

## **Morphological effects in speech reduction are speaker specific and may partly originate from the words' most frequent phonological context**

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A few studies suggest that stem-final segments tend to be reduced less than segments of affixes. For instance, English *-s/* tends to be longer at the end of monomorphemic words than when it forms a suffix by itself [1]. One important question is whether these effects are real, especially because they contradict leading theories of phonology and speech production (see [1] section 2, for detailed explanation). Additional evidence for morphological effects on reduction is therefore necessary.

Another question is whether these morphological effects may originate from the phonological contexts in which the words occur most often. Words differing in their morphological structure may differ in their phonological contexts. These contexts may differ in the extent to which they trigger reduction. Previous work has shown that tokens of a word may be more reduced not only because they occur in a context that triggers reduction, but also because that word *typically* occurs in contexts that trigger reduction (e.g., [2, 3, 4]).

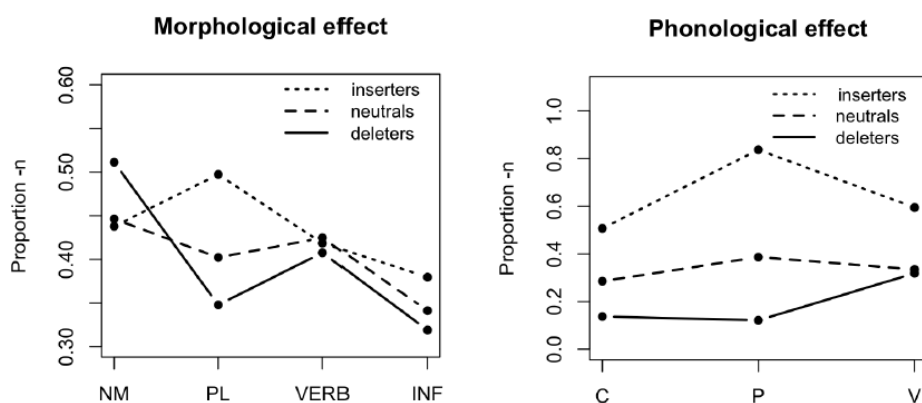
We studied word-final *-en* in Dutch, which occurs at the end of words differing in their morphological structure (henceforth, different morphological categories). Previous studies have reported different */n/-deletion* rates in *-en* for different morphological categories (e.g., [5, 6]). We studied 43,377 word tokens of four morphological categories, which we had extracted from the component of read aloud books from the Spoken Dutch Corpus [7]. The dataset consists of 6230 tokens of stems, 8872 tokens of plural verbs, 14,255 tokens of plural nouns, and 14,020 tokens of infinitives. We noticed that the four morphological categories substantially differ in how often they occur before a pause: plural nouns and infinitives occur more frequently before pauses than monomorphemic words and plural verbs.

Because [8] documented substantial differences among speakers in both */n/-deletion* rate in *-en* and in the phonological contexts in which they delete */n/*, we took differences among speakers into account. We wished to focus on large interspeaker differences, and we therefore distinguished three speaker groups on the basis of speakers' */n/-deletion* rates before a pause, compared to before a speech sound: 1) deleters, who delete */n/* especially before a pause; 2) inserters, who tend to produce */n/* especially before a pause; 3) neutrals, who produce */n/* approximately as often before pauses, consonants, and vowels. We applied a clustering algorithm to obtain these groups and found that they represent different geographical regions.

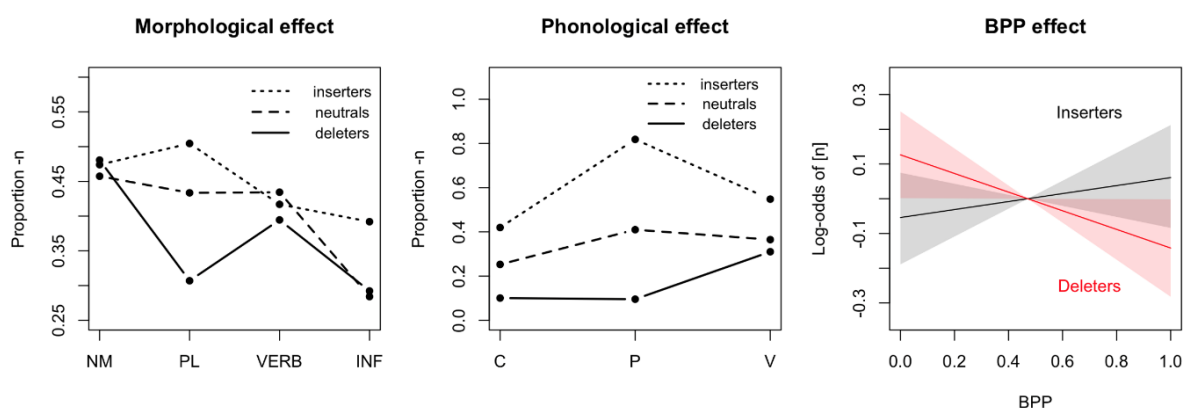
We automatically annotated the presence versus absence of */n/* in *-en* with a bidirectional long short-term memory classifier and analyzed the data with Bayesian regression modelling. We included as fixed predictors in our statistical model: speaker group, morphological category, type of following sound (vowel, consonant, pause), speech rate, word frequency, and the word token's conditional probability in the pre-context. We also included the random variables speaker, speaker group, and word. The results show an effect of morphological category, even though phonological context and differences among speaker groups are included in the model. The direction of the morphological effect, however, depends on the speaker group (see Figure 1, also showing the effect of the following sound, split by speaker group).

We then reran the analysis replacing morphological category by a measure that indicates how often the word occurs before a pause (BPP, analogous to the FRC measure developed by [2]). This predictor showed a large effect. However, when we incorporated both predictors, the effect of BPP decreased. Morphological category explains more variation than the most frequent phonological context in which a word occurs, while the phonological context of the word token remains predictive (see Figure 2).

We conclude that morphological effects, while being speaker dependent, are real and therefore form a challenge for phonological theories and theories of speech production. In addition, based on the BPP effect, we speculate that morphological effects may originate, at least partly, from fossilized phonological effects on the individual words.



**Fig 1.** The proportion of /n/ as a function of morphological function of the /ən/ (left; NM: non-morphemic, PL: plural suffix for nouns; VERB: plural suffix for verbs; INF: infinitive suffix) and as a function of the following phonological context (right; C: consonant; P: pause; V: vowel), split by speaker group, and as revealed by the model without the BPP measure.



**Fig 2.** The proportion of /n/ as a function of morphological function of the /ən/ (left; NM: non-morphemic, PL: plural suffix for nouns; VERB: plural suffix for verbs; INF: infinitive suffix), of the following phonological context (mid; C: consonant; P: pause; V: vowel), and of BPP (right), split by speaker group.

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