Plural predictability and OCP influence plural morpheme duration in English

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This study uses the phonetic realization of English plural /s/ to explore two theoretical questions.

First: Can morphological structure affect phonetic realization? The issue of whether or not morphological structure is relevant in explaining phonetic variation is controversial. While several studies claim to find effects demonstrating that segments in morphemes of complex words are influenced by word structure, it has been suggested that these findings are artefact of how much the given segment contributes to identifying the word as a whole, rather than the morpheme itself.

Second: Can long-distance effects of the OCP be realized in a phonetically gradient manner? Long-distance effects of the Obligatory Contour Principle (OCP) have been documented in English, which displays a dispreference for sequences of nearby coronals. While the conditioning factors in some of these studies have been gradient, with violations occurring more or less often depending on the specific violation, it has yet to be shown that this constraint can cause phonetically gradient realizations of phonemes which violate OCP.

Using the ONZE corpora, plural nouns were extracted along with automatically-generated duration measurements for the plural morpheme and the word as a whole. The data was made up of monosyllabic words ending with an [s] or [z] plural allomorph, following a consonant, and not preceding a sibilant. After excluding tokens with obvious errors, 5494 tokens were analyzed.

In order to measure effects particular to the plural morpheme, a measure of contextual predictability of plurality was calculated for all tokens. This factor, previous word plural probability (PWPP), was measured by calculating, for each word preceding one of the plural words, how often this word occurs before a plural relative to its total frequency in the corpora. For example, the word various occurs frequently before plural nouns, and has a PWPP of 0.345, while pretty has a much lower PWPP of 0.00178. This allows us to quantify the contextual probability of the plural morpheme independently of the contextual probability of the word as a whole. The duration of the word without the plural (stem duration) was included in the model in order to ensure that any effects seen were independent of effects on word duration.

A linear mixed-effects regression model was fit, with log plural duration as the outcome variable. Predictors included log unigram word frequency, log speech rate, various measures of phonological context (e.g. vowel quality, coda complexity, preceding and following phone, utterance finality), word bigram predictability based on preceding and following word, log stem duration, and PWPP. There were additionally random intercepts for speaker and plural word, with slopes by PWPP.

The optimal model was selected using backwards elimination. Factors which contribute to longer /s/ duration include utterance finality (t=14.023, p < .001), simple stem coda (t=4.150, p < .001), and a lax stem vowel (t=-2.885, p < .01). Factors which contribute to shorter /s/ duration include log speech rate (t=-13.663, p < .001), and a stop preceding or following the /s/ (preceding: t=-2.664, p < .01; following: t=-2.086, p < .05).

In addition to the main effects above, there is a significant interaction of stem duration and PWPP (t=3.71, p < .001). This interaction is shown in Figure 1.

![Figure 1: Interaction of PWPP and stem duration](image)

For longer stem durations, the effect of PWPP is either flat or slightly in the unexpected direction. However, for shorter stem durations, there is an effect of PWPP in the expected direction, with shorter plural durations for higher PWPP; that is, higher contextual predictability of plurality corresponds to a more reduced plural morpheme.

Finally, in addition to the expected effects of PWPP, there is a significant effect of a coronal obstruent in the onset (t=-3.627, p < .001). The effect of a coronal obstruent in the onset predicting shorter /s/ duration is consistent with studies showing effects of the OCP in English across intervening
phonemes\textsuperscript{1,7,10}. However, the current finding demonstrates that the OCP operates even at the level of fine phonetic detail.

The effect of the contextual predictability of plurality on plural duration suggests that morphological structure is relevant to the phonetic realization of morphemes. The duration of /s/ is modulated by its contribution to identifying plurality in context, not simply identifying the word. While /s/ is a single-segment morpheme (and therefore potentially the only segment in the word signaling plurality), its contribution to identifying the plurality of the word is modulated based on PWPP. In plural nouns preceded by a word which is highly predictive of plurality (eg. various, PWPP= 0.345), we interpret the results as indicating that since the /s/ is contributing less to identifying the noun as plural, it can be reduced. On the other hand, when preceded by a word with low plural predictability, e.g. pretty (PWPP= 0.00178), the /s/ is more important for identifying the plural. Although this effect is not consistent across all stem durations, it suggests that properties of sub-lexical meaningful units contribute to systematic phonetic variation.

With regards to the finding that for longer stems predictability seems to have the opposite effect on the plural morpheme, we speculate that this may be because subtle phonetic cues to plurality occur early in the word. Previous studies\textsuperscript{8,9} have found that morphological stems which occur in unaffixed and affixed forms are acoustically distinct, and that this difference was enough to cause increased reaction time in participants when the overt plural marking and stem were mismatched. If, in words with longer duration, plural cues disambiguate the word earlier, this may reduce the need for /s/ duration to be modulated as a function of contextual predictability of plurality. In words with shorter stems, these early cues may already be so reduced that /s/ is more important for plural identity.

The present study differs from previous studies in which effects of morphological structure could potentially be explained by a segments’ contribution to identifying the word as a whole. In the present case, systematic variation in the duration of /s/ is shown to occur even within the same plural word. As the relative contribution of a segment to identifying the whole word remains constant for any given word, this systematic variation must have another explanation. Our findings thus contribute to the debate over whether or not morphological structure influences the phonetic realization of morphemes, suggesting that it does in fact play a role. This, in turn, weighs in on the debate over whether complex words are processed as entire units. If plural /s/ duration varies independently of stem duration and is affected by the contextual predictability of plurality, this suggests that the plural morpheme can be processed independently of the word in which it is contained. The two theoretical questions we posed, then, can both be answered in the affirmative. The production of the English plural is phonetically gradient, and is conditioned by plural predictability in context, and gradient effects of the Obligatory Contour Principle.

References