Multisensory Integration in Ferret Auditory Cortex: Effects of Inactivating Visual Cortex

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INTRODUCTION
A subset of neurons in ferret auditory cortex are responsive to visual stimuli or may have their responses to broadband noise modulated by the presence of a visual stimulus (Bizley et al., 2007). Auditory cortical neurons may gain access to visual information through bottom-up thalamic inputs, top-down inputs from the prefrontal and parietal cortices and lateral inputs from visual cortex. However, it is unclear which of these afferent inputs actively contribute to visual sensitivity and multisensory integration within auditory cortex. Here, we assess the contribution of a sub-region of visual cortex — the suprasylvian cortex (SSY) — using reversible inactivation by cooling.

METHODS
Cooling loops were placed on SSY (A) in medetomidine-ketamine anesthetized ferrets. Multi-unit activity was simultaneously recorded in both auditory cortex and SSY in response to an auditory stimulus (A; broadband noise), a visual stimulus (V; white LED) and an audiovisual combination of the two (AV; noise and LED). Neural responses were recorded before, during and after cooling. During cooling, cold ethanol (−70°C) was pumped through the loops to reduce cortical temperature to between 6.0 and 10°C. At such temperatures, visual responses of SSY units could be reversibly suppressed whilst maintaining auditory responsiveness in auditory cortex (B & C).

RESULTS
Inactivation of SSY by cooling reversibly suppressed visual responses of auditory cortical units (D & E) indicating that SSY plays a role in driving visual activity within auditory cortex. In some units, SSY excitation was distinguishable from other sources of visual inhibition (F) suggesting that other regions of visual cortex contribute to multisensory integration. Consistent with this, we also found units in which visual responses were robust to cooling (G), indicating that regions beyond SSY engage both inhibitory and excitatory mechanisms. SSY also appears to engage inhibitory (as well as excitatory mechanisms) as units were recorded in which cooling lead to reversible emergence of visual responsiveness (H).

DISCUSSION
Further experiments are needed to determine the prevalence and anatomical distribution of the effects of cooling observed here. Nonetheless, these preliminary results suggest that SSY contributes to visual responsiveness and multisensory integration within auditory cortex as part of a wider network of brain regions that engages excitatory and inhibitory mechanisms. An open question is whether the effects of SSY are mediated through direct projections to auditory cortex or through indirect intermediaries (I). Future work aims to disentangle these possibilities and identify additional regions within the audiovisual network that subserves multisensory integration in auditory cortex.

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