Factors influencing stream segregation arising from interaural timing differences

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Abstract

The perceptual grouping of sequential sounds can be studied using sequences of alternating 'A' and 'B' tones that differ in one or more acoustic dimension. A and B tones may be grouped together as a single perceptual stream ('integration') or segregate into two perceptual streams. We examined the factors that influence segregation when tones subsets differ in interaural timing cues.

In Experiment 1, listeners (n=12) heard sequences comprising 5×ABA– repetitions ('–' = extended silence), and reported whether integration or segregation was heard at sequence offset (2AFC). A & B were 80-ms pure tones, with a 40-ms silent inter-stimulus interval (ISI) between each tone. The extended silence ("–") was 160 ms. The amplitude envelope shape was varied across trials, but was common for A and B tones within a trial. One envelope comprised 10-ms ramps at onset and offset, and was constant for the intervening 60-ms. The asymmetrical fast attack-slow release (FA-SR) envelope comprised a 10-ms onset ramp and 70-ms offset ramp. The slow attack-fast release (SA-FR) envelope was the reverse of this configuration. In a first task, A and B differed in frequency (f), and envelope shape did not affect segregation. In a second task, A and B differed in interaural phase difference (IPD), and significantly more segregation was heard in the FA-SR envelope conditions.

Experiment 2 (n=12) tested only the FA-SR envelope, and the ISI was varied from 0-60 ms. In the f-only task, segregation decreased with increasing ISI, but in the IPD-only task, segregation increased with ISI. The influence of envelope shape and ISI on IPD streaming suggest that the temporal integration of binaural cues across A and B tones may reduce stream segregation. The data imply an integration window of between 40-200 ms, within the range of previous estimates. In a third task, A and B tones differed in either frequency, IPD, or both. Contrasting with the IPD-only task, IPD-based segregation was not observed in this mixed-cue task. This suggests IPD segregation is highly sensitive to across-trial contextual effects, potentially accounting for differing findings in previous studies.

In Experiment 3, listeners attempted to hear integration to detect a delay imposed on the final four B tones of an 8×ABA- sequence (an adaptive 2I-2AFC procedure). FA-SR tones were tested (ISI = 60-ms, maximum B delay = 40-ms). Preliminary data (n=6) suggest

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performance worsened with increasing f, but IPD had only a marginal impact on overall performance. These findings are consistent with previous studies. However, IPD elevated thresholds substantially on the first repeat of each condition, suggesting that IPD may have initially promoted segregation, but listeners learned to 'ignore' the cue on later repeats.
These experiments suggest that whilst f may be a more robust cue for segregation than IPD overall, each cue appears differently influenced by additional factors, such as ISI or amplitude envelope (Experiments 1 & 2), contextual effects (Experiment 2), and potentially, the time-course of learning effects (Experiment 3). Therefore, stimuli that are optimized for f-based segregation may be suboptimal to observe IPD-based segregation.