Modulation of auditory responses by modality-specific attention in rat primary auditory cortex

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How does attention modulate sensory representations? In order to probe the underlying neural mechanisms, we established a simple rodent model of modality-specific attention. Here we describe results of experiments in freely moving rats in which we have used tetrodes to record neural responses in primary auditory cortex (area A1) while subjects performed this behavior.

Subjects were first trained to perform distinct auditory and olfactory two alternative forced-choice (2AFC) tasks. Training and testing were conducted in a custom three-poke computer-controlled behavioral apparatus. Subjects initiated trials with a center-poke, which triggered presentation of a tone (either 5 or 15 Hz), an task odor (either R(-)-2-Octanol or S(+)-2-Octanol), or both. Subjects responded moving to the left or right poke. Correct responses were rewarded with water. Auditory and olfactory blocks (of 50 trials each) were interleaved in a single session. In auditory blocks, pure tones were either presented with or without a null odor (caproic acid, n=2 and 3 respectively), and subjects were cued to perform the task based on auditory stimuli. In olfactory blocks, both task odors and pure tones were presented simultaneously, and subjects were cued to perform the task based on olfactory stimuli.

After subjects reached consistent performance on the interleaved blocks, tetrode drives were implanted in primary auditory cortex of the left hemisphere. Single unit responses to tones were heterogeneous, and included transient, sustained, and suppressed. Among 304 responsive units recorded, 19% (58 units) showed modality-specific attentional modulation of at least one of the tone-evoked responses; in most cases, the responses to a particular auditory stimulus was enhanced in the auditory block (or, equivalently, suppressed in the olfactory block). In addition, we also observed modality-specific attentional modulation of the spontaneous activity in similar proportion of units (61 units).

Our results suggest that shifting attention from audition to olfaction and back can modulate the activity of single neurons in primary auditory cortex.