

## PRODUCTION PLANNING CONSTRAINTS ON ALLOMORPHY

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### 1. The Locality of Allomorphy Patterns

The realization of the English suffix *-ing* varies between (at least) two distinct pronunciations: [ɪŋ] vs. [in]. Across different varieties of English this variation has been shown to be influenced by gender, speaking style, and socio-economic factors (Fischer, 1958; Labov, 1972; Trudgill, 1972). The segmental phonological context has also been shown to matter (Houston, 1986, and references therein). Crucial for the present paper, the allomorph [in] is more likely when there is a coronal segment immediately following (as in 1a vs. 1b).

- (1) a. While the man was read**in** the book, the glass fell off the table.
- b. While the man was read**ɪŋ** a book, the glass fell off the table.

The effect of phonology is arguably not simply a case of co-articulation or assimilation, since it interacts with morphology. For example, *ing* is much less likely to be pronounced as [in] when it is part of an arguably monomorphemic word like *ceiling* than when it is an affix (cf. Houston 1986). So the alternation between [in] and [ɪŋ] is sensitive to the identity of the morpheme the segmental string is part of. Whether the alternation involves the choice between two listed allomorphs [in] and [ɪŋ] or whether it is derived by morpho-phonological rule is a question that we can remain agnostic about since allomorph choice and morpho-phonological processes obey the same locality constraints (at least according to Kiparsky 1996). We can thus investigate *ing* to test claims about locality in morpho-phonology.

Cyclic theories of morphology assume that complex words are built up from inside out, and predict that the phonology of material that is compositionally added later cannot influence earlier morphological choices. This claim has been argued for in various cyclic theories, including Lexical Phonology (Kiparsky 1996) and Distributed Morphology (Bobaljik 2000, Embick 2010). It should then be impossible for the choice between *the* and *a* to influence *ing* across a syntactic boundary as in (2a) but not in (2b)—at least if the affix combines with the verb after the complement (as is assumed in Distributed Morphology):

- (2) a. While the man was reading, || the/a book fell off the table.
- b. While the man was reading the book, || the/a glass fell off the table.

In global theories of phonology/morphology like standard Optimality theory (see discussion in Embick 2010), there is no reason why such locality generalizations should hold. While one can add constraints to such theories that would force locality, a ranking without such locality effects in which a global phonological markedness constraints drives the choice of a particular affix without regard to syntactic or phonological boundaries should always be possible. In other words, this kind of theory cannot explain why locality should *necessarily* hold. The present paper reports on an experiment in which we crossed syntactic and phonological factors to test the locality of the [in]/[ɪŋ] alternation. The evidence suggests that neither type of theory can account for the full data pattern, and points to an explanation in terms of the locality of production planning.

### 2. METHODS

A production experiment was conducted using 42 items similar to those in (1), using a set of matlab scripts developed in our lab. The experiment was run in a 2x2 latin square design, such that each participant saw only one condition from each item in pseudo-random order, and saw an equal number of trials from each condition across the experiment. There were 42 participants, all native speakers of North American English having grown up in Canada or the US. The recorded data was forced aligned by segment and by word using the prosodylab forced-aligner (Gorman et al. 2011). We used a praat script to extract acoustic measures of pitch, duration and intensity for each word. Furthermore, the data were annotated perceptually by 2 RAs for whether or not [in] or [ɪŋ] was used. The annotation was using a Praat script that made the annotation blind to condition, and the annotators were only able to listen to the affix to make the choice.

### 3. RESULTS

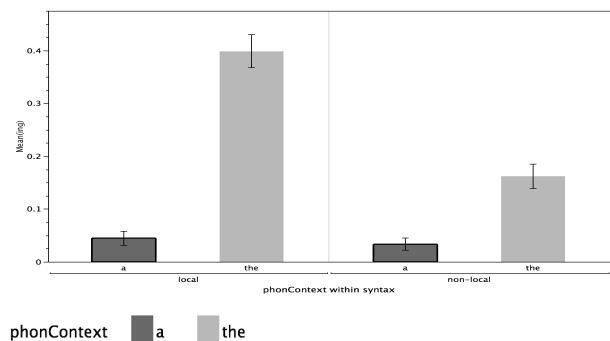


Figure 1. Proportion of [in] by syntactic and phonological context. Error bars show 1 standard error from the mean.

Figure 1 illustrates the proportion of [in] choice by syntax (non-local vs local) and phonology (*a* vs. *the*). A mixed model logistic regression with *syntax* and *phonology* as factors and *item* and *participant* as random effects (using the lme4 package in R) showed significant main effects and a significant interaction. In other words, using [in] is more likely when *the* follows than when *a* follows, and when a direct object follows than when no direct object follows. The significant interaction shows that the phonological influence of the following word is stronger in the local environment. The interaction is predicted by cyclic theories but not by the global theory. However, unexpectedly for the cyclic approach, the effect of phonology was also significant in the subset of data only consisting of the non-local cases.

Let's consider a third possibility: Maybe the effect of phonology on allomorph choice is restricted by the locality of production planning. To test this hypothesis, we quantified the strength of the boundary separating the affix and the following article by extracting a number of acoustic measures. The syntactic break in the examples in (2) correlates with a difference in prosodic boundary strength (Itzhak et al. 2010). One measure of boundary strength is the strength of the following word, so we measured the length of the article. Within the subset of data that included only the article *the*, the length of the article was a significant predictor of [in] pronunciation, and once that was added to the mixed model, *syntax* became irrelevant (the two factors are highly correlated). Furthermore, the length of the article was a significant predictor even within the non-local and within the local syntactic environment. This means that the effect of phonology on allomorph choice depends gradiently on the prosodic strength of the boundary separating the affix from the phonological trigger (which in turn is affected by syntax). Another test with similar results was conducted using the normalized duration of the verb plus affix (raw length minus the expected length based on phonemes), a measure which reflects pre-boundary lengthening.

#### 4. DISCUSSION AND CONCLUSIONS

The results can be accounted for by the hypothesis that *phonological effects are constrained by the locality of production planning*—at least if we make the plausible assumption that the prosodic strength of the boundary between two words correlates with the likelihood that the beginning of the second word will already be phonologically encoded at the time when the first word is planned (see Levelt 1989 et seq., Wheeldon & Lahiri 1997, and Miozzo & Caramazza 1999 for discussions of the locality of production planning). *ing* is encoded as [in] with higher probability when a coronal sound follows—but whether the identity of the following segment is known at the time of encoding determines whether this phonological can take hold. Syntax and prosody influence how likely it is that segmental conditioning environment is present at the time of allomorph choice (or at the time of morpho-phonological alternation processes). The phonological

environment can thus be stated in purely segmental terms.

The hypothesis that across-word-boundary phonological processes (sandhi phenomena) are constrained by the locality of production planning can explain why they tend to be variable (speakers don't consistently encode the next phonological word so the conditioning environments may not be present), and makes new predictions for what types of processes should obey what type of locality pattern (regressive processes should tend to be more variable than progressive ones; processes should be more local when sensitive to low-level segmental information than higher level information since it is encoded later). The hypothesis is supported by length effects on auxiliary contraction (Mackenzie 2011) that also point to production planning constraints, and it fits well with recent psycho-linguistic models of phonological processing (cf. Goldrick, in press).

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#### ACKNOWLEDGEMENTS

Thanks to Itzhak et al. (2010) for letting me adapt their stimuli for this experiment. Thanks to Charles Boberg, Matt Goldrick, Dave Embick, Tobias Scheer, and the audience at talks at McGill and Stanford for helpful comments. This research was funded by FQRSC grant NP-132516 and a SSHRC Canada Research chair and CFI grant 212482.