Explicit representation of frequency differences in the central auditory pathway

Suyash Joshi*[1] and Tania Barkat[1]

[1]Basel University – Switzerland

Abstract

The tonotopic organization is a hallmark of the auditory system, and the smallest perceivable differences in tone frequencies are considered to indicate the frequency resolution of auditory processing. Although the latter, the psychophysically measured frequency discrimination threshold, is believed to be the functional consequence of the former, the tonotopic organization of the auditory system, the precise neural mechanisms that relate the two is not yet understood. Therefore, the theoretical models use implicit representations, such as the difference in excitation patterns evoked by tones, for modeling this relationship. However, whether the auditory system carries an explicit representation of frequency differences between two stimuli is not yet known. In this study, using the mouse auditory system as a model, we asked whether there exists an explicit representation of the frequency differences in the nuclei of the central auditory pathway. Using multichannel silicone probes, we recorded single and multi-unit responses in subcortical (inferior colliculus) and the primary cortical nuclei (primary auditory cortex, A1 and anterior auditory field, AAF) of the central auditory system of awake mice, passively listening to train of pulses composed of either pure tones (PT; 6000 Hz or 24000 Hz) or harmonic complex tones (HCT; F0 1500 Hz or 6000 Hz). We experimentally varied the frequencies (for PT) or the fundamental frequency (for HCT) of the alternating pulses from 0 octaves (same-frequency) up to 0.4 octaves (alternating-frequency) above and below the reference frequency and quantified its effect as a change in spike rate from the reference same frequency signal. Consistent with the tonotopy, same-frequency PT stimuli evoked localized responses. However, an increasingly larger population of recorded neurons responded to increasing differences in alternating-frequency stimuli. All HCT stimuli evoked a broadband response across the population of neurons. Despite the differences between responses to PT and HCT stimuli, a large proportion of neurons showed similar response modulation with increasing frequency difference for PT and HCT stimuli in all three nuclei (IC: 64 % for PT, 38 % for HCT; AAF: 44 % for PT, 40 % for HCT; A1: 54 % for PT, 40 % for HCT). These results demonstrate that an explicit representation of frequency differences is present in the central auditory nuclei. Characterizing such explicit representations and their consequences on the perception of frequency differences will help elucidate the neural mechanisms underlying frequency discrimination.

*Speaker