Perceptual retuning targets features
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Introduction
Previous work has shown that listeners systematically “retune” their categorical boundaries when presented with real-word tokens containing an ambiguous segment. There have been multiple previous studies on this lexically-guided retuning (Jesse and McQueen 2011; McQueen et al. 2006; Norris et al. 2003), but most work thus far has assumed that the retuning is at the level of the segment. In this paper, we show that retuning occurs at the level of features; therefore, we also show that the speech perception mechanism has access to featural representations and not directly to segmental representations themselves.

Basic Design of Experiments
We created separate 41-step continua for F-S and V-Z based on segments extracted from natural productions of an American English speaker, using Praat scripts (Boersma and Weenink 2016). These continua were spliced in as onsets of an [i] vowel taken from a labiodental token. From this set, we selected the two end points [vi-zi] or [fi-si], as well as 12 evenly spaced steps in the middle of each continuum. Therefore, we had separate continua of 14 steps each for F-S and V-Z.

The two continua were tested on 13 native English-speaking participants using a two-alternative forced choice identification task, where the choices were /f/-/s/ and /v/-/z/ respectively for the corresponding continua. The continua each elicited categorical identification functions typical of consonants.

The mid-point of the categorical identification function for the F-S continuum was identified based on the responses and this formed the “ambiguous” token [FS]. This ambiguous token was used in two experiments, wherein the relevant segment /f/ was replaced in words by the ambiguous token. Furthermore, both experiments had the same procedure that included a lexical decision task (LDT) both preceded and followed by a categorization task, that was identical to the one employed to test the continua. The objective of the experiments was to see if the replacement of the /f/ with the ambiguous [FS] in words presented during the LDT affects the categorization of the F-S continuum (Exp. 1) and to see if such retuning in the perceptual space of F-S generalizes to the V-Z continuum (Exp. 2).

Experiment 1
35 native English speakers participated in the task. The LDT consisted of 150 words, including 34 critical monosyllabic test items. 17 test items contained /f/ either in onset position or in coda positions, while the other 17 contained /s/ in similar syllabic positions. Each word contained only one instance of the specified segment and no other instances of /f, s, v, z/. The remaining 116 words were filler words of varying length, 75 of these being phonotactically licit nonce words that did not contain /f, s, v, z/. All the /f/ sounds in the test items were replaced with the ambiguous [FS]. The design of the LDT was similar to the experiments from Norris et al. (2003).

Results
All the participants passed the criterion of higher than 50% accuracy in the LDT (criterion based on (Norris et al. 2003)). An analysis of the responses to the categorization tasks suggested that there was a decreased proportion of alveolar /s/ responses after the LDT (Fig. 1). A one-tail paired Welch test comparing the before-after responses for the F-S continuum showed that there was a significant decrease in alveolar responses in the step 7-27...
Experiment 2  Another 36 native English speakers, distinct from those in Exp. 1, participated. The stimuli in the LDT part of the experiment were identical to those in Exp. 1. However, the before-after categorization tasks involved the V-Z continuum.

Results  Two participant responses were removed from further analysis as they failed to pass the accuracy criterion of 50%. An analysis of the responses to the categorization tasks suggested that there was an decreased proportion of alveolar /z/ responses after the LDT (Fig. 2). A one-tail paired Welch test comparing the before-after responses for the V-Z continuum showed that there was a decrease, similar to Exp. 1, in alveolar responses in the step 28-35 region $[t(33)=-2.4, p<0.05]$.

Discussion  In Exp. 1, a replacement of the /f/ segments with an ambiguous [?FS] during the LDT resulted in a decrease in the alveolar /s/ responses for the F-S continuum, suggesting that there was a phonetic “re-tuning” involved with the segment /f/, whereby a larger phonetic space was reassigned to the /f/ category. This is a replication of previous results. Crucially, in Exp. 2, a replacement of the /f/ segments with an ambiguous [?FS] during the LDT resulted in a similar decrease in the alveolar /z/ responses for the V-Z continuum. This suggests that the retuning seen in Exp. 1 was not for the segment /f/ but was for the place-feature labiodental. Therefore, phonetic retuning seems to target, not segments, but features. More generally, our results suggest the automatic extraction and use of features during speech perception. The results are in line with other recent work arguing that perception accesses features directly and not segmental representations (Chládková et al. 2015).

References


Norris, Dennis, James M. McQueen, and Anne Cutler (2003). “Perceptual learning in speech.” *Cognitive Psychology* 30.2, pp. 1113–1126.