The Features [continuant] and [voice] in Spoken Word Recognition
Danny Moates and Jennifer Zehe
Ohio University

Abstract

Stevens (2005) proposed that a lexical entry is represented by a sequence of bundles of distinctive features. Recognizing spoken words involves extracting such bundles from the acoustic signal and matching them to sequences in the mental lexicon. We tested this hypothesis in a word recognition task. Participants tried to identify a real word (e.g., parking) from a nonword (e.g., tarking) whose target segment differed on [continuant] or [voice]. Results completely supported the hypothesis for [continuant] and largely supported the hypothesis for [voice].

Do distinctive features appear in the mental lexicon? Are they activated when we recognize a spoken word?

Stevens (2005) proposed that a lexical entry is represented by a sequence of bundles of distinctive features. Spoken word recognition proceeds in part by extracting such bundles from the acoustic signal and matching them to sequences in the mental lexicon.

The Matching Hypothesis: If distinctive features play a role in lexical retrieval, then a target segment which matches the replacing segment on one or both of those features will be recovered more frequently than one that does not match. We tested this hypothesis for the features [continuant] and [voice] in a word recognition task.

Nonword Target Word Difficulty
pingly kingly easy /ŋ/ matches /ŋ/ on [continuant] and [voice]
fringly kingly hard /ɪŋ/ matches /ɪŋ/ on [continuant]
fringly kingly hard /ɪŋ/ matches /ɪŋ/ on [voice]
vingly kingly hardest /ɪŋ/ matches /ɪŋ/ on neither [voice] nor [continuant]

Participants heard a nonword (e.g., pingly) and were asked to change it to a real word by changing just one consonant (here, kingly). The target segment (here /ŋ/) was replaced by a consonant which matched the target segment on the feature [continuant] or [voice] or both or neither.

Method

Participants: Forty-three American students, all native speakers of English.
Materials: 13 target segments: voiced stops b, d, g, voiced stops p, t, k, voiced fricatives /v, z, l/. Each target segment appeared in the stressed syllable of 12 or more two-syllable words.
Control: word frequency, number of segments, number of consonants, uniqueness point.
We created nonwords by replacing a target segment with another consonant.
Within each of the 13 sets of words, 25% of the replacing segments matched the target segment on both the features [continuant] (stop, fricative) and [voice] (voiceless, voiced), e.g. /b/ → /p/, /v/ → /b/. 25% of the replacing segments matched the target segment on [continuant] but not [voice], e.g., /d/ → /l/, /v/ → /v/. 25% of the replacing segments matched the target segment on [voice] but not [continuant], e.g., /z/ → /z/, /v/ → /v/. The remaining 25% were recorded in two randomizations on a CD. Each nonword was spoken twice to ensure clarity. The repeated pairs of nonwords were spaced 10 seconds apart.
Procedure: Participants heard nonwords over headphones and were asked to think of a word that could be created by changing just one consonant and write that word on their response sheet.

Results

The responses were scored for errors, defined as any response that was not the target word. The Matching Hypothesis was tested with a 2 x 2 x 2 x 2 analysis of variance on errors, with subjects (F1) and items (F2) as random factors.

Four variables:
- Target value of feature [continuant] (stop, fricative)
- Replacing segment value of feature [continuant] (stop, fricative)
- Target value of feature [voice] (voiceless, voiced)
- Replacing segment value of feature [voice] (voiceless, voiced).

The Target Class x Replacing Segment Class x Target Voice x Replacing Segment Voice interaction was significant in the subject analysis, F(1,42) = 72.10, p < .001 and marginally so in the item analysis, F(1,156) = 3.80, p = .053. Figures 1-4 display the interaction.

Discussion

Clear evidence appears for the influence of [continuant]. When a stop replaces another stop or a fricative replaces another fricative, the error rate is lower than when a stop replaces a fricative or a fricative replaces a stop. That is, when target and replacing segments match on [continuant], recovering the target segment is easier than when they do not match, in accordance with the Matching Hypothesis.

Partial evidence appears for the influence of [voice]. When a voiced target is replaced by a voiceless replacing segment, the error rate is much lower than when it is replaced by a voiceless replacing segment. Matching target segments and replacing segments on [voice] facilitates the recovery of the target segment, in accordance with the Matching Hypothesis.

When the target segment is voiceless, the outcome is mixed. As predicted, voiceless replacing segments are easier when stops replace stops and fricatives replace fricatives. Voiceless replacing segments are not easier when stops are replacing fricatives or fricatives are replacing stops, contrary to the Matching Hypothesis.

The Matching Hypothesis is supported in both of the relevant comparisons for [continuant] and in six of the eight relevant comparisons for [voice].

Conclusion

Matching target and replacing segments on [continuant] produces easier recovery of the target segment. Matching target and replacing segments on [voice] produces easier recovery of the target segment in most cases. These effects are consistent with Stevens' hypothesis that segments are represented as bundles of features in lexical entries.

References