Multisensory interactions and plasticity: fibre tracking and perceptual learning

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Most species including humans perceive the environment by several sensory systems such as vision and audition. Many studies showed that visual perception is substantially modulated by sounds. However, the neural circuits underlying crossmodal interactions and the brain's capacity to adapt to novel multisensory experience is still debated. Two approaches provide new insights into the brain architecture and brain plasticity related to multisensory perception: Fibre tracking and perceptual learning. Fibre tracking based on diffusion-weighted magnetic resonance imaging is a non-invasive technique that reveals the white matter connectivity of the cortex. Probabilistic fibre tracking showed direct white matter tracks between the auditory cortex and the superior temporal cortex and between the auditory cortex and so-called 'modality-specific' visual cortex. The parts of the visual cortex with white matter connections to the auditory cortex also corresponded with brain areas that showed functional brain activity during multisensory perception. The connectivity fingerprint of tracks between the auditory cortex and the superior temporal sulcus (STS) suggests that the temporal cortex is comprised of a network of (partially) segregated brain regions involved in multisensory perception. Perceptual learning is a type of non-declarative learning that results from sensory experience. It likely reflects plasticity in early sensory cortex. Recent research showed that visual perceptual learning is guided by auditory experience. The specificity of these crossmodal learning effects suggests that auditory-guided perceptual learning relies on low-level crossmodal brain circuits. Moreover, experience may also alter these crossmodal circuits. Extensive training with mis-aligned auditory-visual stimulus pairs resulted in a shift of crossmodal spatial tuning. These results suggest a greater degree of multisensory plasticity than previously thought. A possible role of neurotransmitters in mediating plasticity in adults is discussed.