SPATIO-TEMPORAL PATTERNS OF SPIKE OCCURRENCES IN FREELY-MOVING RATS ASSOCIATED TO THE PERCEPTION OF HUMAN VOWELS

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1. Objective

Coding of complex auditory signals like vowels and its subsequent generalization in the corresponding cognitive representation represents an unresolved question of sensory information processing. We investigated if rats could discriminate between vowels that differed in second formant (F2) peak, and how discrimination was affected by changing the fundamental frequency (F0) and formant peaks.

2. Methods

Synthetic vowels (/EH/ and /AO/) with 9 different F0s ranging from 125 to 325 Hz, for which formant peaks were correspondingly shifted 1/3 of the F0 shift (in log units), were generated. Multiple single units were simultaneously recorded from the auditory cortex of freely-moving behaving Long Evans rats. During the training phase vowels were presented at F0s of 175 and 275 Hz at variable sound levels.

3. Results

The performance of 80-95% correct responses to the four stimuli was achieved in 12 sessions and remained stable over sessions also when the remaining stimuli were introduced. During the wait period we observed no changes in the firing rate but significant stationary spatio-temporal firing patterns could be detected. These patterns indicate a very precise repetition of spike discharges, separated by intervals up to several hundreds of ms. In most cases the occurrence of such pattern in a trial was associated with a subsequent NoGo response independent of whether that stimulus was priming a Go response. We observed also that Go trials in which a specific pattern was detected in the waiting period were followed by a faster reaction time than trials without the pattern. Other patterns were found after stimulus presentation which were associated with a set of vowels. There was evidence that the rats responses depended on the relation between fundamental and formant frequencies that they had previously been exposed to.

4. Discussion

Despite the fact that rats basic auditory capabilities differ from that of humans and other species that have previously been used in research on speech sounds, these results suggest that rats use spectral and temporal cues similarly to humans. These animals should be a worthwhile subject for further studies in the domain of speech perception. Furthermore, these

results suggest that rats are capable of generalizing to different instances of the same vowel and that recurrent neuronal networks encode the information with high temporal accuracy.

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