A Corpus Investigation of the Effects of Morphological Structure on Phonetic Duration

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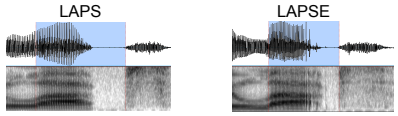
Introduction

The way phonological processes act over multimorphemic words has not been thoroughly investigated. As a first step toward understanding the way morphological structure interfaces with phonological processing, the current investigation explores the influence of morphological structure on phonetic duration.

PREVIOUS FINDINGS

- Phonemes are longer before suffixes than non-morphemic segments (Frazier, 2006; Sugahara & Turk, 2009)
  - LAPS > LAPSE
- Rhymes are longer as suffixes than non-morphemic segments (Losiewicz 1995, Walsh & Parker 1983)
  - LAPS > LAPSE



LIMITATIONS

- Few stimuli
- Small sample size
- Experimental conditions may artificially induce a contrast between mono- and multimorphemic words
- Focused only on phonemes at morpheme boundaries

PRESENT INVESTIGATION

We conducted an analysis of the Buckeye Corpus of Conversational Speech which allowed us to examine a greater number of words (~26,000 tokens) from 40 subjects in naturalistic conditions (Pitt et al. 2007).

- Does phonetic duration vary as a function of morphological structure in natural, conversational speech?
- If so, is the duration of the whole word sensitive to morphological structure on a global level, or is only the morpheme boundary impacted?

Model Construction

TARGET WORDS

- Final phoneme /t/, /d/, /s/, or /z/
- Monomorphemic (19,843 tokens, 444 types)
- Bimorphemic (6,314 tokens, 603 types)
  - Ending in –ed (1,883 tokens)
  - Ending in –s (4,431 tokens)
- Monosyllabic
- Excluded function words and words immediately preceding or following a pause

PREDICTED VARIABLES

1. **Entire Word Duration**
2. **Rhyme Duration:** Rhyme duration was used as a dependent variable in order to be comparable to Sugahara and Turk (2009). Rhyme consisted of the nucleus vowel and following consonants, but excluding the final /t/, /d/, /s/, or /z/.
3. **Final Phoneme Duration:** Final phoneme duration was used as a dependent variable in order to be comparable to Losiewicz (1995) and Walsh & Parker (1983).
4. **Initial Phoneme Duration:** Initial phoneme duration was used because it is the furthest from the morpheme boundary, and thus potentially the least likely to be influenced by morphological structure.

PREDICTOR VARIABLES

The following variables were included in the model because they have been shown to be significant predictors of duration (Gahl, 2008; Yao, 2011)

- **Number of Morphemes** (mono- or bimorphemic)
- **Length in Letters**
- **Log Frequency**
- **Phonological Neighborhood Density**
- **Number of Phonemes**
- **Baseline Duration:** sum of the average phoneme duration for each phoneme in a word. For "cat", the baseline duration would be the sum of the average durations for /k/, /æ/ and /t/.
- **Predictability:** P(WordX WordY)/P(WordY)
- **Part of Speech**

Model 1: Whole Word

Log Whole Word Duration

	Estimate	Std. Error	*t* value
(Intercept)	-1.29	0.08	-15.88
Bimorphemic	**0.09**	**0.01**	**6.34****
Number of Letters	0.03	0.01	**3.68****
Log Frequency	-0.04	0.00	**-10.52****
Phon. Neighborhood	0.00	0.00	**1.89***
Number of Phonemes	-0.07	0.02	**-4.00****
Noun	0.02	0.02	0.67
Adverb	-0.06	0.06	-1.04
Verb	-0.13	0.02	**-5.73****
Predictability	-0.02	0.02	-1.07
Baseline Duration	2.03	0.16	**12.35****

Model 2: Rhyme

Log Rhyme Duration

	Estimate	Std. Error	*t* value
(Intercept)	-1.46	0.14	-10.56
Bimorphemic	**0.36**	**0.03**	**14.07****
Number of Letters	-0.02	0.01	-1.56
Log Frequency	-0.04	0.01	**-5.10****
Phon. Neighborhood	0.00	0.00	-0.42
Number of Phonemes	-0.20	0.03	**-6.94****
Noun	-0.04	0.04	-0.89
Adverb	-0.20	0.11	**-1.72***
Verb	-0.28	0.04	**-6.38****
Predictability	-0.03	0.02	-1.34
Baseline Duration	2.24	0.29	**7.77****

Model 3: Final Phoneme

Log Final Phoneme Duration

	Estimate	Std. Error	*t* value
(Intercept)	-2.70	0.14	-18.90
Bimorphemic	**0.25**	**0.03**	**9.17****
Number of Letters	0.01	0.01	0.49
Log Frequency	-0.01	0.01	-0.89
Phon. Neighborhood	-0.01	0.00	**-3.14****
Number of Phonemes	-0.23	0.03	**-7.45****
Noun	0.10	0.04	**2.30***
Adverb	0.18	0.12	1.48
Verb	-0.08	0.05	**-1.74***
Predictability	0.00	0.03	0.13
Baseline Duration	2.10	0.31	**6.85****

Model 4: Initial Phoneme

Log Initial Phoneme Duration

	Estimate	Std. Error	*t* value
(Intercept)	-1.63	0.12	-13.15
Bimorphemic	**-0.08**	**0.02**	**-3.27****
Number of Letters	0.00	0.01	0.13
Log Frequency	-0.05	0.01	**-7.90****
Phon. Neighborhood	-0.01	0.00	**-5.03****
Number of Phonemes	-0.18	0.03	**-6.91****
Noun	0.03	0.04	0.94
Adverb	-0.11	0.10	-1.12
Verb	0.03	0.04	0.66
Predictability	-0.14	0.02	**-6.34****
Baseline Duration	1.81	0.26	**6.90****

Conclusion

These preliminary results support previous studies and suggest that phonological processing is sensitive to morphological structure. Though morphological structure predicts whole word duration, the phonemes closest to the morphological boundary are most influenced. Final phonemes and rhyme durations are longer in multi- than mono-morphemic words. Interestingly, initial phonemes, those furthest from the morpheme boundary, are significantly shorter in multimorphemic words than monomorphemic words.

Bell et al. (2009) suggest that speed of lexical access affects word duration such that words that are accessed quickly are produced with shorter durations. It is possible that lexical access is slower for multimorphemic words causing the duration to be slower. Berlove & Cohen-Goldberg (2011) found that the vowel space of suffixed words is determined by the lexical characteristics of root, not the suffixed word as a whole. It is possible that lexical information is accessed twice for bimorphemic words (once for each morpheme). Double access could be slow, and as Bell et al. (2009) suggest, slow access would cause the duration to be elongated.

In the future, we plan to add additional variables to these models including previous mention in the interview and speech rate, and to extend the analysis to multimorphemic words with different affixes. Further examination is needed of the factors that contribute to duration, such as whole word frequency or root frequency.

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