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Selectivity and temporal resolution of neural coding in rostral auditory cortex of macaques during a working memory task

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Regions of the rostral superior temporal cortex in primates are hypothesized to constitute a sound-quality processing stream. Although these areas have been implicated in auditory short-term memory, the influence of behavioral context on their tuning properties remains unknown. We recorded the activity of single neurons in this region, including rostral parts of the auditory core areas, during performance of a delayed match-to-sample task. Auditory stimuli were presented serially: a sample sound was followed by 0-2 distracter stimuli (inter-stimulus interval ~1000 ms) before the sample sound was presented again. The animal released a lever to indicate the "match". The stimulus set consisted of 21 sounds, each ~300 ms in length, including synthesized sounds, animal vocalizations (rhesus monkeys and other species), and environmental sounds. The reliability of neural coding was quantified by a classification approach. The stimulus evoking each spike train was estimated by measuring the Euclidean distance between the response and a set of templates, derived from the responses to each stimulus in the set (Foffani and Moxon 2004). These responses and templates were peri-stimulus time histograms of a set bin width; measuring classification performance over a range of bin widths identified an optimal temporal resolution for decoding the spike trains of each neuron. The bin width at which classification performance (as measured by the average percent correct across 21 stimuli) was maximal varied across neurons, with a median of 50 ms for sample presentations; the distribution for match presentations was not significantly different, suggesting that temporal resolution does not vary within a behavioral trial. The median performance of the classifier was 10% correct (twice that expected by chance), and did not vary significantly between sample and match presentations. This low performance appears to result from a sparse (selective) representation, such that one neuron encodes only a subset of the stimuli with high accuracy. The mean number of stimuli classified at >2 standard deviations above chance (as determined by bootstrap simulations) was 4.7 for sample presentations, 4.5 for match, at best bin width (no significant difference by Wilcoxon sign-rank). By contrast, applying the same classification method to spike rate alone yielded lower classification success during match presentations (3.6 vs. 2.9, p=.013). Suppression of the match response by adaptation (or memory-specific mechanisms) may alter spike rate codes in neurons of higher-order auditory cortex, whereas temporal codes are robust to changes in overall discharge rate.