MICROPHONETICS IN SEGMENT PERCEPTION

KLAUS J. KOELER
Institut für Phonetik und digitale Sprachverarbeitung
Universität Kiel
2300 Kiel, FRG

ABSTRACT

For German it has been demonstrated in a number of experiments that in production as well as in perception a level and a level + falling F0 contour on a prestop vowel cue for fortis and lenis stop, respectively. This paper reports on perception experiments that replicate the German findings for English, and relates the results to an interaction of three factors: (a) prestop microprosody, (b) poststop microprosody, (c) global utterance microprosody.

INTRODUCTION

The importance of F0 after stop release as an acoustic cue for the lenis/fortis categorization of stop consonants has been known for a long time (/1/). F0 preceding a stop closure, on the other hand, has not been attributed a similar cue value. For German it has been demonstrated in a number of experiments with the utterance "Diese Gruppe kann ich nicht leiden/leiten," that in production as well as in perception a level and a level + falling F0 contour on a prestop vowel are cues for the lenis/fortis distinction.

EXPERIMENT 1

The test tape of experiment 2 of /2/ was presented to a group of 16 native speakers of English (students of phonetics and languages), in several subgroups, via a loudspeaker in a sound-treated room of the Kiel Phonetics Institute. They classified the stimulus utterances as "leniden" or "lieiden" sentences by ticking the appropriate boxes on prepared answer sheets. Two groups of 6 and 7 British English speakers performed the same test under the same conditions, but they gave their answers by pressing one of two buttons at the recording stations of a reaction-time measurement system. They were students of German spending 6 months in Germany to improve their proficiency in the language.

RESULTS

The German group replicates the results of the previous test (cf. /2/, pp. 24(f)). The two English groups, which do not differ from each other and are, therefore, combined in the data presentation of figure 1, show clearly separate identification functions for level and falling F0. They gave their responses at the time of vowel closure (122-120 Hz) and that the periodicity of the nasal plosion. They, too, occur after a voiceless consonant cluster that interrupts the F0 glide from a low value on "ask" to a high one in the contrastively stressed main word. Generally the F0 peak value when it sets in again at vowel onset is higher for the German group, coalesce in this upward.

EXPERIMENT 2

Two English sentences were constructed that replicate the focal and utterance-final position as well as the segmental structure and the phonetic context of the German test words: (1) /'laedn/ - /'laetn/; and (2) /'waedn/ - /'waetn/.

EXPERIMENT 3

The sentences "I am telling you I said widen/whiten." with regard to level F0 as against the other two F0 patterns, but that theY must be some essential acoustic difference between the English "lyden/leiten" stimuli. The obvious candidates are the strong voicing instead of creak in the final nasal of the English "leiden/leiten" stimuli. The reason for this difference may be that because English speakers generally do not locate the duration ratio at a lower value than the German lenides/leites.

Since the frame was not synthetic, the English test stimuli was not synthesizable. The 21 vocalic nuclei were repeated ten times and randomized to give a test of 210 stimuli, following the same procedures as in the German test. The two groups of native British English speakers in Experiment 1 acted as informants under the same listening conditions in separate sessions.

EXPERIMENT 4

They classified the stimulus utterances as "Lyden" or "Lighten". Since the frame was not synthetic, the English test stimuli was not synthesizable. The 21 vocalic nuclei were repeated ten times and randomized to give a test of 210 stimuli, following the same procedures as in the German test. The two groups of native British English speakers in Experiment 1 acted as informants under the same listening conditions in separate sessions.
followed by a linear fall to 85 Hz, the proportion of level and slope sections staying the same in all stimuli. The first 100 ms of the level F0 were identical with the level section of the level + falling pattern in the longest vowel and changed proportionally with the vowel duration; the remainder descended to 122 Hz. In the third pattern, F0 fell linearly throughout from 119 to 85 Hz.

The original /d/ release was again eliminated, and the 21 synthesized vowels + closure pauses were spliced into the sentence frame. F0 at voice onset of the final vowel was 89 Hz, descending to 69 Hz. The very large amplitude of the regular periodicity in /d/ was adjusted to the one found in "lyden" by applying the reduction factor .35. The durations and the F0 patterns were comparable to the ones in the test stimuli of Experiments 1 and 2, but with important differences in the height of the pre- and postconsonantal F0 ending and starting points.

The test tape construction and the running of the experiment followed the same lines as in Experiment 2. A previous run of the test was reported in /3/. It was repeated here by the same two British English groups as in Experiments 1 and 2. In a pretest, each of the 13 subjects was examined as to whether they distinguished "wh" from "w". Two informants did and were, therefore, excluded from the test because their expectations for "whiten" would have been different.

Results and discussion.

Figure 1 provides the data for the combined group. There are no inter-group divergences. The differences between the three F0 patterns have practically disappeared. The effect of flat F0, which was still quite present in the previous run of the same test, has been levelled out. Otherwise the two test runs provide corresponding locations of the identification functions. Since it is only the response curve for flat F0 that is positioned differently in the "lyden/lighton" and the "widen/whiten" data, the initial consonantal /w/ cannot be responsible for the increase of /d/ judgements. It must be an acoustic feature difference that is peculiar to the flat F0 stimuli. In "lyden/lighton", F0 is flat across the stressed syllable, and a rise from the preceding syllable is masked by voicelessness; after the closure silence, F0 resumes at its low utterance-final value. The flat F0 contour is thus bounded by voiceless stretches on both sides, with low F0 preceding and following. In this environment, the high flat F0, i.e. the fortis cue, becomes perceptually salient. In "widen/whiten", on the other hand, there is an upward glide from the low value of the preceding syllable right into the stressed vowel, and it is only the final 130 - 160 ms that are actually low F0. In this context, the high flat F0 is integrated into a macroprosodic rise-fall pattern and is, therefore, perceptually far less salient, thus losing its fortis cue strength.

GENERAL DISCUSSION

The results of the 3 experiments point to the following prosodic influences on lenis/fortis stop perception in German and English.

1. A flat F0 across a stressed prestop vowel in a focused utterance-final syllable is a fortis cue, compared with falling F0 patterns, in both German and English as long as the flat F0 is clearly detachable from a macroprosodic utterance intonation as a microprosodic manifestation. In German, a flat + falling F0 is also differentiated from a continuously falling F0 as a stronger lenis cue.

2. In English, the category boundary between lenis and fortis is located at lower duration ratios. This leads to a coalescence of the identification functions for flat + falling and continuously falling.

3. A stop release with regular voicing of high amplitude and an F0 fall (below the focus peak) weakens the preconsonantal microprosodic fortis cue.

4. The microprosodic effects of prestop flat and flat + falling F0 are obliterated when they are integrated into macroprosodic utterance pitch patterns.

5. The interaction of pre- and poststop microprosody and of global utterance macroprosody explains why a pretop F0 influence on lenis/fortis perception can only arise under special circumstances and, therefore, not provide a basis for tonogenesis (cf. /1/).

REFERENCES