

Acoustic differences in morphologically-distinct homophones

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Abstract

Previous work demonstrates that a word’s status as morphologically-simple or complex may be reflected in its phonetic realization. One possible source for these effects is phonetic paradigm uniformity, in which an intended word’s phonetic realization is influenced by its morphological relatives. For example, the realization of the inflected word *frees* should be influenced by the phonological plan for *free*, and thus be non-homophonous with the morphologically-simple word *freeze*. We test this prediction by analysing productions of forty such inflected/simple word pairs, embedded in pseudo-conversational speech structured to avoid metalinguistic task effects, and balanced for frequency, orthography, as well as segmental and prosodic context. We find that stem and suffix durations are significantly longer by about 4–7% in fricative-final inflected words (*frees*, *laps*) compared to their simple counterparts (*freeze*, *lapse*), while we find a null effect for stop-final words. The result suggests that wordforms influence production of their relatives.

1 Introduction

When a language-user produces a spoken word, its exact articulation is influenced by a wide range of linguistic and psycholinguistic variables, such as the word’s position in a phrase (Oller, 1973), overall frequency in the language (Gahl, 2008), and its predictability in context (Bell, Brenier, Gregory, Girand, & Jurafsky, 2009; Lieberman, 1963). How do the morphological properties of a word influence its phonetic realization? Discrete, sequential processing architectures (e.g., Levelt, Roelofs, & Meyer, 1999) and other non-interactive models of language production (e.g., Kiparsky, 1982) propose that when phonetic attributes such as duration and pitch are encoded from a phonological representation, the word’s morphological status is inaccessible. However, a growing body of work demonstrates that morphology does interact with phonetic characteristics such as formant trajectory alignment (Scobbie, Turk, & Hewlett, 1999), /l/-darkening (Hayes, 2000; Lee-Kim, Davidson, & Hwang, 2013; Sproat & Fujimura, 1993; Strycharczuk & Scobbie, 2015, 2017), and segment duration (Plag, Homann, & Kunter, 2017; Pluymaekers, Ernestus, Baayen, & Booij, 2010; Smith, Baker, & Hawkins, 2012). For example, the /t/ is aspirated in the derived word *mistime*, but not in the morphologically-simple word *mistake*, even though it occurs in the same phonological environment in both words (Baker, Smith, & Hawkins, 2007; Smith et al., 2012; Zuraw & Peperkamp, 2015).

What causes these effects? One possible mechanism is *phonetic paradigm uniformity*: the influence of an intended word’s morphological relatives on the articulatory realization of that word (Ernestus & Baayen, 2006; Frazier, 2006; Hayes,

2000; Roettger, Winter, Grawunder, Kirby, & Grice, 2014; Steriade, 2000). There is some existing evidence that morphological families affect speech production latencies (Baayen, Levelt, Schreuder, & Ernestus, 2007; Hay & Baayen, 2005). However, these effects are nonetheless compatible with a model that segregates morphology and phonetics, as they arguably involve competition during lexical retrieval processes, rather than during speech encoding or articulation (see Goldrick, Baker, Murphy, & Baese-Berk, 2011; Goldrick, Keshet, Gustafson, Heller, & Needle, 2016). In this paper, we argue that an intended word’s morphological relatives also interact with that word’s phonetic realization, and test this hypothesis by looking at the durational influence of freestanding English stems on the wordforms in their inflectional paradigms. More generally, this work addresses broader questions about interaction among different components of the linguistic signal, and the role of analogy between wordforms in phonological representation.

1.1 Paradigm uniformity

A morphological paradigm is the set of words that have a lemma in common. For example, the inflectional paradigm of the English verb FREE is *free*, *frees*, *freeing* and *freed*. Paradigm uniformity is a pressure for invariance among the phonological forms of an inflectional or derivational paradigm (Hayes, 2000; Steriade, 2000). This phenomenon occurs in the pronunciation of the American English words *capitalistic* and *militaristic*. The unstressed syllable /tə/ in the word *capitalistic* is normally produced with an alveolar tap [kæpɪrəˈlɪstɪk]. This follows the phonological pattern in which intervocalic /t/ is tapped when it is unstressed. However, the same syllable /tə/ in the word *militaristic*—which is unstressed, just as in *capitalistic*—can be pronounced with an aspirated [t] ([ˌmɪlɪt^həˈlɪstɪk]), even though this violates that phonological pattern (Withgott, 1982). This can be accounted for by uniformity pressures within the two words’ derivational paradigms (Steriade, 2000). The syllable that corresponds to /tə/ is unstressed in *capital* /ˈkæpɪtəl/, but is stressed in *military* /ˈmɪlɪtəri/. Even though /tə/ is unstressed in the derived *militaristic*, the pressure for paradigmatic uniformity with *military* prevents it from being realized as a tap in *militaristic*. On the other hand, there is no such influence on *capitalistic*, because the /t/ is also realized as a tap in *capital* (see also S. Davis, 2005, for a different uniformity-based analysis).

While paradigm uniformity has been formalized in several symbolic phonological theories (e.g., Benua, 1997; McCarthy, 2005, see Steriade, 2000 for a summary), it has also been argued to influence more fine-grained production patterns (Frazier, 2006; Hayes, 2000; Steriade, 2000). As one instance, paradigm uniformity may account for incomplete voicing neutralization patterns in Germanic languages (Ernestus & Baayen, 2006, 2007; Kaplan, 2016; Roettger et al., 2014; Winter & Roettger, 2011). For example, the German words *Rad* ‘wheel’ and *Rat* ‘council’ are typically considered to be homophones, ending in a final voiceless segment: both are pronounced [ʁa:t]. *Rad* is morphologically related to *Räder* ‘wheels’, in which

the corresponding segment is voiced [d] ([ʁɛːdɐ]). However, *Rat* has no such voiced relative. A body of research demonstrates that there are fine-grained phonetic differences between *Rad* and *Rat* such that *Rad*, but not *Rat*, is produced with some of the phonetic cues associated with a final voiced segment (see Winter & Roettger, 2011 and Roettger et al., 2014 for recent theoretical and experimental reviews). One account for these results is that incomplete neutralization is the result of paradigm uniformity effects: when a speaker produces the form *Rad*, their production is influenced by the morphologically-related voiced form *Räder*, which affects how voicing cues are realized in *Rad*.

1.2 Mechanisms for paradigm uniformity effects

Phonetic paradigm uniformity effects like incomplete voicing can be operationalized in terms of spreading activations among wordforms (Ernestus & Baayen, 2006, 2007; Goldrick & Blumstein, 2006; Roettger et al., 2014; Winter & Roettger, 2011). Following this proposal, when a speaker retrieves a target wordform for production, semantically- and phonologically-related words are co-activated (Dell, 1986; Goldrick, 2006, 2014; McMillan, Corley, & Lickley, 2009; Peterson & Savoy, 1998; Rapp & Goldrick, 2000). For example, the process of activating the target word *cat* also involves partial activation of the semantic relative *dog*. In non-discrete production models, the activation of both *cat* and *dog* cascades into phonological planning, such that the forms /kæt/ and /dɑg/ are both activated to some extent. Further, activation of the phonological form /kæt/ feeds back to activate phonological relatives such as *hat*, due to the segmental overlap of /kæt/ and /hæt/ (Rapp & Goldrick, 2000). By definition, the other words in a target’s morphological paradigm are close semantic relatives, and are likely to be phonological relatives as well (see e.g. Bybee, 1985, on lexical connections within a paradigm). In some proposals, morphological relatives may always be co-activated (Ernestus & Baayen, 2007), regardless of semantic or phonological similarity. In either case, retrieval of a target form *Rad* [ʁaːt] leads to co-activation of the phonological form of *Räder* ([ʁɛːdɐ]), due to the spreading activations within and between the semantic and phonological retrieval processes.¹

Evidence from speech errors suggests that cascading activation from non-target phonological forms can have gradient influences on articulatory processes (Goldrick et al., 2011; Goldrick & Blumstein, 2006; Goldrick et al., 2016; McMillan et al., 2009). There are at least two pathways through which this might happen. First, partially-

¹It is an open question whether the phonological forms of all members of a morphological paradigm are invariably assembled from constituent forms (Cohen-Goldberg, 2015; Cohen-Goldberg, Cholin, Miozzo, & Rapp, 2013), or are activated in distinct lexical entries supported by abstracted forms (Blevins, 2006; Blevins, Ackerman, & Malouf, 2017; Hay & Baayen, 2005; Jackendoff & Audring, 2017). The proposal here assumes only that non-target phonological forms of morphological relatives can become active through spreading activations (which may or may not involve activation of constituent representations, e.g. Dell, 1986).

activated non-target forms may contribute to an articulatory plan, such that the resulting plan is a mix of target and non-target forms (e.g., Gafos, 2003; Goldrick & Blumstein, 2006). Alternatively, multiple gestural plans may be constructed and simultaneously implemented (or partially implemented), leading to gestural blending in cases where two gestures cannot be executed simultaneously, and overlap when they can be (e.g., Pouplier & Goldstein, 2010).

For the case of target *Rad* and co-activated *Räder*, the prediction is that the relatively strong influence of the close relative *Räder* should affect the production of [ʁa:t], even in normal speech (see also Gafos, 2003). In particular, the influence of co-activated /d/ should lead to a blend of corresponding /t/ and /d/ realizations, such that *Rat* is produced as partially voiced (Ernestus & Baayen, 2006, 2007; Gafos, 2003; Goldrick & Blumstein, 2006; Roettger et al., 2014; Winter & Roettger, 2011). This mechanism generates predictions about phonetic paradigm uniformity effects more broadly (and see references above). When a word has a high degree of semantic, grammatical, and/or phonological similarity to its paradigm members, its final articulatory realization should be influenced by those members (Goldrick, Folk, & Rapp, 2010).

1.3 Paradigm effects on English inflected forms

One proposed and measurable type of phonetic uniformity effect involves word and segment duration (Frazier, 2006; Steriade, 2000). There is evidence that durational targets are specified in a wordform’s phonological plan (Katz, 2010, 2012; Seyfarth, 2014; Tauberer & Evanini, 2009), and duration has previously been used as a test case for interaction among plans (Goldrick et al., 2011). Here, we investigate the effects of monosyllabic English words such as *free* on an inflected paradigm member with a heavier coda, such as *frees*. The paradigm uniformity account predicts that the timing of the segments in *frees* should be influenced by the durational targets of *free* (see Frazier, 2006 for a similar proposal based on moraic structure).² As a baseline for what the timing of *frees* should be if there were no interference from paradigm members, we compare each inflected word to a segmentally-identical but morphologically-simple homophone, such as *freeze*.

The inflected word *frees* should show the following uniformity effects from the influence of *free*. The first kind of effect arises from differences in syllable weight. The word *free* [fi] has no coda, and therefore the nucleus is longer than if it were in a closed syllable (Katz, 2010, 2012; Munhall, Fowler, Hawkins, & Saltzman, 1992;

²One question involves what elements are included in a word’s phonetic-phonological form, which may specify phonological segments, stress, prosodic constituency (Levelt et al., 1999), a range of acceptable phonetic realizations (Goldrick et al., 2011; Lavoie, 2002; Seyfarth, 2014), contrastive or non-contrastive sub-segmental detail (Bybee, 2001; Johnson, 2007; Pierrehumbert, 2002), or other features, all of which which may not be represented together as a single integrated representation (Goldrick, 2014). We assume here that a phonological representation includes, at a minimum, segments and prosodic constituency as well as timing relationships (Katz, 2010, 2012).

Shaiman, 2001). If the lighter form *free* influences the plan for *frees*, the nucleus should be relatively longer in *frees* compared to *freeze*, where it is not influenced by a longer wordform (Frazier, 2006).

The second kind of uniformity effect arises from differences in prosodic alignment. This can be illustrated in a gestural score. Figure 1a shows a partial gestural score for the rime [i] in the freestanding word *free*, which shows the tongue-body constriction gesture associated with the vowel. In addition to constrictions, prosodic effects are also modeled as gestures (Byrd, Krivokapić, & Lee, 2006; Byrd & Saltzman, 2003). Prosodic gestures (π , shown in grey) overlap with constriction gestures, and change the overall rate that the production system moves through the gestural score. For example, because *free* is a prosodic word, it ends in a prosodic-word gesture. While the prosodic gesture is activated, it slows the rate at which constrictions are produced (Byrd et al., 2006; Byrd & Saltzman, 2003), thus causing word-final lengthening (Oller, 1973; Wightman, Shattuck-Hufnagel, Ostendorf, & Price, 1992). Because *free* ends with a tongue-body constriction, the prosodic-word gesture overlaps mainly with this constriction, resulting in elongation of the [i].

By comparison, Figure 1b shows a partial score for the [iz] rime of *freeze*. In this score, the prosodic-word gesture overlaps mainly with the [z] constriction. Thus, the most elongated segment in *freeze* is [z], while in *free*, [i] is relatively more elongated. This follows empirical work showing that final lengthening effects are greatest on segments immediately adjacent to a prosodic boundary (Byrd et al., 2006; Byrd & Saltzman, 2003; Shattuck-Hufnagel & Turk, 1998).

Figure 1c shows a partial score for the morphologically-complex *frees*. If the gestural score for *free* is co-activated and influences the production of its morphological relative *frees*, the prosodic gesture in *free* is predicted to influence the timing of the corresponding gesture in *frees*. Thus, the prosodic-word gesture in *frees* will be activated earlier than would otherwise be expected. The result is that the domain of word-final lengthening will extend earlier into the production of *frees* than of *freeze*, and the string [f.i] is predicted to be overall longer in inflected *frees* compared to morphologically-simple *freeze*.

In addition, if the prosodic gesture is activated earlier in *frees* than in *freeze*, it will overlap more of the tongue-tip [z] gesture than in *freeze*, slowing the production of the word-final consonantal constriction. Since English sibilants are highly elastic with respect to domain-edge prosodic effects (Cho, Lee, & Kim, 2014; Hofhuis, Gussenhoven, & Rietveld, 1995; Klatt, 1976; Oller, 1973), the expectation is that the durations of English word-final [s, z] suffixes should be lengthened by a longer prosodic gesture in English inflected words. However, not all segments are equally sensitive to prosodic lengthening effects (Fougeron, 2001; Keating, 2006; Oller, 1973). In particular, word-final [t, d] are less elastic than vowels and sibilants (Berkovits, 1993; Hofhuis et al., 1995; Klatt, 1976). Thus, lengthening in English words with [t, d] inflections (*ducked*, *tied*) is less likely to be observable on the suffixes themselves.

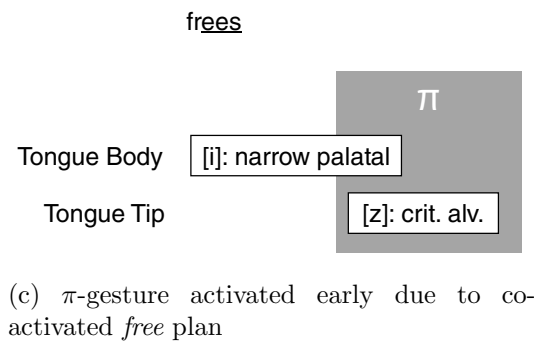
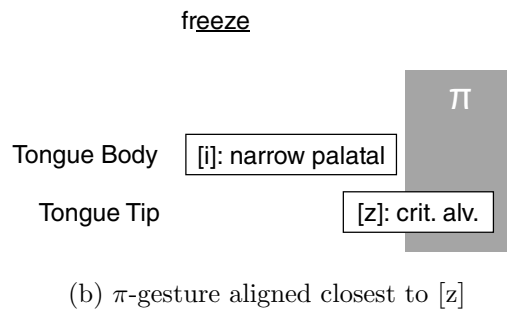
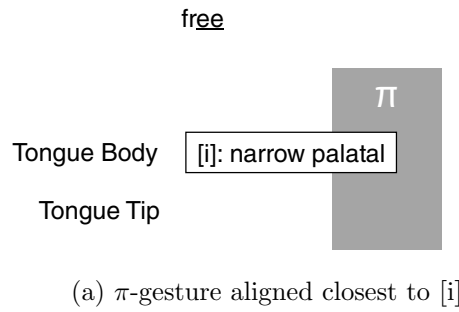


Figure 1: Partial articulatory scores showing the activation of gestures over time (from left to right) during the rime of *free* (1a), *freeze* (1b), and *frees* (1c). Prosodic (π) gestures (grey) at the ends of words cause other gestures to be lengthened in duration.

1.4 Previous evidence

Prior work has compared the durations of simple and inflected English homophones (*tax/tacks*), but with unclear results. Two laboratory studies report that suffix durations are longer in inflected words than their simple homophones (Losiewicz, 1992; Walsh & Parker, 1983), and two report the same pattern for vowel or stem durations (Frazier, 2006; Sugahara & Turk, 2009, as well as mixed results discussed in Sugahara & Turk, 2004). However, a major concern with the interpretation of these findings is that the word productions were elicited in short lists of homophones and in short phrases intentionally designed to highlight contrasts between the target words. It has been shown that phonetic variation between orthographically-distinct homophones increases when the target homophones are dictated in an isolated-word list or in contrastive sentences, as compared to when the target words are disguised in longer contexts (Fourakis & Iverson, 1984; Kharlamov, 2014; Port & Crawford, 1989, see also Roettger et al., 2014; Winter & Roettger, 2011). Thus, while the participants in these studies may have been encouraged by the experimental design to produce phonetic distinctions, those distinctions may have been motivated by orthography or metalinguistic knowledge as much as by the words' morphological properties (Fourakis & Iverson, 1984; Jassem & Richter, 1989; Kharlamov, 2014; Mousikou, Strycharczuk, Turk, Rastle, & Scobbie, 2015, see also Ernestus & Baayen, 2006; Warner, Good, Jongman, & Sereno, 2006; Warner, Jongman, Sereno, & Kemps, 2004).

More broadly, the generalizability of previous reports has also been criticized (see Bermúdez-Otero, 2010; Hanique & Ernestus, 2012; Mousikou et al., 2015; Plag, 2014; Plag et al., 2017), including the findings of one corpus study that reports longer suffix durations for inflected words (Song, Demuth, Evans, & Shattuck-Hufnagel, 2013). These studies have often tested very few items (3 homophone pairs in Walsh & Parker, 1983; 6 pairs in Losiewicz, 1992; 9 non-homophonous words in Song et al., 2013), found the effect only at a slow speech rate (Sugahara & Turk, 2009), only utterance-finally (Song et al., 2013), or were not robust to current statistical practices (Plag, p.c., on Losiewicz, 1992). Additionally, the inflected and simple words in the prior laboratory work were not balanced for frequency, which is well known to influence acoustic duration.³ Several authors also raise a concern about orthographic differences (Fourakis & Iverson, 1984; Winter & Roettger, 2011 on incomplete neutralization; Mousikou et al., 2015; Sugahara & Turk, 2004, 2009 on duration), which might affect production independently of morphological status

³For example, Frazier (2006) found that vowel durations were longer in inflected words than in morphologically-simple homophones. However, the log wordform frequency in the SUBTLEX-US corpus (Brysbaert & New, 2009; Brysbaert, New, & Keuleers, 2012) was significantly greater for the morphologically-simple words ($\mu = 2.90$) compared to the inflected words in that study ($\mu = 2.02$; unpaired $t(32) = 2.48$, $p < 0.05$; excluding two inflected words *brayed* and *rued* which have zero frequency in SUBTLEX). Losiewicz (1992) had the same confound (Hanique & Ernestus, 2012); and see also discussion in Sugahara and Turk (2004, 2009).

(Brewer, 2008; Bürki, Spinelli, & Gaskell, 2012; Ernestus & Baayen, 2006; Warner et al., 2006, 2004). Specifically with regard to duration, Warner et al. (2006, 2004) and Brewer (2008) find that words spelled with more letters are produced with longer durations.

In addition to these concerns, a recent study of a larger number of non-homophonous inflected and simple words in conversational speech reports the *opposite* pattern for English [s] suffix durations: final [s] is *shorter* when it signals an inflectional suffix (Plag et al., 2017). Since this study found the opposite pattern as prior laboratory experiments, one interpretation is that the experimental work may have been confounded by task effects or other methodological issues. At the same time, a corpus-based analysis raises a different set of analytical and interpretability challenges due to the heterogeneous word types in the data, as well as the unbalanced prosodic contexts that English inflected and uninflected words tend to appear in. We return to these questions in the discussion §4.3.

1.5 The current study

In the current study, we analyze the stem and suffix durations in forty pairs of monosyllabic English homophones, in which one member of the pair is inflected (*frees*) and the other is morphologically-simple (*freeze*). Under the paradigm uniformity account, the prediction is that stem durations should be relatively longer in inflected words like *frees*, compared to simple *freeze*, due to the prosodic influence of a lighter word (*free*) on the inflected but not simple words. This account also predicts that the suffix duration in *frees* should be lengthened relative to the same segment in *freeze* as a result of the longer prosodic gesture in *frees*. Because the theory predicts no differences between different morphological suffixes, we include a variety of [s, z, t, d] English suffixes in our stimulus set. Besides these planned tests, we also use the data to explore the influence of probabilistic variables on inflected words (Cohen, 2014; Cohen Priva, 2012; Hay, 2003; Rose, Hume, & Hay, 2015; Schuppler, van Dommelen, Koreman, & Ernestus, 2012). In particular, we evaluate whether the predicted influence of morphological relatives is stronger if these relatives are more frequent, in either absolute or relative terms.

In order to elicit more natural speech and avoid metalinguistic task effects, yet still maintain a phonetically-controlled context, we adapt a method used by Port and Crawford (1989), Baker et al. (2007), and Smith et al. (2012) in which the homophone pairs are embedded in conversational dialogues that are matched for prosodic and segmental context. These dialogues are read by pairs of naïve participants who are already friends, and who are familiarized with the dialogues prior to participation in the experimental task (see Warner, 2012).

This method has several crucial advantages over previous work. First, by using controlled dialogues rather than completely spontaneous speech, we are able to collect productions of a large number of homophone pairs which are matched for frequency and orthographic length, factors that have been potential confounds in

previous work (Hanique & Ernestus, 2012; Mousikou et al., 2015; Plag, 2014; Plag et al., 2017). The use of homophone pairs allows us to compare matched stems, and to be sure that durational differences are truly independent of segmental content.

Second, by concealing the task and target words within a meaningful conversation, speakers are unlikely to explicitly attend to orthographic or morphological differences in the targets. In particular, because Plag et al. (2017)—who looked at spontaneous speech—found a durational effect in the opposite direction as previous experimental work, this method allows us to evaluate whether that difference can be ascribed to metalinguistic task effects in the lab reading experiments. While our hypothesis does not predict the result in Plag et al. (2017), if we do replicate their effect in an experiment that uses conversational speech styles, it would suggest that task effects did in fact confound prior experimental work, and thus help reconcile that study’s findings with earlier work.

Third, our hypothesis requires that the target words be parsed as having both prosodic and morphological structure. By embedding the words in a meaningful conversational dialogue, speakers are much more likely to generate an appropriate prosody and morphological parse, as compared to if they produce items from a word list or in a fixed carrier phrase. The dialogue context further encourages participants not to produce items with a uniform list intonation, which is argued to interfere with lexical effects on word durations (Gahl, 2008, 2015; Gahl & Strand, 2016).

2 Methods

2.1 Participants

Forty participants were recruited from the UC San Diego community. They each brought a friend to the experiment, and together read through a list of short conversational dialogues that included the target words. All participants and their friends reported that they had started learning to speak English before age 6. Both members of each pair gave informed consent, and both optionally received course credit in exchange for participation.

2.2 Stimuli

The target words were 40 pairs of English homophones in which one member of the pair was uninflected, and the other had an inflectional suffix. 26 pairs had fricative [s] or [z] suffixes (e.g., plural *lapse/laps*, third-person singular *freeze/frees*) and 14 had stop [t] or [d] suffixes (past *duct/ducked*, participle *tide/tied*).

2.2.1 Dialogues

The two homophones in each pair were embedded in phonetically-matched dialogues (Baker et al., 2007; Smith et al., 2012). Each dialogue was a short conversation

between two people, and was preceded by a one-sentence description of the scenario in which the conversation took place. For example, the descriptions and dialogues for the target words *freeze/frees* were the following:

Two housemates are wrapping up a surprise birthday party that they put on for a friend.

B: It looks like most people are leaving now. I guess I'm going to start cleaning up a little bit.

A: There's so much cake leftover. I don't want it to go bad.

B: If we freeze it, it should be fine.

Two rural neighbors are talking about a friend, Rich, who is an avid hiker and animal-lover.

B: Rich decided to take care of the injured hawk that he found yesterday.

A: They don't do well in captivity. Wouldn't it be better to let it go?

B: If he frees it, it won't survive.

The complete set of 40 dialogue pairs is given in Appendix A. All of the target words received nuclear accent in their phrase. Within each pair of dialogues, each of the two target homophones were preceded by the same number of syllables and stresses in the phrase. If the target homophones were not in the first phrase of the speaker's turn, there were also the same number of syllables, stresses, and phrases between the beginning of the turn and each of the two target homophones. To manage the possibility that a suffix could be resyllabified, the targets were followed by the same segment, or by a phrase boundary.⁴ To control for the spread of phrase-final lengthening, each pair of target homophones was followed by the same number of syllables in the phrase and turn. In addition, the targets bore the same type of focus, occurred on the same conversational turn (e.g., the third turn in the dialogue), and where it was possible, the target words (or their phrases) had the same discourse relation with the preceding utterance.

2.2.2 Frequency and orthography

Across pairs, the morphologically-simple and inflected words were not significantly different on log SUBTLEX wordform frequencies (mean of differences = 0.21, paired $t(39) = 1.03$, $p > 0.3$), log SUBTLEX word frequency specific to the words' part-of-speech ($\mu_d = 0.20$, $t(39) = 0.87$, $p > 0.39$), or on orthographic length ($\mu_d = -0.33$ letters, $t(39) = 1.65$, $p > 0.1$).

⁴In some cases in which both words were followed by a vowel or semivowel, they had different qualities. For two pairs, the target words were followed by a different segment, but excluding these from the suffix duration analysis did not qualitatively affect the results. Additionally, the target words in 33 of 40 pairs were preceded by the same segment, or else by vowels or semivowels with a different quality.

In addition to being matched across the stimulus pairs overall, both frequency measures were matched across the 26 fricative-final pairs alone (frequency: $\mu_d = 0.40$, $t(25) = 1.39$, $p > 0.17$; part-of-speech-specific frequency: $\mu_d = 0.51$, $t(25) = 1.66$, $p > 0.11$) and across the 14 stop-final pairs alone (frequency: $\mu_d = -0.13$, $t(13) = 0.48$, $p > 0.64$; part-of-speech-specific frequency: $\mu_d = -0.39$, $t(13) = 1.49$, $p > 0.16$). Orthographic length was matched overall, as well as across the fricative-final pairs alone ($\mu_d = 0.19$, $t(25) = 0.93$, $p > 0.36$). However, orthographic length was not matched across the stop-final pairs ($\mu_d = -1.29$, $t(13) = -4.84$, $p < 0.001$); we discuss this issue further in §4.1.

2.2.3 Predictability norming experiment

Beyond the effects of frequency on word and segment durations, it is well-known that words that are predictable in the discourse context are shortened (e.g., Bell et al., 2009; van Son & Pols, 2003). We estimated the contextual predictability of each word by recruiting 40 different participants for a cloze norming task via Amazon Mechanical Turk, using the JavaScript library `jsPsych` (de Leeuw, 2015). On each trial, each cloze participant saw the first part of one dialogue (including the one-sentence description), which was truncated immediately before the target word. They were asked to complete the partial dialogue with the first word, phrase, or sentence(s) that came to mind. Cloze participants saw half of the 80 dialogues (i.e., only one member of each dialogue pair). We collected 20 individual completion judgments per dialogue.

The predictability of each target word was considered to be the proportion of individuals who wrote down that word immediately following the partial context ($\mu = 0.09$, $\sigma = 0.18$, range = 0.00–1.00). On this measure, there was no significant difference between inflected and morphologically-simple words, either across pairs overall or across fricative pairs or stop pairs, by either paired *t*-test or paired Wilcoxon test (since the distribution of predictability was highly non-normal; all $p > 0.15$). We also used this experiment to estimate the probability of inflectional agreement in the dialogues containing inflected words. For each dialogue containing an inflected word, the probability of inflectional agreement was considered to be the proportion of individuals who wrote down a word with the same inflection immediately following the partial context. For example, in the *frees* dialogue above, the probability of third-person singular agreement was the proportion of participants who completed the truncated phrase in the third turn of the dialogue “*If he ...*” with any third-person singular verb. We explore these data further in §3.3.3 (see also Cohen, 2014; Pluymaekers, Ernestus, & Baayen, 2005; Rose et al., 2015).

2.3 Procedure

2.3.1 Lists

Each participant pair in the primary experiment read through one of four lists containing half of the dialogues. Each list included one member of each of the 40 homophone pairs, comprising 20 inflected targets and 20 simple targets. The fricative-final and stop-final pairs were evenly divided between the inflected and simple targets, so that the inflected targets in a particular list included half of the 26 fricative-final pairs and half of the 14 stop-final pairs. The first list was constructed by pseudo-randomly selecting one member from each dialogue pair, and sorting them in a random order. The second list was the mirror-image of the first list (i.e., the first list began with the dialogues containing *prize*, while the second list began with *pries*). To control for possible trial order effects, the third and fourth lists were reversed versions of the first two lists. The order of the dialogues is provided in Appendix B.

Lists were randomly assigned to participants so that each list was seen by 10 participant pairs. Participants were given their experimental list at least one day in advance. They were instructed to familiarize themselves with the dialogues and to share the list with their friend before arriving for the experiment. They were asked to try to read the dialogues as conversationally and as naturally as possible. During the recording session, participants were given additional time before each item to silently review each dialogue before reading it out loud. To avoid clear speech styles, participants were told not to worry if they stumbled or misspoke, and just to start over where they left off as they would normally do. This resulted in some excluded data, described below in §3.1.

2.3.2 Recording

Participants were given the same role (speaker A or speaker B—see example in §2.2.1) for all of the dialogues in their list. The target words were always produced by speaker B. Each participant pair sat together in a sound-attenuated booth in a quiet room. Speaker B was sometimes the original participant and sometimes the friend that had been recruited, assigned arbitrarily based on the order in which they entered the booth. Both participants wore head-mounted microphones, and the person given the speaker B role was recorded at a 44.1 kHz sampling rate with 16-bit depth. Although both microphones were set up in the same way, the person assigned to the speaker A role was not recorded.

2.4 Segmentation

Each target word was extracted from the dialogues recorded by the participant pairs, and segmented into two regions. The stem region was the word onset to onset of the final [s, z, t, d] suffix segment. For example, for the words *freeze/frees* [fɹi:z],

Table 1: Criteria used to mark the onset of the stem region in the target words.

Word-initial segment	Example	Onset boundary
[p, t, k, tʃ, b, d, g, m, n]		beginning of closure
[f]	we freeze	onset of broadband frication noise
[s]	we seize	onset of sibilant noise > 3500 Hz
[h]	the hose	intensity drop following a vowel
[l]	the laps	onset of low intensity trough
[ɹ]	already wrapped	onset of intensity rise
[oʊ]	an ode	end of preceding nasal closure

the stem was [fi]. For the words *mist/missed* [mist], the stem was [mis]. The suffix region was the final segment [s, z, t, d].

Segmentation was performed using the waveform and broadband spectrogram view in Praat (Boersma & Weenink, 2016). The acoustic criteria that were used to mark the onset boundary for the stem region are given in Table 1, with the following additional procedures. For five pairs, an onset plosive followed another plosive segment (e.g., in the phrase *bad bruise*). If the preceding segment was unreleased, the midpoint of the two-segment closure was used as the stem onset boundary (e.g., the midpoint of the [db] closure in *bad bruise*). For [l]-initial pairs, if the intensity contour was flat, the onset of a low F2 or high F3 plateau was used as a boundary instead.

The [s, z] fricative suffixes were segmented from the onset to the offset of sibilant noise in the range above 3500 Hz. If there was broadband aspiration noise following the sibilant noise, it was not included in the suffix duration. If a plosive preceded the sibilant (e.g., *lax/lacks* [læks]), the plosive release burst (if any) was not included in the suffix duration.

The [t, d] stop suffixes were segmented from the onset of the closure to the offset of a release burst (if present), or to the end of the closure, if a release burst was not visible. Closure durations were also segmented; all results for [t, d] suffixes were the same when closure durations were analyzed alone. If there was no burst, no closure (complete or incomplete), and a relatively small drop in intensity, the segment was considered to be an approximant. If there was also no drop in intensity, no audible percept of a coronal stop, and no visible F2 transition (when adjacent to non-front vowels), it was considered to be deleted. Plosives that were part of a coda cluster (e.g., *duct/ducked* [dʌkt]) were segmented beginning after the first segment’s release burst. If no release burst was visible, the midpoint of the two-segment closure was used as the suffix onset boundary.

3 Results

The experiment was run until reaching 40 included participant pairs, with a total of 1600 tokens of the target words (1 of 2 words in each of 40 homophone pairs * 40 participants). Data from one additional participant was excluded without being annotated because of a lisp.

3.1 Exclusions

65 tokens (4.1%) were excluded from all analyses because the target word was disfluent, which was defined as a hesitation immediately before the word, a mispronunciation or speech error on the target word (whether or not the speaker corrected it), or laughter during the word. 40 additional tokens (2.5%) were excluded because the speaker misread the target phrase (e.g., they said *had packed it* instead of *had it packed*). 54 tokens (3.4%) were excluded from the duration analyses because the suffix segment was judged to be deleted (see criteria given in §2.4; an analysis of deletion rates appears below in §3.3.1), as well as 5 other tokens (0.3%) which had no visible landmarks on the spectrogram that could be used for segmentation.

For the stem duration analysis only, 22 tokens (1.4%) were excluded because they were 2.5 standard deviations or more from the mean stem duration of their respective items. For the suffix duration analysis only, 33 (2.1%) [t, d] tokens were excluded because they were approximated, 29 (1.8%) because they were spirantized, and 6 (0.4%) because they were phrase-final but unreleased, which made it impossible to identify the suffix offset. Additionally, 25 tokens (1.6%) were excluded from the suffix duration analysis because they were 2.5 standard deviations or more from the mean suffix duration of their respective items.

3.2 Models

Stem and suffix durations were analyzed in separate linear mixed-effects models. Fixed effects were word type (simple or inflected) and suffix manner (fricative [s, z] or stop [t, d]), plus the interaction. These analyses were planned, designed to replicate a significant interaction found with 20 different participants and variant dialogues in a pilot experiment.⁵ Models also included by-item intercepts and slopes for word type, and by-participant intercepts and slopes for all three fixed effects. Each homophone pair was treated as a single item for the purpose of random groupings. Mixed-effects models were fit using the R package `lme4` (Bates, Maechler, Bolker, & Walker, 2015; R Core Team, 2015).

Effect sizes were estimated with the R package `lsmeans` (Lenth, 2016) by predicting the appropriate marginal means from each model, and then calculating the

⁵For the suffix durations, pilot results were the same as those reported here; stem durations and other measures were not analyzed. Pilot results are reported by Seyfarth, Garellek, Malouf, and Ackerman (2015, oral presentation).

Table 2: Summary of by-group parameter estimates and residual error. Word type was coded as -1 for simple and 1 for inflected words; manner was coded as -1 for fricatives and 1 for stops. Overall model estimates are given in Figure 2.

		σ (stem model)	σ (suffix model)
By-item	Intercepts	0.066	0.031
	Slopes for word type	0.014	0.004
By-participant	Intercepts	0.025	0.008
	Slopes for word type	0.004	0.001
	Slopes for manner	0.005	0.008
	Slopes for word type by manner	0.006	0.001
Residual error		0.040	0.024

difference and p -value for the contrast with the default Kenward-Roger approximation for degrees of freedom (Halekoh & Højsgaard, 2014). The multivariate t distribution was used for multiplicity correction within each family of tests (stem durations and suffix durations).

3.2.1 Stem durations

The left panel of Figure 2 shows a summary of stem durations, by word type and manner of the suffix. Figure 3 shows the durations estimated by the model, and Table 2 provides a summary of the by-group parameter estimates. Crucially, for fricative-final words, stem durations were significantly longer in inflected words (*frees*) compared to simple words (*freeze*) ($\hat{\beta} = 18\text{ms}$, $t(39.73) = 2.91$, $p < 0.02$). However, for stop-final words, stem durations were not significantly different between word types ($\hat{\beta} = -16\text{ms}$, $t(47.43) = 1.82$, $p > 0.14$), with a non-significant effect in the reverse direction.

3.2.2 Suffix durations

The right panel of Figure 2 shows a summary of suffix durations, by word type and manner of the suffix. Figure 3 shows the durations estimated by the model, and Table 2 provides a summary of the by-group parameter estimates. Crucially, for fricative suffixes, suffix durations were significantly longer in inflected words compared to simple words ($\hat{\beta} = 6\text{ms}$, $t(32.51) = 2.73$, $p < 0.03$). However, for stop suffixes, suffix durations were not significantly different between word types ($\hat{\beta} = -2\text{ms}$, $t(33.12) = 0.54$, $p > 0.8$). Results were qualitatively the same if release bursts were excluded from the suffix region, and stop suffix durations were considered to be the closure only.

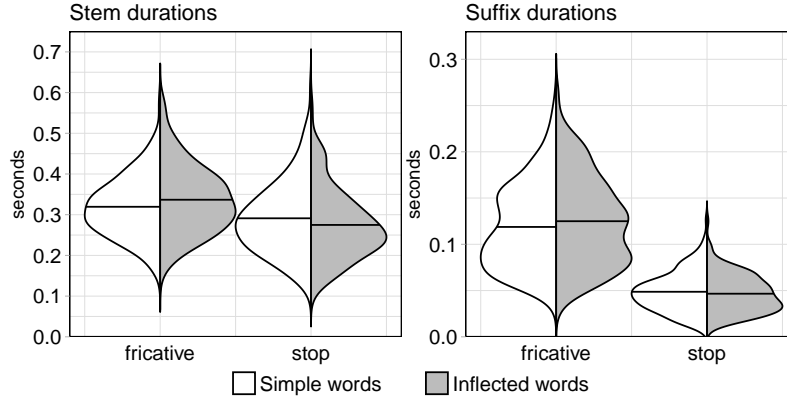


Figure 2: Stem and suffix durations for morphologically-simple and inflected words, by manner of the suffix. The violins are density plots of the empirical durations for simple words (left side of each violin) compared to inflected words (right side of each violin). Horizontal lines show the empirical means for each subgroup.

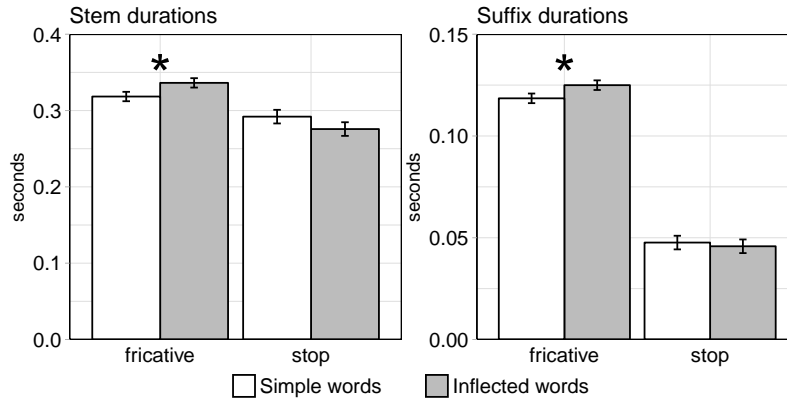


Figure 3: Model estimates for stem and suffix durations for morphologically-simple and inflected words, by manner of the suffix. Error bars show \pm the standard error of the difference between groups.

3.3 Additional analyses

3.3.1 Deletion rates

Final [t, d]-deletion is a well-attested process in American English. Further, a variety of studies have found that final [t, d] are deleted more often when they represent an inflectional suffix (as in *paced*) than when they do not (*paste*) (Bybee, 2000; Guy, 1980, 1991; Guy, Hay, & Walker, 2008; Labov, Cohen, Robins, & Lewis, 1968; Neu, 1980, among others). In our data, deletion rates were roughly the same regardless of inflectional status. Excluding disfluent or misread tokens (§3.1), 27/249 = 10.8% of inflected [t, d] suffixes were deleted, and 26/251 = 10.4% of morphologically-simple [t, d] suffixes were deleted (plus 1 token that was both misread and deleted).

To evaluate whether the non-effect was driven by particular items or subjects, we fit a logistic mixed-effects model (using the [t, d] data only) to predict deletion, with a fixed effect of word type (simple or inflected), plus by-item and by-participant intercepts and slopes. The effect of word type was marginally non-significant in the expected direction ($\hat{\beta} = -2.22$, $z = 1.70$, $p < 0.09$). While it is difficult to interpret a null result, the balanced design of the dialogues suggests that the robust differences in deletion rates that have previously been reported may have been partially driven by frequency effects (Guy et al., 2008) or by the different segmental contexts in which simple and inflected words tend to appear (cf. Bybee, 2002).

3.3.2 Frequency and dual-route models

Besides wordform frequency, several other probabilistic measures may influence the realization of the inflected words in our study. For example, in a dual-route model of morphological processing, morphologically-complex words are accessed through both whole-word representations, and through decomposed constituent forms (e.g., Baayen, 1992; Caramazza, Laudanna, & Romani, 1988; Frauenfelder & Schreuder, 1992; Hay, 2003; Schreuder & Baayen, 1995, and see footnote 1). If the complex wordform has a high frequency relative to its components, it is predicted to behave more like a morphologically-simple form, potentially including stem reduction (Cohen, 2014; Hay, 2003; Losiewicz, 1992; Zuraw & Peperkamp, 2015, though see Hanique & Ernestus, 2012). Additionally, two studies have also found that suffixes are lengthened (Cohen, 2014) or less likely to delete (Schuppler et al., 2012) with higher relative frequency.

This processing model potentially has implications for the paradigm-uniformity account. For example, Winter and Roettger (2011) and Roettger et al. (2014) predict that if a paradigm member is highly frequent, it should exert a stronger influence on its morphological relatives during speech processing. We explored this prediction by examining whether inflected words with high-frequency freestanding stems (such as *guys*) show stronger or weaker effects.

Following Hay (2001) (and others), we also tested whether inflected words with a high frequency relative to their freestanding stems (such as *bored*) show different

effects. If relative frequency conditions uniformity effects, this might account for Cohen’s (2014) finding that high relative frequency of a complex form is associated with reduced stems (cf. Hay, 2003). High relative frequency means that the inflected form is relatively more frequent than the freestanding stem, and so the influence of the freestanding stem word’s independent plan may be weaker (cf. Zuraw & Peperkamp, 2015). In §1.3, we argued that the stem word’s influence should produce relatively longer durations. Therefore, when this influence is weaker, the stems in inflected words should be relatively shorter.

These analyses should be interpreted with caution, in particular because the stimuli were not selected to include a broad range of either frequency measure. Following the procedure in §3.2, we fit a separate linear mixed-effects model to predict stem durations. The model included stem word frequency as an additional fixed effect, as well as all interactions with word type and manner, plus by-participant random slopes. We also fit three models which replaced the stem word frequency parameters with relative frequency, in order to predict stem durations, suffix durations, and stop deletion rates. Stem frequency was the log wordform frequency of the freestanding stem in SUBTLEX. Relative frequency was the log ratio of the inflected word frequency to the freestanding stem frequency.

There was no effect of stem word frequency on stem durations ($p > 0.3$), or of relative frequency on stem or suffix durations ($p > 0.4$). However, there was a marginally non-significant effect in which inflectional stop suffixes were less likely to delete as relative frequency increased ($\hat{\beta} = 0.99$ per SD, $z = 1.95$, $p < 0.051$). This supports Schuppler et al. (2012), who had a similar finding for Dutch /t/ suffixes in a corpus of spontaneous speech.

3.3.3 Predictability effects

In addition to frequency, we explored a possible effect of the probability of an inflection in context (Cohen, 2014; Rose et al., 2015). Inflectional probability was estimated using the cloze norming experiment, as described in §2.2.3. We fit additional models, following the procedures in §3.2 and §3.3.2, to predict suffix durations and stop deletion rates. As before, because the stimuli were not selected to include a broad range of the predictability measure, these results should be interpreted with caution. There was a marginal effect of inflectional probability, such that inflectional fricative suffixes (but not stop suffixes) were non-significantly longer with lower inflectional probability ($\hat{\beta} = 12\text{ms}$ per SD, $t(39.40) = 2.05$, $p < 0.10$). There was no significant effect of inflectional probability on stop deletion rates ($p > 0.17$).

3.3.4 Speech rate

Differences in participant speech rates should be captured in the by-participant intercepts, which reflect overall participant differences in mean durations. Because of the relatively large number of participants, and the balanced design of the exper-

imental lists (§2.3.1), it is unlikely that the results could have been influenced by different global speech rates. In an exploratory analysis, fixed-effects parameters for experimental list were added to the models (§3.2), but no list was produced with significantly longer or shorter durations than any other list overall. To evaluate whether participants’ speech rates changed over the course of the experiment, an additional parameter for trial number was included. There was an effect of trial number on stem (but not suffix) durations, such that participants slowed down over the course of the experiment ($\hat{\beta} = 12.5$ ms over 40 trials, $p < 0.001$), which did not affect the crucial results. There were no significant interactions between trial number and word type or manner of the suffix, and by-participant slopes for trial number did not significantly improve the model.

More generally, it is not clear that a more direct measure of speech rate would be a useful control. A standard way to measure speech rate is to count the number of syllables or segments in a local region near the target. However, many of the target words by design had narrow focus in their phrase, were part of a short phrase, or were phrase- or utterance-final, which means that a local average syllable or segment rate would not necessarily be indicative of how the target word was produced. Prior analyses that use a direct speech rate measure have in fact excluded phrase-final tokens and tokens in short phrases, due to these issues (Bell et al., 2009; Gahl & Strand, 2016; Gahl, Yao, & Johnson, 2012; Seyfarth, 2014).

4 Discussion

English words with English [s, z] inflectional suffixes (e.g., *frees*) had significantly longer stems and suffixes than morphologically-simple homophones (*freeze*). This result supports the phonetic paradigm uniformity account, which predicted that inflected words such as *frees* should be influenced by the phonological plan of their freestanding stems, such as *free*. In particular, we predicted (following Frazier, 2006) that the stem in an inflected word should be lengthened, because the same stem has a lighter coda and a longer duration when it occurs as a word on its own. Further, the freestanding stem word *free* is subject to prosodic domain-final lengthening. This should influence the timing of prosodic gestures within the inflected relative *frees*, such that the stem and suffix are lengthened when they occur within the inflected word *frees*.

4.1 Results for stop suffixes

In addition to the positive results for [s, z] suffixes, we found a null effect for stem and suffix durations when the final suffixes were [t] or [d]. As discussed in §1.3, final [t, d] segments are less elastic and less sensitive to domain-final lengthening effects than [s, z], and thus it is not necessarily surprising that we did not find evidence for observable lengthening of [t, d]. Only one prior study has investigated

[t, d] durations (Losiewicz, 1992), but also found a null result using a mixed-effects analysis (Plag, p.c.). The prosodic paradigm uniformity hypothesis does predict that the stems should be longer in monosyllabic inflected words, regardless of the final consonant, but it is difficult to interpret a null result. It should be stressed that a null result is not incompatible with the theoretical proposal, but we would consider a positive result in the opposite direction (i.e., significantly shorter stems or suffixes in the inflected words) to be evidence against the hypothesis.

There are several factors that may have contributed to the null result. First, in §2.2.2, it was observed that orthographic length was unbalanced across stop-final pairs. However, complex words had more letters than simple words, and the stem duration effect for stop-final pairs is in the opposite direction: complex words are non-significantly shorter than simple words. Therefore, it is unlikely that an orthographic confound caused the null result.

An alternative explanation comes from different parts-of-speech between the simple and inflected words. Several corpus studies report significant differences in word duration as a function of part-of-speech (Gahl, 2008; Gahl et al., 2012; Seyfarth, 2014). In particular, nouns tend to be longer in duration than verbs. Because these differences are generally attributed to systematic differences in phrase position and accent in spontaneous English speech (Gahl, 2008; Gahl et al., 2012), and because the items in the current study were matched for phrase position and accent (see §2.2), part-of-speech was not intentionally balanced across pairs. Impressionistically, we found that participants were very reliable at accenting the expected word. During segmentation of the data, we noted only 21 tokens (1.3% of the data) in which an unexpected word was accented; exclusion of these data did not qualitatively affect the results.

Nevertheless, it is also plausible that nouns are more likely to attract a stronger prominence than verbs, even with all else held equal, which might result in longer durations. Table 3 shows the distribution of part-of-speech for simple and inflected words (see also Appendix A), within fricative-final pairs (*freeze/frees*) and within stop-final pairs (*tide/tied*). While the fricative-final pairs were balanced for part-of-speech ($\chi^2 = 2.56, p > 0.27$), the stop-final pairs included mainly verbs among the inflected words, but mainly nouns among the simple words ($\chi^2 = 17.14, p < 0.001$). This confound could thus have led to a null result for the stop suffixes (with a non-significant trend such that the inflected words were shorter).

To explore this possibility (cf. Conwell, 2016; Li, Shi, & Hua, 2010), we measured homophone vowel pitch as a proxy for phonetic prominence. We fit maximal two mixed-effects models predicting average pitch and pitch slope (maximum pitch minus minimum pitch, divided by the length of the vowel) as a function of part-of-speech (noun, verb, and other). However, there were no significant differences in either pitch measure between the parts-of-speech. This suggests that prominence did not differ between nouns and verbs in our experiment.

Table 3: Distribution of part-of-speech for simple and inflected words, by manner of the suffix.

Word type	Noun	Verb	Other
<i>Fricatives</i>			
Simple	17	7	2
Inflected	16	10	0
<i>Stops</i>			
Simple	10	2	2
Inflected	0	12	2

4.2 Other accounts

4.2.1 Internal hierarchical prosodic structure

Although we argue that the lengthening of inflected words derives from the influence of their morphological relatives, there are other accounts that may accommodate this result. One proposal is that an English inflected word like *tacks* has a hierarchical prosodic structure, such that the inflectional suffix is adjoined to an internal prosodic-word constituent corresponding to the stem *tack* (Goad, White, & Steele, 2003; Sugahara & Turk, 2009, contra Hall, 2001; Raffelsiefen, 2005). Because syllable rhymes are lengthened before prosodic boundaries at various levels of prosodic constituency (Wightman et al., 1992), the stem within an inflected word should be lengthened.

While this analysis is possible, it entails that the final [z] of *frees* either comprise its own syllable, or else be extra-syllabic (not part of any syllable) (Goad et al., 2003; Sugahara & Turk, 2009). However, psycholinguistic evidence is lacking to support either possibility; and from a formal perspective, there are alternative accounts for the phenomena that extra-syllabicity has been used to explain (Hall, 2002). The exception is the durational lengthening observed here (Sugahara & Turk, 2009, p. 482–485), which we claim can be explained by a more general uniformity mechanism. Sugahara and Turk (2009, p. 506) argue against the uniformity account on the grounds that it would require including duration—which is highly variable in usage—in phonological representation. However, there is more recent evidence which supports this assumption (Katz, 2010, 2012; Seyfarth, 2014; Tauberer & Evanini, 2009).

4.2.2 Communicative enhancement

One reason to expect that inflectional suffixes might be lengthened is because a suffix like the [z] in *frees* signals a morphosyntactic property (third-person singular agreement, in our materials), whereas the same [z] suffix in a word like *freeze* carries

no additional information beyond that conveyed by any other word-final segment (Cohen Priva, 2012; Hanique & Ernestus, 2012; Pluymaekers et al., 2010; Rose et al., 2015). This suggests an alternate explanation for our finding that inflectional [s, z] suffixes were longer: speakers may use the details of phonetic implementation to enhance the perceptibility of a morphological property. The prediction is that [s, z] suffixes should be lengthened when they are unpredictable in context. While previous work has found suggestive effects (Cohen, 2014; Rose et al., 2015, though see Hanique, Ernestus, & Schuppler, 2013), we did not find a significant effect of inflectional probability on suffix duration in our analysis. It may be the case that inflectional suffixes are lengthened in general to enhance intelligibility, independent of the local probability of an inflection. While we consider this account to be plausible, it does not straightforwardly predict that the *stems* in inflected words should be lengthened as well (cf. Cohen, 2014, who found that stems are *shortened* with lower inflectional probability).

A variant of this hypothesis is that small durational (or other phonetic) differences between suffixes might be used as a cue to identify morphological complexity. Kemps, Wurm, Ernestus, Schreuder, and Baayen (2005) and Blazej and Cohen-Goldberg (2014) investigate whether listeners are sensitive to durational differences in the initial syllable of words that do or do not have an additional suffix (*-er*, *-ly*, *-less*, *-ness*). The behavioral results indicated that participants were able to anticipate an upcoming suffix. However, because the experiments compared morphologically-simple monosyllabic words to morphologically-complex polysyllabic words, it is not clear whether listeners were anticipating an additional morphological constituent, or simply an additional upcoming syllable in the stem (see also Lehiste, 1972). There are well-known durational differences in syllable length within monosyllabic and polysyllabic words (Turk & Shattuck-Hufnagel, 2000; White & Turk, 2010), and listeners are able to take advantage of those differences to identify whether a syllable is likely to be part of a polysyllabic word (distinguishing e.g. *captain* from *cap tucked*; M. H. Davis, Marslen-Wilson, & Gaskell, 2002; Salverda, Dahan, & McQueen, 2003). Walsh and Parker (1983) tested listeners' sensitivity to durational differences in monosyllabic English simple and inflected homophones (*lapse*, *laps*), but found a null result (cf. §1.4). There is therefore currently no unambiguous evidence that listeners take advantage of morphologically-conditioned durational differences.

4.2.3 Planning costs

A reviewer asks whether the longer durations for the inflected [s, z] words can be interpreted as the result of planning costs. Under this proposal, a word like *freezes* is assembled from a phonological stem constituent plus an additional suffix /-z/, whereas a word like *freeze* does not have such multiple phonological constituents that need to be assembled (e.g., Cohen-Goldberg, 2015; Cohen-Goldberg et al., 2013; Levelt et al., 1999). Due to the additional planning complexity and cost

during phonological encoding, *frees* is phonetically elongated compared to *freeze*, which is not as costly to assemble.

While greater planning costs for a target word might intuitively be associated with greater naming *latencies*, articulation duration does not necessarily scale with planning costs (Buz & Jaeger, 2015; Kirov & Wilson, 2013). In order to explain our results, this proposal requires a link between planning cost and phonetic duration (see Arnold & Watson, 2015; Buz & Jaeger, 2015; Jaeger & Buz, 2017, for discussion). One proposed link that is relevant to our data involves production fluency. In order to maintain fluent delivery, speakers slow down articulation while waiting for speech planning to be completed (Bell et al., 2009; Christodoulou, 2012; Zerkle, Rosa, & Arnold, 2017), even within a word as encoding and articulation proceed from beginning-to-end (Watson, Buxó-Lugo, & Simmons, 2015). For the assembly of *frees*, the prediction thus might be that the stem will be lengthened in order to buy time for assembly and coordination of the upcoming suffix /-z/.

However, there are two crucial difficulties for this account as an explanation of our results (see Buz & Jaeger, 2015; Jaeger & Buz, 2017). First, speech planning theories generally take the syllable or phonological word as the unit that is passed to the articulation system (Crompton, 1982; Dell, 1986; Levelt et al., 1999; Levelt & Wheeldon, 1994; Wheeldon & Lahiri, 1997). Because all of the stimuli in our experiment were monosyllabic, each full word would need to be assembled before being articulated, and there would be no opportunity for speakers to lengthen the stem while waiting for assembly. Second, even if segments were the unit of articulation rather than syllables or larger units, this account does not predict that the word-final [s, z] segments themselves should be lengthened, as they were in our experiment. By the time articulation of the final [s, z] begins, phonological encoding of the full word must be complete, and the speaker has no need to slow down production.

4.3 Comparison with previous work

Our finding that the English words inflected with [s, z] had longer stems and suffixes than uninflected words agrees with some existing experimental work (Frazier, 2006; Sugahara & Turk, 2009; Walsh & Parker, 1983). However, it does not reconcile the differences between that work and Plag et al. (2017), who analyzed suffix durations in a spontaneous speech corpus. In particular, Plag et al. (2017) found that voiceless [s] suffixes were *shorter* in inflected words compared to uninflected ones; as well as a more complicated pattern of differences within several kinds of voiced [z] suffixes (e.g., plural [z] was longer than third-person singular [z]). These corpus results are not predicted by the paradigm uniformity account, or by any current production theories (Plag et al., 2017, p. 29–32).

Why did our suffix duration results pattern in the opposite direction as Plag et al. (2017)? In an exploratory analysis, we tested interactions between voicing, word type, and manner. The crucial effect of word type on suffix durations (or on stem durations) did not significantly differ between voiced and voiceless suffixes,

either overall, within fricatives, or within stops (all $p > 0.24$). There was a significant effect of voicing on suffix durations ($\hat{\beta} = 31\text{ms}$ difference between voiced and voiceless, $t(36.31) = 3.10$, $p < 0.01$), but this effect did not qualitatively alter the results reported in §3.2.2, nor did it vary significantly by manner ($p > 0.3$). Additionally, we found that a model which included the two- and three-way interactions involving voicing was not significantly better than a model with only word type, manner, their interaction, plus voicing with no interactions (by likelihood ratio test; $p > 0.38$). Two methodological differences were the use of read-aloud versus truly-spontaneous conversational speech, and the analysis of homophones versus non-homophones. However, it is unclear whether either consideration would cause the morphological effect to reverse direction, or to interact with voicing as in Plag et al. (2017).

It is also possible that the unbalanced nature of the corpus data in Plag et al. (2017) influenced the analysis. For example, Hsieh, Leonard, and Swanson (1999) find that in natural speech, plural nouns appear in final position much more often than third-person verbs, and are thus lengthened more often. Other work has pointed out that different parts-of-speech (likely correlated with inflectional status) may systematically occur in different prosodic and segmental contexts (see §4.1; Bybee, 2002). Thus, it may be the case that the patterns reported in Plag et al. (2017) reflect such systematic differences in context in natural speech, rather than representational or processing differences. Plag et al. (2017) take the possibility of systematic differences into account and include an appropriate variety of lexical and contextual control variables in their models. However, in order to accurately estimate parameters for correlated variables (e.g., suffix type and syntactic position), it is necessary to have many observations in most cells of the design, which may not have been the case (the analysis selected about 650 tokens at random from the corpus). Further, as the authors acknowledge (p. 14), it is challenging to code and statistically control for the effects of diverse prosodic contexts.

4.4 Conclusions

We found that English inflected words with [s, z] suffixes had significantly longer stems and suffixes than uninflected words that were segmentally-identical: *frees* is not homophonous with *freeze*. This supports predictions based on a model of phonetic paradigm uniformity, in which the durational targets of a target word’s morphological relatives influence the realization of that word (Frazier, 2006; Hayes, 2000; Steriade, 2000). We found this result based on a large and diverse set of word types, which were balanced for frequency and orthography, and elicited in phonetically-matched conversational speech designed to avoid metalinguistic task effects that have challenged the interpretability of previous work (see e.g. Bermúdez-Otero, 2010; Hanique & Ernestus, 2012; Mousikou et al., 2015; Plag, 2014; Plag et al., 2017).

This finding challenges discrete accounts of language production in which mor-

phonological information does not interact with phonetic realization (Kiparsky, 1982; Levelt et al., 1999). In particular, the phonetic paradigm uniformity account suggests one specific mechanism involving the cross-influence of phonological plans among morphological relatives (cf. Kuperman, Pluymaekers, Ernestus, & Baayen, 2007), and makes straightforward, testable predictions about phonetic realization (Frazier, 2006; Kaplan, 2016, and see ongoing work by Abby Kaplan). Future work might investigate especially the cross-linguistic validity of these predictions, and further explore the interaction of probabilistic variables with paradigm uniformity effects.

Acknowledgments

We are grateful to Ingo Plag, the Spoken Morphology Research Unit at Heinrich Heine University Düsseldorf, and the audience at the 3rd American International Morphology Meeting for helpful discussion, comments, and advice. We also thank Alexia Pimentel for assistance with recording the experimental participants. Any errors or omissions are ours. This research was supported by a National Science Foundation Graduate Research Fellowship to the first author under grant #DGE-1144086. Any opinion, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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A Items

board, bored

board (Noun)

Two restaurant executives are talking about expanding to a new location downtown.

B: Getting this construction permit is going to be more of a headache than I thought. I was hoping we could just get the city planning committee chairman to sign off on it, so we wouldn't have to bring it before the whole committee. But the chairman said we need to go to the next meeting.

A: Do you think we can still just ask the committee chairman at the meeting?

B: No. . . now we'll have to ask the board at the meeting.

bored (Adjective, participle)

Two neighbors are talking about volunteering with their city government.

B: The planning committee released their meeting schedule this week. They're not discussing my proposal for the new library exhibit until January.

A: I'm sorry to hear that. Are you still excited about volunteering at the meetings?

B: No. . . now I think I'll just be bored at the meetings.

booze, boos

booze (Noun)

Two friends are talking about a football game that B went to with their mutual friend, Tim.

A: How was the football game yesterday? I heard Tim got really drunk and started a fight!

B: It was great—we won in double overtime!

A: How could he get angry about winning?

B: Well. . . I think Tim just had too much booze.

boos (Noun, plural noun)

Two friends are talking about a football game that B went to with their mutual friend, Tim.

A: How was the football game? I'm impressed that you drove all the way up to Portland just to see your team play.

B: It was fine—we won, but Tim got pretty upset that he was the only one cheering for our team.

A: I bet that must have been frustrating.

B: Yeah. . . all his cheers were drowned out by boos.

brood, brewed

brood (Verb)

Two high school students are talking about their college applications.

A: Are you still upset about your SAT scores?

B: A little bit. I'm really worrying about my chances. My grades haven't been so great this year either.

A: Oh, I'm sorry. You've been stressing about this a lot. Do you want to talk about it?

B: I just brood sometimes. Thanks anyway, though.

brewed (Verb, past)

Two accountants are working together in an office in the late afternoon.

A: I'm heading out for lunch. Do you want anything?

B: I brought my lunch today. I'm feeling really tired anyway.

A: Oh, maybe you need some caffeine! Do you want me to pick up some tea while I'm out?

B: I just brewed some tea. Thanks anyway, though.

bruise, brews

bruise (Noun)

Two friends are talking about an intramural baseball game.

B: Anderson got hit with a baseball yesterday. The pitcher was trying to throw a fastball but missed.

A: Is Anderson all right?

B: Yeah, but he got a bad bruise.

brews (Noun, plural noun)

A has just arrived at a housewarming party. Most of the guests have been there for a little while.

B: If you're thirsty, Anderson brought all of this beer. He went to that fancy beer place he's always talking about.

A: Oh, I think he spends too much money there.

B: Yeah, but he got these good brews.

chard, charred

chard (Noun)

B is giving A a tour of a newly-planted vegetable garden.

A: You have a huge garden! I can't wait to come over for dinner in a few months.

B: Thanks! I've got some great Mediterranean recipes planned out. Be careful when you're stepping over the fence.

A: Oops, I think I stepped on something! What's growing here?

B: Hm... it looks like it's chard. It'll be fine, don't worry.

charred (Adjective, participle)

A is out on some errands, and is calling B on the phone.

A: Hi, I forgot to take the lasagna out of the oven. Could you check on it for me?

B: Sure, I'll go take a look.

A: Does it look okay? Did it burn around the sides of the pan?

B: Hm... it looks like it's charred. It's fine in the middle, though.

choose, chews

choose (Verb)

Two college students are walking back to their dorm.

B: We should get back soon, so we don't miss our course enrollment time.

A: Are you worried about getting a math section with a bad TA?

B: If we choose one, we'll be fine. I looked through the course reviews.

chews (Verb, third singular)

Two roommates are talking.

B: I read that lilies can be dangerous to animals.

A: Do you think we should keep them away from the cat?

B: If he chews one, he'll get sick. We should just put them outside.

clause, claws

clause (Noun)

Two lawyers are revising a contract that they've been hired to write.

B: Pat added this one sentence to the contract that I think is going to cause us a lot of trouble.

A: Yeah, and he also gave us a big list of other changes that he wanted us to make.

B: I think those are mostly low priority. We can work on those later.

A: So which of Pat's ideas do you want to start with?

B: Let's try changing his clause.

claws (Noun, plural noun)

Two roommates are talking about a cat that they just adopted.

B: The cat has been scratching the sofa a lot.

A: Should we get another scratching post?

B: Well, we don't have a lot of space in that room.

A: So how should we deal with the cat instead?

B: Let's try trimming his claws.

cruise, crews

cruise (Noun)

Two young friends are talking about their families' vacation plans.

B: My grandparents fired their travel agent last year. They started booking everything online themselves.

A: I didn't know your grandparents could use the internet.

B: Yeah... that's how they found their cruise.

crews (Noun, plural noun)

A naval historian is giving a lecture about Caribbean piracy.

B: The pirates would go from island to island, robbing townships and abducting young men.

A: Did they mostly just force people into serving on their ships?

B: Yes... that's how they found their crews.

daze, days

daze (Noun)

Two political campaign workers are talking about the election results that were announced the day before.

B: When Kate found out that she won the election, she was just in a state of total shock.

A: That's great! What did she say after the shock had worn off?

B: Once she'd gotten past the daze, she thanked all of her supporters. She was very thoughtful.

days (Noun, plural noun)

A journalist is talking to a co-worker about a political convention in New York City.

B: Every morning, we went to two or three fundraising meetings, then we listened to some of the candidates' speeches during lunch, then we had a five-hour press conference with the candidates immediately afterwards.

A: So it sounds like you were pretty busy! Did you get to go out at night, once all the events were over?

B: Once we'd gotten through the days, we just wanted to go to sleep. We were so exhausted.

duct, ducked

duct (Noun)

A repair person just arrived at an office on a hot summer day.

A: Maintenance sent me over to fix your broken air conditioning system. They said you're not getting any air flow here. Have you checked to see if your vent is blocked?

B: No... but this duct is blocked.

A: Okay, we'll take a look.

ducked (Verb, past)

Two friends on a baseball team are talking about the last pitch.

B: The pitcher threw a wild fastball. Grace almost got hit!

A: Did you see what happened? Did she swing in time?

B: No... but Grace ducked in time.

A: At least she's okay.

flex, flecks

flex (Verb)

Two construction workers are working on a new house.

B: Two more pallets of lumber just arrived. Could you get the forklift and take one of them to Sheila? She's putting up a frame for the shed in the back.

A: Sure, I'll go do that now.

B: Just be careful when you load them up.

A: Why? They look pretty sturdy.

B: We can't let them flex. If they're bent, we can't use them.

flecks (Noun, plural noun)

An art historian is showing a colleague around a Gothic church.

B: This is the area where the earthquake last month caused most of the damage. But there was a silver lining too—when that stairwell collapsed, we found a mural behind the broken stones.

A: Do you know yet if the mural was originally part of the building?

B: Not yet. A forensics team came in to analyze the paint on the mural. They took some samples last week, but we haven't gotten the results back yet.

A: Oh, I hope they didn't damage it! Did they scrape off any of the paint?

B: They scraped off some flecks. It's the normal procedure.

freeze, frees

freeze (Verb)

Two housemates are wrapping up a surprise birthday party that they put on for a friend.

B: It looks like most people are leaving now. I guess I'm going to start cleaning up a little bit.

A: There's so much cake leftover. I don't want it to go bad.

B: If we freeze it, it should be fine.

frees (Verb, third singular)

Two rural neighbors are talking about a friend, Rich, who is an avid hiker and animal-lover.

B: Rich decided to take care of the injured hawk that he found yesterday.

A: They don't do well in captivity. Wouldn't it be better to let it go?

B: If he frees it, it won't survive.

graze, grays

graze (Verb)

Two farmers are talking about their shared pasture, near a busy highway.

B: I'm worried about my sheep. I think the highway construction is scaring them.

A: Why do you say that?

B: They went back to the barn right away this morning. They usually graze first.

grays (Verb, third singular)

A retired couple is out for lunch together.

B: I keep finding all these white hairs around my temples!

A: I wouldn't worry about it. It makes you look distinguished.

B: I didn't think my hair would turn white right away. Hair usually grays first.

guise, guys

guise (Noun)

Two neighbors are talking on the porch.

A: Nice to chat with you. It looks like the plumbing company just got here, so I should go let them in.

B: Oh, did you call Northern Plumbing? Don't trust them with your money. Remember how Martha and Tony around the corner got scammed? That's them.

A: Are you sure it's the same company? It's a similar van, but I thought they were called Mission Plumbing.

B: It's a different guise, but it's the same company.

A: Oh. . . I'll keep an eye on them. Thanks.

B: No problem. Talk to you later!

guys (Noun, plural noun)

Two bicycle store employees are talking.

A: Do you have a minute to help me unload the delivery truck?

B: I want to keep an eye on those three customers. I think they're with the ring of bike thieves that's been trying to sell us parts.

A: Are you sure they're part of that group? I don't recognize them.

B: They got different guys, but they all work together.

A: How do you know?

B: I saw their van out in the parking lot.

hose, hoes

hose (Noun)

Two neighbors are talking about a community garden.

A: I left some things out yesterday when I was watering the plants. Did you put anything away?

B: Yeah, I put the hose away, back in the shed.

A: Thanks—sorry for leaving a mess everywhere.

hoes (Noun, plural noun)

Two neighbors are talking about a community garden.

A: I left some tools out yesterday when I was weeding the garden. Did you put any of them away?

B: Yeah, I put the hoes away, back in the shed.

A: Thanks—sorry for leaving a mess everywhere.

lapse, laps

lapse (Noun)

Two soccer players just finished a game.

B: Miranda was pretty upset after she let that goal through.

A: She went left and the ball went right. She almost never misjudges it like that.

B: Yeah... it was just a lapse. She'll bounce back tomorrow.

laps (Noun, plural noun)

Two athletes just finished a morning workout.

B: I'm exhausted. Let's take it easy this afternoon. My calves are going to be sore.

A: Did we spend too much time on the track?

B: Yeah... it was all the laps. I'll bounce back tomorrow.

lax, lacks

lax (Adjective)

Two students are walking to class.

A: The lecture started a couple minutes ago. Do you think the professor is going to mark us late?

B: I heard she doesn't actually care. I think she'll be pretty lax.

A: That's good to know.

lacks (Verb, third singular)

Two students are talking about a mutual friend.

A: Jay just told me that he's going out tonight. But this morning, he said he'd be up all night finishing the final paper for his class.

B: He doesn't have a great work ethic. It's something he really lacks.

A: Well, I'm sure he'll get his paper done eventually. He always manages to pull it off.

lynx, links

lynx (Noun)

A park ranger is giving a presentation on how they deal with injured animals.

B: Right now, we're caring for a dog and a wild cat that were injured by non-native predators. We're hoping that the cat will be well enough to be released back into the area soon.

A: Are you going to release the dog too?

B: No, just the lynx. We'll see if the dog can be put up for adoption.

links (Noun, plural noun)

An IT worker is giving a presentation on parental-control software for browsing the internet.

B: This software will keep your kids from clicking on URLs that go to potentially unsafe sites. It actually hides them, so kids won't even see them on their screen.

A: Will it hide the images I don't want my kids to see too?

B: No, just the links. You'll have to use other software to block images.

mist, missed

mist (Noun)

Two commuters are chatting in a coffee shop.

B: How has the traffic been so far?

A: The traffic isn't bad, but it's always so foggy in the morning. I can never see the bay on my way to work.

B: Well, it's not bad now. It's just mist out there.

A: That's nice to hear! Maybe it will clear up while I'm driving.

missed (Verb, past)

Two tennis players are talking about the match they just watched.

B: Becca fumbled her first serve attempt, so the other player got to serve first.

A: She's been having trouble with her wrist. Is that still bothering her? Maybe that's the reason she fumbled.

B: No, I think she's fine. She just missed out there.

A: That's too bad.

nose, knows

nose (Noun)

A doctor is helping a patient who is having trouble breathing at night.

A: I always wake up feeling short of breath. Do you have any suggestions?

B: Try using this breathing strip for a week first. It should help keep your sinuses open, and relieve congestion while you're sleeping.

A: I'll give it a try—do I put it on my sinuses?

B: Place it on your nose. There's an adhesive that will help it stick.

knows (Verb, third singular)

Two event planners are working on a schedule for an upcoming fundraiser.

A: Did you ask Taylor for her opinion on the fundraiser schedule? I thought we'd start advertising about three weeks before.

B: She said that we aren't going to raise any money if we don't start at least two months in advance.

A: Oh, is that what Taylor thinks?

B: It's what Taylor knows. She's run a lot of fundraisers before.

ode, owed

ode (Noun)

Two poets are talking about their friend, Gordon.

A: Gordon's really excited about the open-mic night next week.

B: I know. He said he just finished writing something to present. Now he's busy practicing his performance.

A: Did he write a poem for it?

B: Yeah... he wrote an ode for it.

owed (Verb, past)

Two parents are talking about their college-age daughter, Jan.

A: Jan said she had a great time on the ski trip. She said it turned out to be pretty expensive, though.

B: Yeah, she asked me if she could borrow five hundred dollars and pay me back when her job starts.

A: Five hundred dollars? Was that Jan's share of the trip?

B: Yeah... that's what Jan owed for it.

pact, packed

pact (Noun)

Two parents are talking about a backpacking excursion that their teenage sons had been planning.

A: It looks like it's going to rain pretty heavily this weekend. Are Peter and Kevin really still going on a trip to the mountains?

B: Yeah, they made a pact for their trip. They've been planning it for months, and they agreed not to put it off.

A: Well, tell them to bring the snow chains. There might be snow up there.

B: I will. I put the chains in the back of the car already.

packed (Verb, participle)

Two parents are talking about a backpacking excursion that their teenage sons had been planning.

A: Peter and Kevin had a ton of stuff in the car yesterday, but it's empty now. I thought they were going to take a trip.

B: Yeah, they had it packed for their trip. Kevin told me they decided to put it off until next week.

A: Why—what happened? They were really looking forward to going.

B: The weather report said it was going to snow all weekend. They didn't want to drive in the weather.

past, passed

past (Noun)

Two congressional representatives are talking about a vote last month.

B: The majority leader wasn't happy that I didn't vote for her bill last month, but I think she understands why. She knows that it would have hurt me in my district's next election, and her bill ended up getting approved anyway, even without my vote.

A: So do you think that she's forgiven you for it?

B: Yeah... it's in the past.

passed (Verb, participle)

Two congressional representatives are talking about a vote the next day.

B: We need to be sure that everybody from our party is there to vote on the conservation bill tomorrow.

A: Are you worried about whether the bill is going to be approved?

B: No... it'll get passed.

paste, paced

paste (Verb)

Two office workers are working on a newsletter.

B: Thanks for helping me with the newsletters. Let's put this photo on the front page.

A: Should we just staple it to the front?

B: I thought we'd paste it there instead. Then we won't have to damage the edges.

A: That's a good idea.

paced (Verb, participle)

Two runners are talking about a trail race that goes through a state park next month.

B: Sam said he's been training to run the trail race with Amy next month. Amy's run it every year for the past five years, but Sam said he's pretty nervous about all the hills.

A: Did he say he'd run through the course together with her?

B: He said they'd paced it together. He hasn't run through it with Amy yet.

A: I'm sure he'll do fine. Amy's a great trainer.

pause, paws

pause (Verb)

Two friends are watching a news program on TV.

A: This show always has really interesting charts, but they never show them for very long.

B: I pause at them sometimes.

A: I usually watch them live. Maybe I should just record them.

paws (Verb, third singular)

Two friends are talking.

A: I like your aquarium! Does your cat bother the fish when she's climbing up on the mantle?

B: She paws at them sometimes.

A: Be careful. My friend lost a goldfish that way.

please, pleas

please (Adverb)

A parent and their child are buying ice cream.

B: Go ahead and ask for your favorite flavor, but be sure to be polite.

A: Do I have to say thank you?

B: You have to say please.

A: Could I have some mint chocolate chip ice cream, please?

B: That's right. Then you should say thank you afterwards.

pleas (Noun, plural noun)

A tour group is being shown around a municipal court room.

B: The next room is where the judge formally presents the charges to people accused of a crime.

A: Does the judge listen to their cases?

B: He listens to pleas.

A: Then what?

B: If someone pleads innocent, their case is assigned to another judge.

praise, prays

praise (Noun)

A is talking to a vet about his dog's behavior issues.

B: If you're having trouble with your dog obeying commands, you need to be firm.

A: How should I reward him? Should I give him a treat for obeying?

B: You should give him praise. You can give him a treat sometimes, but you shouldn't do it very often.

A: Okay, I'll remember that.

prays (Verb, third singular)

Two football fans are talking about how their favorite players celebrate when they score a touchdown.

B: I think John is very professional. He never rubs it in the other team's face when he scores.

A: Really? Isn't John the guy that dances every time he scores a touchdown?

B: John's the guy who prays. Terry is the one that dances. He got a penalty for it last year.

A: I remember when that happened.

pride, pried

pride (Noun)

Two college-age friends are chatting.

A: How did Sarah's blind date with Franklin go?

B: She said it didn't go very well. She thought he was really irritating.

A: What about him annoyed her?

B: His pride annoyed Sarah. He would never admit he was wrong.

pried (Verb, past)

Two neighbors are talking after a burglary at one of their houses.

A: Do you know how the burglar got in? Were any of the windows broken?

B: He probably came in through the front door. He left some mud on the carpet.

A: How was he able to get your door open?

B: He pried our door open. We found the broken crowbar he used.

prize, pries

prize (Noun)

Two neighbors are chatting at a barbecue.

A: Oh, here comes Don. He's got his poodle with him.

B: It looks like that poodle has gotten groomed pretty recently.

A: Didn't Don just enter him in a dog show?

B: Yeah, he won a prize. Don's been doing well now that he's retired.

pries (Verb, third singular)

Two neighbors are chatting at a barbecue.

A: Oh, here comes Don. He looks like he's got something on his mind.

B: Uh oh. I'm going to go see how the grill is doing.

A: Why don't you want to talk to Don?

B: Well, he really pries. He always asks very personal questions.

quartz, quarts

quartz (Noun)

A museum director is talking to an artist.

A: Do you need any more stone to finish the sculpture?

B: I need some more quartz.

A: Sure, we'll order some right away.

quarts (Noun, plural noun)

Two chefs are starting their morning shift.

A: Do we still need two more pints of milk to make the cheese for today?

B: We need two more quarts.

A: Okay, I'll go get some from the fridge.

raise, rays

raise (Noun)

Two coworkers are chatting.

B: I just had my performance review yesterday. Did I tell you about that?

A: No! How did it go? Did you get a good evaluation?

B: Yeah... it went pretty well. I got a good raise.

A: That's great! I scheduled mine next week, so I'm crossing my fingers.

rays (Noun, plural noun)

Two friends are chatting.

B: Daniel looks really tan! Did he go to the beach this weekend?

A: He said he spent the whole day there. He definitely got a good tan.

B: Yeah... it looks like he did. He got some good rays.

A: I guess we missed out. I always get sunburned anyway.

rapt, wrapped

rapt (Adjective)

A is running for city mayor.

A: How do you think that speech went?

B: It went really well! You had great delivery, and you covered all the key issues.

A: Thanks—did it seem like the audience was paying careful attention?

B: They were paying rapt attention.

wrapped (Verb, participle)

B just gotten a call from a friend who's getting married soon.

A: Thanks for RSVPing to our wedding reception! A couple people have asked about what kind of gifts would be appropriate, so I just wanted to call to let you know that we're not expecting attendees to bring anything.

B: Oh, thanks... I need to tell James that.

A: Uh-oh. Did he already buy a present?

B: He's already wrapped a present.

ruse, ruses

ruse (Noun)

Two roommates are talking.

A: Who was that at the door?

B: It was someone asking if we needed carpet cleaning services. I said no, but he claimed he needed to come in anyway because city hall had designated our house as the possible source of a mold infestation on this block, and his company was the only one licensed to deal with it.

A: Isn't that kind of a complicated story?

B: It's a complicated ruse. I've read about this scam online.

rues (Verb, third singular)

Two neighbors are chatting about their friend, Ed.

A: Did you hear that Ed broke his leg on his skydiving trip last month? He was really upset! He was even planning to sue the tour company.

B: Yeah, he told me about it. He said that they ended up paying him six hundred dollars to waive his rights to a lawsuit. But then his lawyer told him he could have won a lot more in court if he hadn't signed the waiver.

A: Is that a decision Ed regrets?

B: It's a decision Ed rues. He's been dwelling on it too much.

sax, sacks

sax (Noun)

A is helping B, a musician, pack up the car for an out-of-town gig.

B: Thanks for helping me with all this stuff.

A: No problem. Should I get your instrument first, or the recording equipment?

B: Let's start with the sax.

A: Sure. I'll put it in the front of the car so it doesn't get damaged.

sacks (Noun, plural noun)

A is helping B pick up supplies for a new garden shed that B is building.

B: Thanks for helping me get all this stuff home.

A: No problem. Should we carry the bags of cement first, or the roofing material?

B: Let's start with the sacks.

A: Sure. These are heavy!

seize, sees

seize (Verb)

Two TSA officers have identified a suspicious package in the concourse.

A: That piece of luggage doesn't belong to any passengers on this plane. Should we confiscate it now?

B: If we seize it, there might be a big scene. Let's just tell the baggage handlers.

A: That's a good idea. Let's do that instead.

sees (Verb, third singular)

Two travelers are waiting in an airport security line.

A: Do you think it's okay to take this pocket knife through security? It looks like the guy at the X-ray machine isn't paying very close attention.

B: If he sees it, there might be a big scene. You should just drop it in the mail.

A: That's a good idea. Let's do that instead.

size, sighs

size (Noun)

B is at the customer service desk at a department store.

B: I bought a shirt from your company's online store, but you guys sent me this one instead of what I ordered.

A: Sure, I can exchange that for you. Is it the wrong color?

B: No, it's the wrong size. I ordered a medium.

sighs (Noun, plural noun)

Two political analysts are watching a candidate give a speech on TV.

B: I don't think Allan is going to win the election. He has a good record, but he doesn't relate well to the voters.

A: Do you think it's his body language?

B: No, it's all the sighs. He doesn't seem excited.

suede, swayed

suede (Adjective)

B has just walked into a shoe store.

A: Good morning! Just let me know if you need help finding anything.

B: Hello. I was hoping to find a pair of leather boots.

A: Of course. Are you looking for a particular kind of leather boots today? Fancy ones, or boots for when it rains?

B: I was looking for suede ones today...so they won't be for rain.

A: No problem—please follow me.

swayed (Verb, past)

Two neighbors are chatting.

A: That was some storm yesterday! The weather channel said the wind speed got up to fifty miles per hour.

B: Wow! I guess we got pretty lucky. I was watching the willow tree in our yard get blown around for a couple hours.

A: Did your tree end up losing any branches in the wind?

B: It definitely swayed in the wind...but it's fine, thankfully.

A: That's good to hear.

tease, teas

tease (Verb)

Two parents are talking while their son Eugene is playing a game with his cousins.

A: I'm glad Eugene is finally playing Jenga with his little cousins.

B: Maybe...I wish he would be nicer to them.

A: He keeps saying how well they're doing at the game. It seems like he's trying to be nice!

B: He's trying to tease them. They don't realize he's being sarcastic yet.

A: Oh...maybe we should say something to him.

teas (Noun, plural noun)

Two coffee shop customers are waiting at a table for their order to be ready.

A: I don't know why we keep coming back here.

B: I know... we've been here for twenty minutes and our order still isn't up!

A: Can you see what's on the counter? Are there two coffees there for us?

B: It looks like two teas there. That must be another customer's order.

A: Let's go somewhere else next time. This place takes forever.

tide, tied

tide (Noun)

Two friends are staying at a beach cabin in the summer.

A: Do you want to go fishing this morning?

B: The conditions out there aren't good for fishing right now.

A: Is the wind too high?

B: No... the tide is too high.

tied (Verb, participle)

Two parents are talking before a little league awards ceremony.

A: Did you put together the award yourself?

B: Sort of. I added all these blue ribbons to this medal I bought.

A: What's keeping the ribbons together? Are they all glued underneath?

B: No... they're tied underneath.

tract, tracked

tract (Noun)

Two friends are talking.

B: Did you see Russell trying to hand out all those copies of "Our World's Promise" at the book fair?

A: What's that? Is it another religious book that he wrote?

B: Well... it's a tract he wrote.

tracked (Verb, past)

Two camp directors are planning for the summer.

B: Russell said that there was a bear last year that had been getting close to the cabins. But he talked to the park rangers, and they think they've scared it off for good.

A: Were they able to find the bear's den?

B: Yeah... once they tracked it there.

B Item presentation order

- List 1:** prize, tide, choose, nose, booze, tracked, lynx, lacks, quartz, praise, bored, sighs, missed, crews, past, pleas, charred, flex, ode, rues, brews, laps, paws, guys, swayed, freeze, days, ducked, hose, raise, paced, seize, brood, pride, rapt, teas, pact, graze, claws, sacks
- List 2:** pries, tied, chews, knows, boos, tract, links, lax, quarts, prays, board, size, mist, cruise, passed, please, chard, flecks, owed, ruse, bruise, lapse, pause, guise, suede, frees, daze, duct, hoes, rays, paste, sees, brewed, pried, wrapped, tease, packed, grays, clause, sax
- List 3:** sacks, claws, graze, pact, teas, rapt, pride, brood, seize, paced, raise, hose, ducked, days, freeze, swayed, guys, paws, laps, brews, rues, ode, flex, charred, pleas, past, crews, missed, sighs, bored, praise, quartz, lacks, lynx, tracked, booze, nose, choose, tide, prize
- List 4:** sax, clause, grays, packed, tease, wrapped, pried, brewed, sees, paste, rays, hoes, duct, daze, frees, suede, guise, pause, lapse, bruise, ruse, owed, flecks, chard, please, passed, cruise, mist, size, board, prays, quarts, lax, links, tract, boos, knows, chews, tied, pries