information (or lack thereof) that is necessary for perception of self-motion.
Subsequent diffusion-weighted imaging (DWI) study investigated how those optic-flow selective areas communicate through white-matter pathways, by combining fMRI and DWI. Analysis of DWI data using probabilistic fibre tractography in mrTrix toolbox (Tournier et al., 2012) yielded tracts connecting these regions. Results of fibres tractography were then evaluated using Linear Fascicle Evaluation (LiFE; Pestilli et al., 2014), and tested for statistical evidence supporting the existence of the tracts. White-matter tracts connecting the multisensory areas (e.g. VIP) and vestibular areas (e.g. PIVC) were identified. The anatomical shape and location of this fascicle are consistent with of that identified in post-mortem studies (Sachs, 1892; Vergani et al., 2014). The significant statistical evidence further supports the existence of this tract. These findings indicate that the multisensory and vestibular regions communicate through this pathway, and support integration of visual and vestibular signals underlying the processing of visual cues to self-motion.