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A Cortical Circuit for Audio-Visual Predictions

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Team work makes sensory streams work: our senses work together, learn from each other, and stand in for one another, the result of which is perception and understanding. Learned associations between stimuli in different sensory modalities can shape the way we perceive these stimuli (Mcgurk and Macdonald, 1976). During audio-visual associative learning, auditory cortex is thought to underlie multi-modal plasticity in visual cortex (McIntosh et al., 1998; Mishra et al., 2007; Zangenehpour and Zatorre, 2010). However, it is not well understood how processing in visual cortex is altered by an auditory stimulus that is predictive of a visual stimulus and what the mechanisms are that mediate such experience-dependent, audio-visual associations in sensory cortex. Here we describe a neural mechanism by which an auditory input can shape visual representations of behaviorally relevant stimuli through direct interactions between auditory and visual cortices. We show that the association of an auditory stimulus with a visual stimulus in a behaviorally relevant context leads to an experience-dependent suppression of visual responses in primary visual cortex (V1). Auditory cortex axons carry a mixture of auditory and retinotopically-matched visual input to V1, and optogenetic stimulation of these axons selectively suppresses V1 neurons responsive to the associated visual stimulus after, but not before, learning. Our results suggest that cross-modal associations can be stored in long-range cortical connections and that with learning these cross-modal connections function to suppress the responses to predictable input.

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