The productivity of a root-initial accenting suffix, [-zu]: judgement studies

Shigeto Kawahara · Sophia Kao

Abstract In many languages affixes can assign accents on roots to which they attach. Some previous studies have claimed that accents assigned by affixes universally fall on syllables next to the affixes (Kurisu 2001; Revithiadou 2008). Kawahara and Wolf (2010) document a newly-coined suffix which counterexemplifies this generalization: the new Japanese suffix [-zu] assigns an accent on root-initial syllables. This paper reports five experiments that test the productivity of non-local accentuation of this suffix. The first three experiments show that given four-mora roots, Japanese speakers prefer initial accents in *zu*-words to those in monomorphemic words. However, when *zu*-words are derived from four-mora long roots, speakers prefer default antepenultimate accentuation to initial accentuation. The last two experiments using shorter roots show that speakers assign initial accents to *zu*-words more often when derived from shorter roots. Overall, the experiments support the initial accenting behavior of [-zu], contributing to the typology of affix-controlled accentuation.

Keywords Japanese · Accents · Preaccentuation · Locality · Experimental phonology

1 Introduction

1.1 (Non-)locality of affix controlled accentuation

Many languages have affixes that assign accents/stress onto the root. In most cases, an accent assigned to roots by affixes is local; i.e. prefixes assign a root-initial ac-

S. Kawahara (✉)
Rutgers University, New Brunswick, NJ, USA
e-mail: kawahara@rci.rutgers.edu

S. Kao
State University of New York, Stony Brook, NY, USA
e-mail: azraelezs@gmail.com

cent and suffixes assign a root-final accent. This locality restriction is illustrated by the examples in (1)–(2). (Throughout this paper we mark Japanese accents with an apostrophe after the prominence-bearing vowel, reflecting the phonetic pitch fall associated with accent in Japanese. We use semi-phonemic romanization to represent the Japanese words and our stimuli.)

(1)   Japanese [ma-] and [-ke] (Poser 1984:76, 79)

     a.   [minami] 'south'

     b.   [ma-mi'nami] 'truly south'

     c.   [minami'-ke] 'the house of Minami'

(2)   Greek genitive [-u] (Revithiadou 2008:152)

     a.   [a'nθrop-os] 'man-NOM'

     b.   [anθro'p-u] 'man-GEN'

Some scholars have claimed that accents assigned by affixes, in fact, must universally be local (Kurisu 2001; Revithiadou 2008) and proposed a constraint/mechanism that accounts for this purported universal. Kurisu (2001:210–211) proposes a constraint that requires that the affix and its accent appear on adjacent syllables. Revithiadou (2008:150) states that "[an accent] never lands further than the immediately neighboring syllable [from its affix]." Alderete (2001a) likewise observes that "the site of the mutation must be 'close enough' to the base-mutating affix" (246), and concludes that "when an affix-triggered alternation is local, it is bound to either a prosodic or a morphological category adjacent to the affix" (247), except when the affix-triggered alternation puts an accent on the language's default position. See also Alderete (1999:136–140) for further discussion.[1] In summary, affixes and the changes that they bring onto their roots tend to be local.[2] However, Kawahara and Wolf (2010) document a newly-coined suffix in Japanese, [-zu], which exhibits root-initial accenting behavior.

To illustrate their findings, some background remarks on Japanese accents are in order. In Japanese, accents are phonetically realized as a HL pitch fall. Japanese accents are often phonologically represented as a diacritic (Haraguchi 1977; Poser 1984), although nothing in this paper hinges on this assumption. The presence of an accent is contrastive in nouns, adjectives, and verbs (e.g. [a'me] (accented) 'rain' vs. [ame] (unaccented) 'candy'; [hu'ru] (accented) 'to rain' vs. [huru] (unaccented) 'to

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[1]Relatedly, in discussing cases of derived environment effects, McCarthy (2003a:21–28, 36–38) observes that a phonological change caused in a derived environment must be triggered by the segment that is itself derived (either phonologically or morphologically). In case of morphological derived environment effects, then, a derived phonological change must be caused by a newly added affix, which predicts a local interaction between the locus of the phonological change and the affix.

[2]The general issue of locality in phonology has been much debated in the literature (e.g. Archangeli and Pulleyblank 1994; Benus and Gafos 2008; Gafos 1999; Itô 1986; Liberman and Prince 1977; McCarthy 2003a, 2003b; Ní Chiosáin and Padgett 1997; Odden 1994; Walker 1998; Walker et al. 2008 and many others). The issue of phonological locality has recently been discussed actively in the context of Harmonic Serialism (Jesney 2009; Kimper to appear; McCarthy 2006, 2011; Pruitt 2010). It is beyond the scope of this paper to address the locality property in phonology in general terms; this paper instead focuses on the locality of affix-induced accentuation patterns.

shake'), and the placement of accents is also contrastive in nouns (e.g. [a'sa] (initial accent) 'morning' vs. [asa'] (final accent) 'hemp') (Smith 1998). Therefore, the distribution of lexical accents in nouns is generally unpredictable in Japanese. However, there are several environments in which accent locations are predictable. For example, loanwords—or more generally speaking, nonce words—show accents on the syllable containing the antepenultimate mora, especially when that syllable is heavy (e.g. [faburi'izu] 'Febreze'), which is considered to be the default (see Katayama 1998; Kubozono 2006, 2008; McCawley 1968; Shinohara 2000; Shiozaki 2007 for discussion). Moreover, there are some morphologically-controlled accentuation patterns, as in (1). The case that Kawahara and Wolf (2010) document is another instance of morphologically controlled accentuation.

The suffix that Kawahara and Wolf (2010) discuss is a loanword from the English plural -*s*, and is now used to form group names. This suffix lengthens root-final syllables if they are light, and assigns a root-initial accent, as illustrated by some attested examples of *zu*-words that show initial accenting, shown in (3).[3]

(3) Attested examples of *zu*-words with initial accentuation (based on Kawahara and Wolf 2010)

    a. /raion+zu/ → [ra'ion-zu] 'lion'

    b. /gintama+zu/ → [gi'ntamaa-zu] 'personal name'

    c. /doro'n+zu/ → [do'ron-zu] 'disappearing'

    d. /awa'+zu/ → [a'waa-zu] 'bubble'

Kawahara and Wolf (2010) conjecture the following diachronic story about the origin of initial accenting behavior. In Japanese compounds, the initial syllable of the second member of the compound receives an accent; e.g. /minami-amerika/ → [minami-a'merika] 'South America' (Itô and Mester 2007; Kubozono 1995, 1997, 2008; Kubozono et al. 1997; Poser 1990). The suffix [-zu] took on a compound-like accentual pattern because [-zu] was first extensively used in forming baseball team names, which have the structure [X-[Y-zu]]. Because of this compound structure, [Y-zu] received an initial accent, e.g. [seibu-ra'ion-zu], 'Seibu Lions'. The suffix [-zu] started being used without the initial element X of the compound structure [X-[Y-zu]], but it retained its existing association with initial accentuation.

To confirm the productivity of initial accenting behavior, Kawahara and Wolf (2010) conducted an elicitation study with 16 native speakers of Japanese. In their elicitation study, they found that generally, Japanese speakers assign root-initial accents to *zu*-words derived from unaccented and final accented roots, but preserve root accents if they are not final, as exemplified in (4).

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[3]Another potential candidate for a root-initial accenting suffix in Japanese is [-ji] 'temple' as in /toodai+ji/ → [to'odai-ji]. See Giriko (2009) for detailed description of its accentual behavior. Poser (1984:92–97) also notes some other examples from Japanese which may be considered as initial accenting, including the compound accentuation that we will discuss below shortly. However, he (1984:93) also explicitly mentions that "[the initial-accenting] effect can in most cases be obtained without the use of a rule directly assigning accent to the initial syllable."

(4)   General results of elicitation by Kawahara and Wolf (2010)

    a.   Unaccented root: /usagi+zu/ → [u'sagii-zu] 'rabbit'

    b.   Final accented root: /gomi'+zu/ → [go'mii-zu] 'garbage'

    c.   Non-final accented root: /mura'saki+zu/ → [mura'sakii-zu] 'purple'

Although Kawahara and Wolf's (2010) study finds the general patterns in (4), there are some problems with the design of the elicitation. First, syllable and morphological structure was not controlled in the stimuli. For example, some stimuli contained heavy syllables while others contained only light syllables; since syllable structure affects accent placement in Japanese (Kubozono 2003, 2006, 2008), it should be controlled. Similarly, some stimuli were morphologically complex, and they indeed showed exceptional behavior compared to monomorphemic words. Therefore, the morphological structure of the stimuli should also be controlled.

Second, Kawahara and Wolf (2010) used real words for stimuli, and therefore the true productivity of [-zu]'s accentual behavior remained to be tested. Finally, only 12 speakers consistently showed initial accentuation, and thus to guarantee the generalizability of the study, more extensive study is warranted. Since [-zu] is a new suffix, and since the existence of a non-local affix-controlled accentuation has an implication for the general typology of morphologically controlled accentuation (see Sect. 1.2), systematic studies of the accentuation of *zu*-words are necessary. This paper takes on this task.

The current study builds upon Kawahara and Wolf's (2010) study and reports five experiments that test the initial accenting behavior of [-zu]. The current studies controlled syllable and morphological structure, and used nonce words to test the true productivity of root-initial accentuation. This study also used auditory judgements rather than orthography-based elicitation. This mode of presentation exposes speakers with several potential pronunciations for *zu*-words; it therefore avoids a situation in which initial accentuation goes unnoticed by the participants.

1.2 Why [-zu] is interesting

Before moving on to the description of our experiments, some discussion of why studying [-zu] is important for phonological theory is in order. First, generally, the initial accenting behavior of [-zu] instantiates a non-local interaction between two phonological elements: the suffix assigns an accent to a syllable that is far away from it. For example, in words like [sakuragi] 'family name', speakers can assign root-initial accent onto its initial syllable ([sa'kuragii-zu]) (Kawahara and Wolf 2010), i.e. across three intervening syllables and four moras. The suffix [-zu] therefore instantiates a case of non-local interaction between two elements in phonology.

Second, as Kawahara and Wolf (2010) discuss, current phonological theories of morpheme realization predict that such initial accenting behavior is possible. For example, many theories of morpheme realization assume that affix-controlled accents arise from an underlying floating accent (Akinlabi 1996; Goldsmith 1976; Revithiadou 2008; Wolf 2007; Zoll 1996), and an alignment constraint can dictate where the accent should dock (Akinlabi 1996; Alderete 2001b; Gordon 2003; Zoll 2003). Given the standard assumption that an alignment constraint can be morpheme-specific (McCarthy and Prince 1993; Prince and Smolensky 1993/2004),

these theories predict that a floating accent associated with [-zu] can be indexed to an alignment constraint that requires it to be aligned with a root-initial syllable. These mechanisms together predict the existence of a root-initial accenting suffix. See Kawahara and Wolf (2010) for the details of the implementation of this sort of analysis.

To take another example, in the anti-faithfulness theory of morpheme realization, affix-controlled accentuation patterns arise from anti-faithfulness constraints, which require some specific change in roots (Alderete 1999, 2001a). This theory can—and perhaps should—have position-specific versions (Beckman 1997) of anti-faithfulness constraints (Alderete 1999:140). If so, then there can be ANTI-DEP(accent)-initial, which requires the insertion of root-initial accents. In short, current theories of morpheme realization predict the existence of a root-initial accenting suffix, and [-zu] would fulfill an otherwise puzzling typological gap.

1.3 A brief preview

The rest of this paper reports five experiments that test the productivity of non-local accentuation triggered by [-zu]. The first three experiments show that given four-mora roots, Japanese speakers prefer initial accents in *zu*-words to those in monomorphemic words. However, the experiments also show that initial accenting in long *zu*-words involves a marked metrical configuration. When *zu*-words are derived from four-mora long roots, speakers prefer default accentuation to initial accentuation. The last two experiments using shorter roots show that speakers assign initial accents to *zu*-words more often when derived from shorter roots. Overall, the experiments support the initial accenting behavior of [-zu], contributing to the typology of affix-controlled accentuation.

2 Experiment I: a rating experiment

2.1 Introduction

In order to test the true productivity of the initial-accenting behavior of [-zu], we started with a well-formedness judgment study. In this experiment, Japanese participants were asked to judge the naturalness of various accent patterns in monomorphemic words and *zu*-words.

2.2 Method

2.2.1 Stimuli

The stimuli were all nonce words in Japanese, and the roots consisted of four light syllables. We used four-syllable roots for the following two reasons: first, unaccented pronunciation is possible most commonly in nonce words that consist of four light syllables (Kubozono 1996, 2006). Second, in three-mora roots, the derived initial accents in *zu*-words can be explained as a trochaic accent assignment on the non-final foot; i.e. [(CV'CV)(CVV)-zu] assuming bimoraic right-aligned iterative footing in Japanese (Poser 1990), plus the assumption that prosodically trapped [-zu] is unfooted (Itô and Mester 1992; Kawahara and Wolf 2010;

Kubozono 1999, 2006; Mester 1994). Initial accents in *zu*-words derived from four-syllable roots would preclude this analysis.

Final accented roots were not used in this experiment for two reasons: in isolation, final accented roots are phonetically very hard—if not impossible—to distinguish from unaccented roots (Vance 1995). Second, nonce words are hardly ever pronounced with a final accent, but instead pronounced with default accents.

The stimuli consisted of four conditions, two of which were the target conditions. The two target conditions were *zu*-words derived from accented nonce roots and those derived from unaccented nonce roots. We included root accents as an experimental variable, because Kawahara and Wolf (2010) found that while *zu*-words derived from unaccented roots receive initial accents, those derived from accented roots tend to keep the roots' accents (see (4)). We characterized these two sets of stimuli by taking advantage of the epenthetic status of word-final vowels, which is known to affect the accentedness of loanwords that consist of four light syllables (Kubozono 1996, 2006). For unaccented nonce roots we used those forms that do not end with epenthetic vowels; for accented nonce roots we used those that end with vowels that can be interpreted as epenthetic vowels (i.e. [o] after coronal stops and [u] elsewhere). Each condition had 10 items. The whole stimulus list is provided in Table 1.

The other two conditions were baseline conditions. One condition was initially accented monomorphemic nonce words with the shape of [CV'CVCVCVVda]. This condition served as a baseline for ill-formedness because long monomorphemic words with initial accent are considered to be ill-formed in Japanese (Kubozono 2008). The other baseline condition had the accent on the syllable containing the antepenultimate mora ([CVCVCVCV'Vda]), which is considered to be the default (Katayama 1998; Kubozono 2006, 2008; McCawley 1968; Shinohara 2000; Shiozaki 2007). This condition hence served as a baseline for well-formed forms.

2.2.2 Recording and acoustic editing

A native female speaker of Japanese, who was naive to the purpose of the experiment, pronounced all the stimuli in a sound attenuated booth at the Rutgers Phonetics laboratory. She produced all the stimuli in isolation, and the stimuli were presented in Japanese *katakana* orthography with additional accentual marks on a computer screen in front of her. *Katakana* was used because it is the standard style for nonce-words. Japanese orthography does not mark accentuation, but a few minutes of instruction was sufficient for the speaker to understand the convention. A Powerpoint presented one stimulus per slide. Her speech was recorded through an AT4040 Cardioid Capacitor microphone with a pop filter in a sound-attenuated recording booth and amplified through an ART TubeMP microphone pre-amplifier (JVC RX 554V), digitized at a 44.1 K sampling level.

The speaker repeated all the stimuli three times, and we chose tokens that had minimal creakiness, no clipping and no aberrant F0 contours. The recorded stimuli were edited out at zero crossings, and the average amplitude was modified to 65 dB for each file, using Praat (Boersma and Weenink 2008). Every *zu*-word root and its derived *zu*-word were concatenated with a 500 ms inter-stimulus interval.

Table 1 The stimuli of Experiment I

Monomorphemic stems with initial accent	Monomorphemic stems with antepenultimate accent	Unaccented roots	Zu-words	Accented roots	Zu-words
[ku'yamenaada]	[kuyamena'ada]	[mihusoni]	[mi'husonii-zu]	[soku'demu]	[so'kudemuu-zu]
[wa'binohaada]	[wabinoha'ada]	[wamahibo]	[wa'mahiboo-zu]	[keni'zayu]	[ke'nizayuu-zu]
[ma'kenuraada]	[makenura'ada]	[darakuri]	[da'rakurii-zu]	[roba'yumu]	[ro'bayumuu-zu]
[ga'yohamooda]	[gayohamo'oda]	[chiyogise]	[chi'yogisee-zu]	[zame'soku]	[za'mesokuu-zu]
[ra'mowamiida]	[ramowami'ida]	[buhamera]	[bu'hameraa-zu]	[guna'redo]	[gu'naredoo-zu]
[na'rigumaada]	[nariguma'ada]	[mopeseno]	[mo'pesenoo-zu]	[seri'ponu]	[se'riponuu-zu]
[hi'darameeda]	[hidarame'eda]	[hamarake]	[ha'marakee-zu]	[numa'sedo]	[nu'masedoo-zu]
[po'yazetaada]	[poyazeta'ada]	[kayadoni]	[ka'yadonii-zu]	[nobi'waru]	[no'biwaruu-zu]
[mi'goseteeda]	[migosete'eda]	[zokomare]	[zo'komaree-zu]	[teru'zobu]	[te'ruzobuu-zu]
[zo'ritapeeda]	[zoritape'eda]	[rasobowa]	[ra'sobowaa-zu]	[rene'gunu]	[re'negunuu-zu]

2.2.3 Procedure

All stimuli were converted to mp3 files (at 128 kbps and a 44.1 K sampling rate) and then embedded in an online questionnaire through Sakai (https://sakai.rutgers.edu). The participants were asked to take the test in a quiet environment and wear headphones if possible. The first page of the test showed a consent form to participate in the online experiment, and the second page showed the instructions. The introduction explained the basics of Japanese accents, using two minimal pairs ([ame] 'candy' (unaccented) vs. [a'me] 'rain' (accented), and [hashi'] 'bridge' (final accent) vs. [ha'shi] 'chopstick' (initial accent)), because not all Japanese speakers are explicitly aware of the difference. Then the instructions presented some examples of *zu*-words, explaining how the suffix is being used to form group names. Then the instructions stated that the experiment was about the accentual properties of [-zu]. They were asked to treat [-zu] as a suffix that forms group names rather than the (English) plural suffix.

In the main section, the participants were asked to listen to each stimulus, and then judge the naturalness of accentuation on a 5-point scale rating (provided in Japanese): (A) very natural, (B) somewhat natural, (C) neither natural nor unnatural, (D) somewhat unnatural, (E) very unnatural. (We could not use a numerical scale because of a restriction on Sakai.) They were asked to judge the naturalness of a particular accent contour in each word. They were explicitly asked to pay attention to the naturalness of the accents rather than the segmental composition of the stimuli. They were also asked not to rate the naturalness of how the speaker produced the stimuli.

The test started with a practice session where the participants ran through five practice items, which were unique to the practice block. The main experiment was organized into two blocks separated by a break sign. In the first part, listeners were presented with monomorphemic stimuli with initial and antepenultimate accents. After the first block, a break sign appeared which prompted the listeners to take a break until they were ready to proceed. In the second block, listeners were then presented with *zu*-words preceded by their roots. None of the target stimuli were repeated; hence each block contained 20 items. The order of stimuli within each block was randomized by Sakai. There was no fixed inter-trial interval.

2.2.4 Participants

Ninety-one native speakers of Japanese have participated in the experiment, and 77 of them finished it (drop rate = 15%). The gender breakdown was as follows: 29 female; 46 male; 2 no response. Most speakers participated in this experiment during their class time at Waseda University (Tokyo), supervised by Prof. Mafuyu Kitahara. In this and other experiments, only the data from those who finished the experiment enter into subsequent analyses.

Some comments on the participants' dialects are in order. For all the experiments we report in this paper, although we invited participants primarily from universities in Tokyo (Chuo University, Sophia University, the University of Tokyo, and Waseda University), we did not strictly control for dialects. There are four reasons; (i) most speakers of Japanese are at least familiar with Tokyo Japanese, (ii) most Japanese speakers are not uni-dialectal, (iii) it is extremely difficult to obtain a large number

of pure Tokyo speakers, and (iv) most importantly, Kawahara and Wolf (2010) have shown that speakers from different dialects show similar initial-accenting behavior, presumably because [-zu] is a new suffix.

2.2.5 Statistics

The responses were converted to numerical values as follows: very natural $= 5$; somewhat natural $= 4$; neither natural nor unnatural $= 3$; somewhat unnatural $= 2$; very unnatural $= 1$. Then we used a linear mixed model (Baayen 2008; Baayen et al. 2008; Bates 2005; Jaeger 2008) with subjects and items as random factors, using the `lmer` function of the `lme4` package (Bates et al. 2011) implemented in R (R Development Core Team 1993–2011). We then employed contrast analyses comparing specific conditions. The `lme4` package does not compute p-values, because the exact procedure to calculate degrees of freedom is not known yet. Therefore, the p-values were instead calculated by the Markov chain Monte Carlo method using the `LanguageR` package (Baayen 2009).

2.3 Results

The results appear in Fig. 1, which shows the average naturalness ratings of the four conditions: monomorphemic initial accents (1.95), monomorphemic antepenultimate accents (4.43), initial-accented *zu*-words derived from unaccented roots (3.16), and initial accented *zu*-words derived from accented roots (3.14). We observe that given monomorphemic words, Japanese speakers prefer antepenultimate accents to initial accents. The initial accents received much higher ratings in *zu*-words than in monomorphemic words (the ill-formed baseline) ($t = 22.8$, $p < 0.001$). This difference indicates that speakers do accept initially-accented forms if they are derived by [-zu], supporting the nature of [-zu] as an initially accenting suffix. The initial
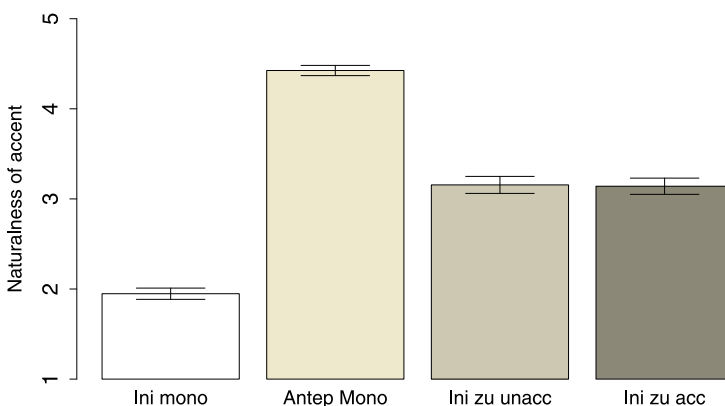

Fig. 1 The average naturalness ratings in four conditions: monomorphemic words with initial accents; monomorphemic words with antepenultimate accents; *zu*-words with initial accents derived from unaccented roots; *zu*-words with initial accents derived from accented roots. The error bars represent 95% confidence intervals based on variability across all tokens

accenting in *zu*-words was nevertheless rated lower than the default antepenultimate accent in monomorphemic words (the well-formed baseline) ($t = -24.6$, $p < 0.001$). Speakers rated initial accenting in *zu*-words derived from unaccented roots slightly better than in *zu*-words derived from accented roots, but this difference was not significant ($t = -1.81$, n.s.).

2.4 Discussion

The fact that Japanese speakers rated initial accenting higher in *zu*-words than in monomorphemic words supports the initial accenting property of *zu*-words. However, the naturalness rating was lower in initially-accented *zu*-words than in monomorphemic words with antepenultimate accents. This situation is comparable to what Steriade (2000) found in the stress assignment of the suffix *-able* in English: words like *di'sciplinable* can only receive initial stress, but there is something marked about this pronunciation. Similarly, as Bailey and Hahn (2001) point out, words like *sphere*, *splurge* and *flail* "sound less English-like" than a word like *rat*. These cases imply that not all attested forms are equally grammatical (Berent and Shimron 1997; Coetzee 2004, 2008; Kawahara 2006; Shinohara 2004; Steriade 2000); i.e. *zu*-words with initial accents are acceptable but still marked, i.e. contain a metrical configuration that is disfavored.[4] Presumably, due to its diachronic origin (see Sect. 1.1), [-zu] assigns an accent on root-initial syllables. However, when this initial accenting behavior results in a marked metrical configuration, speakers can avoid it. The following experiments address this hypothesis.

Finally, Experiment I did not find a difference in rating between *zu*-words of accented roots and *zu*-words of unaccented roots, unlike Kawahara and Wolf (2010). The failure to find a difference may be due to the fact that Experiment I did not present our speakers with *zu*-words that preserve root accents, which is what Kawahara and Wolf's speakers did most often for accented roots. This possibility was addressed in the next experiment.

3 Experiment II: a forced choice test

3.1 Introduction

The previous experiment supported the initial accenting behavior of [-zu]. However, we failed to find a difference between unaccented roots and accented roots, unlike Kawahara and Wolf (2010). This failure may have resulted from the fact that Experiment I did not present *zu*-forms that preserve the accents of roots. Moreover, given that the rating was higher for monomorphemic words with antepenultimate accents than for *zu*-words with initial accents, it would be interesting to investigate whether antepenultimate accent would be better than initial accenting for *zu*-words. Experiment II was conducted to address these questions.

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[4]In this paper, we use the term 'marked' in the sense that is used in Optimality Theory (Prince and Smolensky 1993/2004): a structure is marked when it violates a markedness constraint (and hence can be ruled out in candidate selection). The nature of this markedness constraint is discussed in Sects. 3.4 and 7.2.

3.2 Method

3.2.1 Stimuli

The words used in this experiment were the same as those used in Experiment I. The design had three conditions: monomorphemic words, *zu*-words derived from unaccented roots, and *zu*-words derived from accented roots. For each condition, we prepared three accentual possibilities: initial accent, second syllable accent, and antepenultimate accent. Initial accent was included to test the initial accenting property of *zu*-words. The second syllable accent forms were included because those forms preserve root accents in the accented root condition (e.g. [zame'soku] → [zame'sokuu-zu]). For the sake of completeness, the second syllable accent forms were included for monomorphemic words and *zu*-words derived from unaccented roots as well. Finally, antepenultimate accents were included because they are default accents in Japanese loanwords and nonce words (Katayama 1998; Kubozono 2006, 2008; McCawley 1968; Shinohara 2000; Shiozaki 2007).

3.2.2 Recording and acoustic editing

The same stimulus sounds used in Experiment I were recycled when appropriate. Those that were not available from the previous experiment—all types of words with second syllable accents, and the two types of *zu*-words with antepenultimate accents—were re-recorded with the same recording setting as Experiment I. The acoustic editing procedure was also identical to that of Experiment I.

3.2.3 Procedure

The experimental procedure was almost identical to Experiment I. In this experiment, the participants were asked to listen to three accentual patterns, and then choose the most natural one. For *zu*-words, listeners were first asked to listen to the pronunciation of roots by pressing the play button for roots. Then they were asked to play the three choices of accentuation of the corresponding *zu*-words, again by pressing corresponding play buttons. The order of the three choices was randomized by Sakai. The entire experiment was blocked into two parts. Part I presented 10 monomorphemic stimuli and part II presented 20 *zu*-words. The order of the stimuli within a block was randomized by Sakai.

The participants were asked to take the test in a quiet environment and wear headphones if possible. The introduction explained the basics of Japanese accents, as in the instructions in Experiment I. The instructions then presented some examples of *zu*-words and stated that the experiment was about the accentual properties of [-zu]. They were asked to pay particular attention to the naturalness of accentual patterns rather than the segmental composition of the stimuli or how natural our speaker produced the stimuli.

3.2.4 Participants

The link to the online experiment was advertised on personal blogs of the first author as well as through word of mouth. Forty-eight native speakers of Japanese participated, and 40 of them finished the experiment (18 female; 20 male; 2 non-response; drop rate = 17%).

Table 2 The numbers (and the percentages) of choices that were judged to be most natural in Experiment II

	Monomorphemic words	*Zu*-words of unaccented roots	*Zu*-words of accented roots
Initial	10 (2.5%)	36 (9.1%)	27 (6.8%)
Second	4 (1.0%)	69 (17.4%)	145 (36.5%)
Antepenultimate	384 (96.5%)	291 (73.5%)	225 (56.7%)

3.2.5 Statistics

Chi-square tests were used to access the interactions between particular conditions (monomorphemic, *zu*-words derived from unaccented roots, and *zu*-words from accented roots) and responses (initial, second, and antepenultimate).

3.3 Results

Table 2 shows the numbers (and the corresponding percentages) of choices that were judged to be most natural for each condition.[5] Generally, speakers preferred antepenultimate accent in all three conditions. However, the two *zu*-conditions did produce more initial accenting than the monomorphemic condition. The increase was not large, but statistically significant by a χ^2-test comparing the monomorphemic condition and the two *zu*-conditions in terms of initial vs. non-initial accentuation responses ($\chi^2(1) = 10.8$, $p < 0.01$). Although *zu*-words derived from unaccented roots showed more initial accenting than *zu*-words from accented roots, the difference did not reach significance ($\chi^2(1) = 1.13$, n.s.). Contrary to the hypothesis raised in Sect. 3.1, presenting forms that preserve root accents does not decrease the number of initial accent responses in accent roots enough to make the difference between the two *zu*-conditions statistically significant.

3.4 Discussion

The fact that Japanese speakers chose initial accents more often in the *zu*-conditions than in the monomorphemic condition again supports the initial accenting nature of [-zu]. However, the fact that they more often chose antepenultimate accents than initial accents in *zu*-words may seem at odds with Kawahara and Wolf's (2010) results, although we do see a hint of this pattern in their data as well. Kawahara and Wolf (2010) had three roots that consist of four light syllables, and about half of the twelve speakers assigned initial accents to these words, whereas more speakers assigned initial accents to shorter stems. The avoidance of initial-accents in long *zu*-words is consistent with the hypothesis raised in the previous section that initial accenting in *zu*-words is possible but nevertheless marked.

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[5]The total numbers do not match across the three columns because there were a few non-responses (2 for the monomorphemic condition; 4 for the unaccented *zu*-condition; 3 for the accented *zu*-condition).

The avoidance may be due to the dispreference against initial accents in long words.[6] There are very few if any Japanese long words with initial accents (Kubozono 2008). Moreover, even in the context of compound accentuation, initial accenting on the second member of a compound does not occur when the second member is long (e.g. [minami-kariforunia] (unaccented) 'Southern California') (Itô and Mester 2007; Kubozono et al. 1997). Experiments IV and V address the possibility that initial accenting triggered by [-zu] interacts with a constraint against having an accent "too far away" from the right edge. Nevertheless, the fact that speakers chose initial accents more often in *zu*-words than in monomorphemic words supports the thesis that [-zu] does have the potential to induce initial accenting.

Speakers chose accents on second syllables most often in *zu*-words derived from accented roots ($\chi^2(1) = 82.5$, $p < 0.001$); this result is not surprising, because in this case speakers simply preserved root accents in the derived *zu*-words, just like the informants of Kawahara and Wolf (2010). What was unexpected is that speakers chose accents on second syllables 17.4% of the time even in *zu*-words derived from unaccented roots. One explanation is that [-zu] can assign an accent on a non-final foot, given that [-zu] itself is unfooted and bimoraic feet are right-aligned: i.e. [CV(CV'CV)(CVV)-zu]. We will address this possibility more fully in Sect. 7.2.

4 Experiment III: a free choice test

4.1 Introduction

Although the participants in Experiment II chose more initial accents in the *zu*-conditions than in the monomorphemic condition, suggesting that [-zu] does have the potential to induce initial accentuation, they did not choose initial accentuation for *zu*-words very often. Recall also that in Experiment I, speakers rated initial accent in *zu*-words lower than antepenultimate accent in the monomorphemic condition. These results may imply that initial accentuation due to [-zu] is possible, but nevertheless marked. Therefore, when speakers have an option to choose an antepenultimate accent—which is the default form in Japanese phonology—they do so. To address this possibility, Experiment III asked the participants to choose all possible accentuations for given words.

4.2 Method

The procedure was identical to that in Experiment II, except that this time the listeners were asked to choose all possible accentuation forms, rather than just one. The link to the online experiment was advertised on personal blogs of the first author as well

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[6]An anonymous reviewer raised an interesting alternative: language changes target shorter stems first, and changes diffuse from shorter stems to longer ones (Sano 2010). Given that the suffix [-zu] has recently been introduced to Japanese, the initial accenting property of [-zu] may yet to be diffused to longer roots. We would like to explore this possibility in future studies in which we systematically vary the length of roots to which [-zu] attaches.

Table 3 The numbers of items that were judged to be possible (and their percentages) in Experiment III

	Monomorphemic words	Zu-words of unaccented roots	Zu-words of accented roots
Initial	72 (14.9%)	128 (22.8%)	122 (20.6%)
Second	62 (12.8%)	116 (20.6%)	188 (31.8%)
Antepenultimate	350 (72.3%)	318 (56.6%)	281 (47.5%)

as through word of mouth.[7] Forty-eight speakers participated in this experiment and 37 of them completed the experiment (22 female; 14 male; 1 no-response; drop rate = 23%).

4.3 Results

Table 3 illustrates the results of Experiment III. Initial accentuation was chosen more often compared to Experiment II (22.8% for *zu*-words of unaccented roots and 20.6% for *zu*-words of accented roots). The difference between monomorphemic words and the average of *zu*-words in terms of initial accent selection turned out to be significant ($\chi^2(1) = 7.61$, $p < 0.01$). The difference between the two *zu*-conditions in terms of initial accenting was not significant ($\chi^2(1) = 0.65$, n.s.). Accents on second syllables were most likely for *zu*-words derived from accented roots ($\chi^2(1) = 31.7$, $p < 0.001$) and more likely for *zu*-words derived from unaccented roots than for monomorphemic words ($\chi^2(1) = 10.7$, $p < 0.01$).

4.4 Discussion

Experiment III revealed the same patterns as Experiment II. Antepenultimate accents were chosen most often in all three conditions, showing that Japanese speakers resort to default accents even in *zu*-words. Initial accenting was more likely in *zu*-words than in monomorphemic words.

5 Experiment IV: a free choice test with shorter stems

5.1 Introduction

The three previous experiments showed that Japanese speakers assign initial accents more often to *zu*-words than to monomorphemic words. However, the probability of *zu*-words receiving initial accents is not very high (less than 10% in Experiment II and around 20% in Experiment III). A question therefore arises why the probability of initial accents is so low, when Kawahara and Wolf (2010) found that *zu*-words received initial accents. The low probability in the previous experiments may be related to the fact that initial accents are rare in long words in Japanese (Kubozono 2008). To address this question, we ran a follow-up experiment using shorter, trimoraic roots.

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[7]Since the links to Experiments II and III were posted on the same personal blog site, it is possible that some participants participated in both Experiment II and III. However since we did not record personal information due to IRB regulations, there is no way of knowing for sure about whether some people indeed participated in both experiments.

Table 4 The stimuli of Experiments IV and V

Monomorphemic roots with initial accent	Monomorphemic roots with antepenultimate accent	Unaccented roots	Zu-words with initial accent	Zu-words with antepenultimate accent
[ya'menaada]	[yamena'ada]	[husoni]	[hu'sonii-zu]	[husoni'i-zu]
[bi'nohaada]	[binoha'ada]	[masedo]	[ma'sedoo-zu]	[masedo'o-zu]
[ke'nuraada]	[kenura'ada]	[rakuri]	[ra'kurii-zu]	[rakuri'i-zu]
[yo'hamooda]	[yohamo'oda]	[yogise]	[yo'gisee-zu]	[yogise'e-zu]
[mo'wamiida]	[mowami'ida]	[hamera]	[ha'meraa-zu]	[hamera'a-zu]
[ri'gumaada]	[riguma'ada]	[peseno]	[pe'senoo-zu]	[peseno'o-zu]
[da'rameeda]	[darame'eda]	[marake]	[ma'rakee-zu]	[marake'e-zu]
[ya'setaada]	[yaseta'ada]	[yadoni]	[ya'donii-zu]	[yadoni'i-zu]
[go'seteeda]	[gosete'eda]	[komare]	[ko'maree-zu]	[komare'e-zu]
[ri'tapeeda]	[ritape'eda]	[sobowa]	[so'bowaa-zu]	[sobowa'a-zu]

5.2 Method

5.2.1 Stimuli

We created shorter roots by stripping off the initial syllables from the root forms previously used, which all resulted in nonce words.[8] We did not use accented roots, since trimoraic roots would receive an initial accent because of the default antepenultimate accentuation rule (Katayama 1998; Kubozono 2006, 2008; McCawley 1968; Shinohara 2000; Shiozaki 2007), and it would not be surprising if zu-words derived from initially accented roots receive initial accents. We did not prepare accented roots with medial accents because such forms are rare at best in Japanese loanwords and nonce words (Kubozono 2008). The stimuli are shown in Table 4.

5.2.2 Procedure

The first author, a native speaker of Japanese, pronounced all the stimuli in the same recording condition as in Experiment I, and the same acoustic editing procedure was applied to the recordings as in Experiment I. As with the previous experiments, the stimuli were embedded in Sakai. The procedure was most identical to Experiment III, in which speakers chose all possible pronunciations of monomorphemic nonce-words and zu-words. The experiment was blocked into two parts. In part I, the participants chose all possible accents for the 10 monomorphemic nonce words. In part II, the participants chose all possible accents for the 10 zu-words; the zu-stimuli were preceded by the pronunciation of unaccented roots, presented as separate play buttons. The order of the options and the order of the stimuli within each block were randomized by Sakai.

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[8]We mistakenly included [masedo] from [numa'sedo], a four-mora accented root, as an unaccented root. However, the root was pronounced as unaccented in the stimuli.

Table 5 The numbers of choices that were judged to be possible (and their percentages) in Experiment IV

	Monomorphemic words	*Zu*-words
Initial	89 (27.6%)	163 (46.7%)
Antepenultimate	234 (72.4%)	186 (53.3%)

Besides the difference in stimuli, there were a few differences between Experiment III and Experiment IV. First, given that there were no accented roots, the two options were initial accent and antepenultimate accent; preservation of root accent was not possible. Second, in this experiment, the experimenter sat with the participants, as the test was administered in Japan. The test was administered in a quiet—but not sound-attenuated—room. The participants all wore earphones or headphones.

5.2.3 Participants

The participants were 26 native speakers of Japanese, who were undergraduate and graduate students at Chuo University (Tokyo) and the University of Tokyo. One speaker quit after the first block. Thus the data from the remaining 25 speakers (9 female and 16 male) entered into a subsequent analysis. The experiment took about 10 minutes to complete.

5.3 Results

Table 5 shows the results of Experiment IV. The initial accenting responses increased from the monomorphemic condition to the *zu*-condition, and the antepenultimate responses decreased from the monomorphemic condition to the *zu*-condition $(\chi^2(1) = 25.4, p < 0.001)$.

5.4 Discussion

Zu-words derived from shorter stems receive initial accenting about 47% of the time when *zu*-words are five moras long. *Zu*-words are also less likely to receive antepenultimate accent than monomorphemic words. The contrast between Experiments II–III and Experiment IV shows that the possibility of initial accenting increases when the words in question are shorter.

6 Experiment V: a forced choice test with shorter stems

6.1 Introduction

Experiment IV reveals that given roots that are three-mora long, Japanese speakers accept initial accented *zu*-words almost as often as antepenultimate accented *zu*-words. The final experiment investigated whether Japanese speakers choose initial accenting of *zu*-words over antepenultimate accent even in a forced choice task (i.e. when initial accent and antepenultimate accent are in competition).

Table 6 The numbers (and the corresponding percentages) of items that were judged to be most natural in Experiment V

	Monomorphemic words	*Zu*-words
Initial	20 (7.7%)	113 (43.6%)
Antepenultimate	240 (92.3%)	146 (56.4%)

6.2 Method

The stimuli and the procedure were identical to Experiment IV, except that this time the participants were asked to choose the unique most natural accentual pattern. Twenty-six native speakers of Japanese, who were primarily recruited from Sophia University (Tokyo), participated in this study (18 female; 8 male). The experiment took about 10 minutes. Due to a mechanical error, two speakers doubly-registered their responses. Thus only one of each of their responses was analyzed.

6.3 Results and discussion

Table 6 illustrates the results. *Zu*-words received initial accenting more often than monomorphemic words, and this skew was significant ($\chi^2 = 139.1$, $p < 0.001$). Although antepenultimate responses were more common than initial accents in *zu*-words, initial accents were judged to be more natural than antepenultimate accents 43.6% of the time.

7 General discussion

7.1 Summary

All five experiments show that speakers accept initial accent more often in *zu*-words than in monomorphemic words. These results support the possibility of root-initial accentuation due to a suffix, expanding the typology of affix-controlled accentuation. That is, non-local interaction between a suffix and its accent is possible in human language, i.e. allowed by UG.

On the other hand, we could not detect a difference between *zu*-words derived from accented roots and those derived from unaccented roots, unlike Kawahara and Wolf (2010). We do not have a clear answer as to where this difference comes from: it may be related to a production/judgment difference, although this hypothesis is admittedly speculative. Another possibility is the fact that while Kawahara and Wolf (2010) used real words, the current experiment is based on nonce words. It is possible that speakers are less committed to apply an innovative accentual pattern—root-initial accentuation—to nonce words, thereby obliterating a difference between unaccented roots and accented roots. Testing these possibilities warrants further controlled experiments.

Finally, in Experiments II–V, antepenultimate accent—the default accentuation in Japanese—was chosen more often than initial accent even in *zu*-words. Taken together, we conclude that initial accenting is possible, but is nevertheless marked. To summarize, presumably due to its diachronic origin, [-zu] assigns a root-initial accent (see Sect. 1.1). However, in long *zu*-words, this initial accenting nature of [-zu] results in a marked metrical configuration, in which case speakers can avoid it and resort to other accentual patterns.

7.2 The nature of [-zu]

Our experiments show that the initial accenting propensity is more clearly observed when *zu*-words are derived from three-mora roots than when they are derived from four-mora roots. The results show that in addition to a requirement that *zu*-forms receive initial accents, there is a dispreference against having initial accents in long words. This dispreference could for example be formalized as a constraint that prohibits a long lapse at the end of words (for *LAPSE constraints, see Kager 2001). Regardless of how we formalize this dispreference, when it overrides [-zu]'s requirement for initial accenting, speakers resort instead to default antepenultimate accent. However, initial accenting due to [-zu] does sometimes happen, overriding this requirement.

As anticipated in Sect. 3.4, an alternative explanation emerges: *zu*-words receive an accent on the non-final foot. This hypothesis predicts that *zu*-words derived from three-mora roots should receive initial accent: [(CV'CV)(CVV)-zu]. This theory also explains why in long-zu words, speakers sometimes assign an accent on the second syllable (i.e. [CV(CV'CV)(CVV)-zu]) in Experiments II and III.

While there may be some truth to this theory, it cannot be the whole story. First of all, in Experiment I, speakers judged initial accents in long *zu*-words to be more natural than initially-accented monomorphemic words. If [CV(CV'CV)(CVV)-zu] were the only structure permitted by [-zu], this result would remain unaccounted for. Second, speakers do choose initial accenting more often in *zu*-words than in monomorphemic words in Experiments II and III. Therefore initial accenting must be a possible, if not the best, accent assignment pattern in *zu*-words.

7.3 Further theoretical implications

We would like to close this paper by discussing what [-zu] tells us about phonological theory in general. First, our results show that initial accenting in *zu*-words is possible, but nevertheless marked at the same time. This behavior shows that not all possible forms are equally well-formed (Berent and Shimron 1997; Coetzee 2004, 2008; Kawahara 2006; Shinohara 2004; Steriade 2000).

Second, the behavior of [-zu] shows that a suffix can affect a segment that is not adjacent to it. To generalize, a suffix can assign an accent across three or four moras, showing that two non-local phonological elements can interact, at least in the context of affix-controlled accentuation.

Third, current theories of morpheme realization predict the existence of such long-distance accentuation. For example, an Autosegmental Theory of morpheme realization postulates an underlying floating accent (Akinlabi 1996; Goldsmith 1976; Wolf 2007; Revithiadou 2008; Zoll 1996), which can be directed to word-initial syllables by a morpheme-specific alignment constraint (McCarthy and Prince 1993; Prince and Smolensky 1993/2004). Therefore, the existence of [-zu], which shows initial accentuation due to a suffix, is theoretically assuring.

Finally, our results also raise several theoretical questions. Our studies show that non-local interaction is possible when it comes to suffix-controlled accentuation. A question arises whether the same sort of long-distance interaction is possible at

the segmental level. A related question is how to build a model of phonology which is flexible enough to allow patterns like [-zu] while also retaining the restrictiveness needed to explain other locality restrictions observed in other domains of phonology (see footnote 2). We will leave these questions for future research.

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