PHONETIC DIFFERENCES BETWEEN *MIS*- AND *DIS*- IN ENGLISH PREFIXED AND PSEUDO-PREFIXED WORDS

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ABSTRACT

It has been claimed that speakers distinguish between phonemically-identical initial syllables that differ in morphological structure, but the phonetic details are poorly understood. Five SSBE speakers read scripted dialogues containing words with such syllables, half with true prefixes (Pr) e.g. *mistimes, displease,* and half with pseudo-prefixes (PsPr) e.g. *mistakes, displays*. Each word occurred both with nuclear (N) stress and in postnuclear (PN) position. Pr words were longer up to voicing onset in the second syllable and had longer [ɪ] and *VOT*, and shorter [s] than PsPr words. For *mis*-, the average amplitude of the burst + aspiration was higher in Pr than PsPr. Implications for models of morphological decomposition are discussed.

Keywords: prefixes, phonetic detail, morphology.

1. INTRODUCTION

Phonetic detail provides information about word boundaries [3, 10, 11], and can also provide cues to morphological structure. For example, Kemps et al. [7] compared the phonetic properties of singular and plural nouns in Dutch. The singular nouns were monomorphemic CVCs whose plural forms have the suffix *–en*, e.g. *boek* [buk] > *boeken* [bukə(n)], *book(s)*. The vowel, stop closure and burst duration were shorter in the first syllable of *boeken* than in *boek*. Consequently, the singular was longer than the same syllable in the plural. Mean f0 was also lower in singulars than in matching syllables in plurals.

Kemps et al.'s [7] results parallel Lehiste's [8] for English derivational morphology, but neither study demonstrates that phonetic detail *directly* reflects morphological structure. Similar patterns are found for non-morphologically related word pairs in Dutch and English, e.g. *ham* and *hamster* [e.g. 3, 10, 12]. This paper investigates prefixes and pseudo-prefixes as a clearer test of morphological influences on phonetic detail.

Ogden et al. [9] and Hawkins [4, 5] contrast the bimorphemic Pr word *mistimes,* which contains a prefix and base, with the monomorphemic word *mistakes,* which has the same phoneme string as the prefix in *mistimes*, but is not productive, hence *mis- in mistakes* is a PsPr. The relative durations of the components of /mɪst/ are noted to differ in the Pr and PsPr forms in ways that produce rhythmic differences: the first syllable of *mistimes* has a heavier beat than *mistakes*.

The above description is based on observational evidence, but we lack quantitative data on multiple tokens. Moreover, the distinction appears to be more gradient than binary in some contexts, PsPr words can take on Pr characteristics if spoken in unnatural contexts, and little is known about how the morphological contrast interacts with sentence stress. One challenge is in eliciting multiple tokens of controlled yet natural-sounding speech from several speakers. This study uses scripted dialogue, which appears to engage speakers sufficiently.

2. METHOD

2.1. Participants

Five female speakers of Standard Southern British English (SSBE) mean age 24 years, participated. Four further SSBE speakers, 3 female and 1 male, acted as partners to the experimental speakers in the dialogues; their speech was not analysed.

2.2. Materials

2.2.1 Word classification

All English words beginning with /mɪs/ or /dɪs/, with lexical stress on the second syllable, were identified using CELEX [2] and classified as either prefixed or pseudo-prefixed. Following Wurm [13], a word was deemed prefixed if 1) when the prefix is removed, there is still a free-standing word; 2) the prefixed word has a semantically-transparent relationship to its stem, e.g. *displease* and *please*; and 3) the meaning of the prefix is consistent with other uses of that prefix, e.g. the prefix /mɪs/ means '*wrongly, badly, or unsuitably*'. If a word did not conform to these criteria (regardless of its etymology), it was deemed pseudo-prefixed, e.g. *displays, mistakes*.

The ten word pairs used each comprised a Pr and a PsPr word (5 *mis*-, 5 *dis*-). The words in each pair had the same number of syllables and stress pattern and were phonemically matched as closely as possible at the start of syllable 2. See Table 1.

Some *mis*- words were used in more than one pair, as few pseudo-prefixed *mis*- words have a stressed second syllable. More *dis*- words conform to the criteria: only *distasteful* appears twice.

Table 1: Prefixed and pseudo-prefixed *mis*- and *dis*- word pairs. (N.B. Asterisked word pairs have different numbers of syllables in isolation, but in the experimental sentences foot length was equalized by adding unstressed syllables (italicized text in brackets) after the word with fewer syllables.

mis- Prefixed (Pr)	*mis*- Pseudo-prefixed (PsPr)
1. mistiming (*it*)	mysterious*
2. mistimed	mistakes
3. mistiming (*them*)	mystique* (*I think*)
4. mistyped	mistakes
5. mistimes	mistakes
dis- Prefixed (Pr)	*dis*- Pseudo-prefixed (PsPr)
6. distrusts	destroyed
7. distasteful	distinctive
8. displeased	displayed
9. discoloured	discovered
10. distasteful	distorted

2.2.2 *Sentence and dialogue construction*

For each pair, four sentences were constructed: prefixed *vs*. pseudo-prefixed words, with nuclear stress (N) *vs*. in post-nuclear position (PN).

The critical sentence pairs were matched for foot structure and (in most cases) segmental content of the preceding syllable/segment. To aid segmentation, *mis*- words were preceded by [s] or [z] in all but one pair. *Dis*- words were preceded by a vowel, /l/, /m/ or a fricative.

Pilot work suggested that realizations of prefixes/pseudo-prefixes quickly become unnatural if repeatedly read in unrelated sentences. Therefore, each experimental sentence was embedded in a dialogue to provide a realistic context and encourage natural reading. The experimental sentence was always read by the subject (speaker B), as in the example (N stress):

Pr A. *I'm going shopping with Sherry and Tina.*
B. *Oh, what're they like? I've not talked to them yet.*
A. *Friendly. But Sue doesn't seem to like them.*
B. *I think she* ***distrusts*** *them.*

PsPr A. *I hope we don't get found out.*
B. *No, we've got rid of all the evidence.*
A. *What did Kate do with the papers?*
B. *I think she* ***destroyed*** *them.*

Ten filler word pairs that shared an initial phoneme sequence, e.g. *fired*/*fined*, underwent the same process of sentence and dialogue construction as the experimental words; and 8 more dialogues with the low-frequency words *mysterious* and *mystique* were made, to increase their frequency in the task.

2.3. Recording

Recordings were made in the sound-treated room at Cambridge University's Phonetics Lab, using high-quality equipment. The participant (P) and partner talker had familiarized themselves with the dialogues in advance. They sat opposite each other with a Sony ECM-16T microphone approximately 40 cm from P. They read the dialogues as naturally as possible, six times in random order.

2.4. Analysis

Recordings were digitized at 16 kHz sampling rate onto a Silicon Graphics machine running *xwaves+*. Durations of the following segments in the *mis*/*dis*-words were measured: [m]/[d], [ɪ], [s], *stop closure*, *VOT* (burst + aspiration). Their total duration, from the beginning of the word to the onset of periodicity for the second vowel, is termed *m/dɪsCh-*. Average absolute amplitudes (dB) of [ɪ], [s] and *VOT*, and relative amplitudes: [ɪ]/[s]; [ɪ]/*VOT*; *VOT*/[ɪ]; *VOT*/[s] were calculated.

Segmentation criteria were: [m] start: onset of nasal murmur; [d] start: end of preceding vowel's formant structure, or preceding fricative noise; [ɪ] start: (after [m]) abrupt amplitude increase in higher formants, (after [d]) periodicity onset; [s] start: offset of periodicity; *stop closure* start: frication offset; *VOT* start: transient onset to the onset of periodicity. For all but *VOT*, the end of each segment was the start of the next one.

3. RESULTS

Data were analysed using mixed-effects modeling [1]. A mixed model allows for variance resulting from both random and fixed factors to be accounted for, thus increasing statistical power. This is particularly useful when dealing with data from different speakers and words. For each dependent variable, a model was created with 2 random factors: speaker and word; 3 fixed factors: type (Pr/PsPr), stress (N/PN), MorD (*mis-*/*dis-*) and their interactions. Predictors that did not contribute significantly to the model were removed incrementally and the resulting model's goodness of fit checked using R^2 and a likelihood ratio test.

3.1. Durations

The differences between N and PN conditions are described first. Although the *mis-*/*dis-* syllable in N actually precedes the nuclear stress, the syllable is likely to be longer in an N than PN word when not phrase-final. Hence, N segments were predicted to be longer than comparable PN segments. These predictions are supported for the syllable duration (*m/dɪsCh-*), [s], *stop closure* and *VOT*. For segments further from the stressed syllable, the picture is more complex. [m] and [d] show the predicted pattern for Pr words only, whereas PsPr [m] is longer in PN than N. [ɪ] duration does not differ in N vs. PN conditions. See Table 2.

Table 2: Mean duration (ms) of *m/dɪsCh-* components for statistically significant comparisons (**p*=0.057; all others *p*<0.05).

Component	N	PN	F/t (df)
1.*m/dɪsCh-*	215.2	204.9	F(1,994) = 100.6
2.[m] Pr	30.8	26.8	t(496) = 3.4
3.[m] PsPr	28.4	30.7	t(496) = 1.9*
4.[d] Pr	52.0	44.2	t(496) = 5.8
5.[s]	61.5	60.1	F(1,997) =4.0
6.*stop closure*	31.7	30.4	F(1,995) = 60.8
7.*VOT*	33.6	32.2	F(1,994) = 6.0

Table 3: Mean duration (ms) of *m/dɪsCh-* components for statistically significant comparisons (p<0.05).

Component	Pr	PsPr	F(df)
1.*m/dɪsCh-*	219.8	200.3	F(1,994) = 11.3
2.[ɪ]	47.0	42.2	F(1,998) = 15.2
3.[s]	57.8	63.8	F(1,997) = 6.4
4.*VOT*	40.2	24.2	F(1,994) = 112.3

The differences between Pr and PsPr words are the main focus of this study. They are shown in Table 3. N and PN conditions are pooled because there are no interactions. The durational aspects that consistently distinguish between Pr and PsPr words are: *m/dɪsCh-*, [ɪ], [s], *VOT*. *VOT*, *m/dɪsCh-* and [ɪ] are longer, and [s] shorter in Pr than PsPr words.

3.2. Amplitude

Differences due to stress (N vs PN) are described first. Absolute amplitudes of [ɪ] and *VOT* are greater in N than PN, as is [ɪ] in relation to [s]. [ɪ] in relation to *VOT* is also greater in N than PN for *mis-* words; but the opposite relation holds for [ɪ]/*VOT* in *dis-* words, because [ɪ] has unusually low amplitude in N stressed *dis-* words. *VOT* in relation to [s] is larger in N than PN for Pr *dis-*.

Amplitude differences between Pr and PsPr words exist for *mis-* words. As expected, *VOT* is more prominent in Pr than PsPr (*VOT*:*mis-* N; *VOT*/[ɪ]:*mis-* PN). See Table 4.

Table 4: Absolute (dB) and relative amplitude for statistically significant comparisons (p=*0.07**0.06; all other p<0.05).

Component	N	PN	F/t(df)
[ɪ]	67.3	65.6	F(1,994) = 88.2
VOT	57.0	55.7	F(1,992) = 46.1
[ɪ]/[s]	1.137	1.127	F(1,994) = 5.6
[ɪ]/ *VOT* (Pr *mis*)	1.177	1.143	t(992)=3.4
[ɪ]/ *VOT* (Pr *dis*)	1.176	1.204	t(992)=2.8
VOT/[s] (Pr *dis*)	0.953	0.930	t(992) = 2.8
	Pr	**PsPr**	t(df)
VOT (*mis* N)	59.3	58.6	t(992) = 1.8*
VOT/[ɪ] (*mis* PN)	0.878	0.838	t(992)=1.9**

4. DISCUSSION

Information about morphological structure is present in the phonetic detail of Pr words. *Mis-* and *dis-* Pr are clearly distinct from PsPr in terms of segmental durations, and *mis-* shows amplitude differences too. The vowels are currently being examined for differences in formant frequency, and [s] for differences in spectral moments.

These effects of morphological structure are independent of whether the *mis-* or *dis-* word bears N stress or is in PN position. Stress does independently affect durations of some segments, especially towards the end of *m/dɪsCh-*, and the amplitude of [ɪ] and *VOT*. The morphological effects are also more direct than those shown by [7, 8] as number of syllables was matched across Pr and PsPr word groups.

The differences between the two word types support Ogden et al's [9] analysis of the phonological structure of Pr and PsPr words. [s] is relatively short and *VOT* relatively long in Pr *m/dɪsCh-*, consistent with them being in coda and onset positions respectively. In PsPr *m/dɪsCh-*, the relatively long [s] and short *VOT* is consistent with *sCh-* being an onset, or ambisyllabic (both coda and onset). The morphological differences directly drive differences in phonological structure that, in turn, are reflected in the phonetics.

Although the durational differences between Pr and PsPr words are robust in the current experiment, the distinction may be less well-defined if less natural materials are used, raising the intriguing possibility that it is a gradient rather than binary distinction. Pilot testing showed that if produced as isolated words or in decontextualized sentences, PsPr words can take on characteristics similar to those of Pr ones and vice versa. One of the aims of this experiment was to collect controlled yet natural-sounding speech from all speakers. The consistent differences between the Pr and PsPr words suggest that this was achieved.

As other similar types of systematic phonetic detail are useful in speech perception [e.g. 3, 11], it is expected that Pr/PsPr phonetic differences are also used. The usefulness of such phonetic detail in perception is being tested in a follow-up study where cross-spliced versions of the experimental sentences are presented in noise. Inappropriate phonetic detail is predicted to reduce intelligibility.

The Pr/PsPr differences also have implications for decomposition. First, they provide information about whether a word is likely to be stored and accessed in a decomposed or whole-word form. During processing, if, for example, the characteristics of *m/dɪsCh-* signal a Pr, it would be efficient to give preference to Pr words, so that the root of the word in question might be matched to all roots that have previously occurred with the Pr and are consistent with the phonetic input so far. This strategy fits both dual-route [e.g. 13] and less binary [e.g. 5] theories.

The gradient nature of the distinction between phonetic characteristics of Pr and PsPr words may have further implications for the extent of decomposition in storage and processing. For example, a Pr word that consistently takes on the characteristics of Pr *m/dɪsCh-*, in all speech contexts, would be more likely to be stored and accessed in a decomposed form than one whose production is more variable.

Another factor that is proposed to play a role in the extent of decomposition is relative frequency [6]. Complex words are likely to be decomposed if their root frequency is higher than that of the whole word. Further work should seek to establish whether phonetic characteristics of Pr and PsPr words are related to such frequency differences or whether they reflect a polysystemic organisation [5] with multiple overlapping systems for morphologically complex words.

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ACKNOWLEDGEMENTS

Funded by an AHRC studentship to R. Baker.