# Rhythm's role in genitive construction choice in spoken English

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## 0. Introduction[1]

English has two syntactically distinct constructions for expressing the possessor and possessum relationship: the *s*-genitive and the *of*-genitive:

(1) a. the car's wheel b. the wheel of the car

The *s*-genitive (1a) is a single noun phrase, where the possessor *car* occurs before the possessum *wheel* accompanied by the possessive clitic *–s*. The *of*-genitive (1b) consists of two noun phrases, with the possessor *car* located in a prepositional phrase headed by *of*.

The choice between the two English genitive constructions is not a free one. Rather, the choice of one genitive construction over the other is conditioned by the interaction of semantic, syntactic, phonological, and sociolinguistic factors (e.g., Rosenbach 2002, Hinrichs and Szmrecsányi 2007; Kreyer 2003; Szmrecsányi and Hinrichs 2008; Tagliamonte and Jarmasz 2008). In this study, we examine the influence of rhythm, which has been known to interact with syntax, in predicting genitive construction choice in spoken English. We do so by incorporating rhythmic factors into a single model of genitive choice alongside previously identified predictors using logistic regression modeling. We find that while rhythm significantly influences construction choice, its explanatory role is small relative to other known predictors. Thus, rhythm—and phonological factors at large—must not be discounted in studies of syntactic variation, but the converse is also crucially true: rhythm alone does not do or explain everything.

The paper is organized as follows. Section 1 motivates our investigation of rhythm's effect on genitive construction choice, reviewing previous work on prosody-syntax interaction and presenting our definition of rhythm for this study. Sections 2 and 3 present our spoken English genitive data and introduce each of the predictors in our model, respectively. Results of our analysis are in §4, with discussion in §5. Section 6 concludes.

## 1. Rhythm and its role in syntactic construction choice

Rhythmicity is, as characterized by Abercrombie (1967), "the periodic occurrence of some sort of movement, [which produces] an expectation that the regularity of succession will continue." This definition of rhythmicity forms one of the fundamental assumptions of metrical theory: because we expect regularity, languages strive towards a perfect state of rhythmicity, where stress is equally distributed and spaced (Selkirk 1984; Hayes 1995; a.o.). One of the most desired rhythmic states in language, then, is a "fundamental contrast between stressed and unstressed syllables" (Schlüter 2005: 19), as in the word *álabàster*, where exactly one unstressed, weak syllable occurs between each stressed syllable. Language tries to avoid deviation from the equal distribution of stress. Clash—adjacent strong syllables (*thirtéen mén*)—is dispreferred, as is lapse—adjacent weak syllables (*Míllington's regrét*). Selkirk (1984) terms this rhythmic drive towards equally distributed stress "the Principle of Rhythmic Alternation," describing it as "a sort of Platonic ideal to which the rhythmic structure, grounded in syllables, tones, and syntactic structure, aspires" (55).

While the interaction of rhythm and syntax has long been noted in the generative literature, the early work in this vein focused largely on the influence of syntax on metrical and prosodic structure. Some even questioned the bi-directionality of the phonology-syntax relationship (e.g., Vogel and Kenesei 1990). Recent research, however, has suggested and demonstrated the influence that rhythm, rhythmicity, and the Principle of Rhythmic Alternation can exact on syntax. From psycholinguistic studies of processing and production to studies in historical change, rhythm's effects on syntax—and in particular, syntactic word order choice—are more and more evident.

Psycholinguistic experiments have shown that the Principle of Rhythmic Alternation has a significant influence on syntactic word order. In a study on word order in English noun phrase coordination, McDonald, Bock, and Kelly (1993) found that "words are more likely to be ordered in a way that enhances rhythmic alternation between stressed and unstressed syllables" (215). More subjects ordered the constituents *surprise* and *sin* as *surprise and sin* rather than *sin and surprise*. The former order maintains a perfectly alternating stress pattern—*surPRISE and SIN*—while the latter violates the Principle of Rhythmic Alternation with two unstressed syllables between stressed ones—*SIN and surPRISE*. The effect of rhythm in

McDonald et al. (1993) proved even more significant to word order than the Heavy-last Principle of ordering short constituents before longer ones.

The Principle of Rhythmic Alternation also influences diachronic syntactic construction change and variation. Schlüter (2005) provides numerous examples from the history of English showing that there is a historical tendency to avoid rhythmic clashes and lapses. For instance, the strive for eurhythmy explains the disproportionate disuse of *a*-adjectives such as *aware* in pre-nominal positions. The majority of English nouns have initial stress, and, as such, exhibit stress clash when pre-modified by *a*-adjectives, which have final stress. The use of the phrase *aware person* is therefore rarer than a construction without pre-modification, *the person who was aware*. Outside the noun phrase, Schlüter also shows the effect of the Principle of Rhythmic Alternation on adverbial and verbal structures.

More closely related to the present study, Anttila, Adams, and Speriosu (2010) explored the role of stress clash in predicting the English dative construction, which, similar to the English genitive, varies in syntactic word order. They questioned whether rhythm helps in the choice between the double object construction (*We gave the child the dog*.) and the prepositional construction (*We gave the dog to the child*.). Anttila et al.'s data from the Switchboard Corpus and a written corpus of informal blogs suggests that prosody significantly affects the choice of dative construction. To avoid stress clash, speakers preferentially choose the more eurhythmic alternative, which is modeled by Anttila et al. in Optimality-theoretic terms.

Following the precedent set by recent literature showing the two-way interaction of syntax and prosody, the goal of the present study is to explore the influence of rhythm—specifically, the Principle of Rhythmic Alternation, following Schlüter (2005)—on genitive construction choice. We proceed with the hypothesis that the Principle of Rhythmic Alternation plays a role in predicting and determining which genitive construction speakers use. If speakers indeed optimize for rhythmicity, they should choose the more rhythmic construction over the less rhythmic. For example, compare the *s*- and *of*-genitive pair in (2):

(2) a. the chíldren's vóices — W S W S W
b. the vóices of the chíldren — W S W W W S W

The *s*-genitive, (2a), exhibits perfect alternating rhythm, with lexical stresses distributed evenly throughout the construction, as shown by the alternating S(trong)s and W(eak)s marked below the words. On the other hand, the alternative *of*-genitive in (2b) does not have perfectly alternating rhythm:

three unstressed W syllables occur between the two stressed S syllables, forming a lapse in rhythm. Our prediction, dictated by the Principle of Rhythmic Alternation, is that speakers will choose the more optimally rhythmic variant of the genitive—in (2), for example, the *s*-genitive.

Our study differs from Anttila et al.'s (2010) in that their analysis of prosody in the dative alternation is more nuanced than the basic definition of the Principle of Rhythmic Alternation. In addition to stress clash, Anttila et al. also include in their model constraints on the formation and well-formedness of higher level prosodic phrases. There are potential complications, however, in using higher-level prosodic phrasing such as sentence stress in predicting syntactic word choice. Utilizing higher level prosody in a model opens the door to confounds between prosody and syntax, semantics, and processing since prosodic structures are in part defined by syntactic constructions (Selkirk 1984; a.o.). For this study, therefore, we are primarily concerned with the simple alternation of stressed and unstressed syllables, as formulated in the Principle of Rhythmic Alternation, and its influence on genitive construction choice, leaving the question of higher-level prosodic effects open for future investigation.

In studying the effects of rhythm on syntax, we find it of the utmost importance to also consider the relative effect of rhythm with respect to other known predictors that influence genitive construction choice. In their study on English datives, Anttila et al. (2010) focus primarily on prosody, mentioning only in passing that other constraints—syntactic, semantic, informational—may also take part in determining syntactic word order. But, it is truly impossible to judge the actual effect of rhythm on syntax if it is examined in isolation without controlling for the effects of other non-rhythmic conditioning factors. In their series of experiments, McDonald et al. (1993) note that prosody influences word order "only in the absence of an animacy contrast" (188). Judging from McDonald et al.'s results, discounting syntactic, semantic, informational, and sociolinguistic factors in a study of syntactic construction choice is dangerous—as is discounting phonological and rhythmic factors. For example, (2a) is not only more rhythmic than (2b), but also it is the preferred order of 83% of the animate possessors in our dataset of spoken alternating genitives. Thus, in addition to asking the question of how good a predictor of genitive choice rhythm is, we also ask: when combined with the previously identified factors, both phonological and non-phonological, how important are rhythmic influences?

## 2. The data

Our study utilized spoken data from the manually parsed Penn Treebank portion (Marcus et al. 1993) of the Switchboard corpus of American English (Godfrey and McDaniel 1992) under the hypothesis that rhythmic and phonological effects will be most apparent in spoken contexts. Exploration of rhythm in written data is saved for further research (see Grafmiller forthcoming). The Switchboard corpus consists of telephone conversations between native American English speakers who did not know each other and were assigned random, predetermined conversation topics.

The key criterion for identifying the data in this study was the reversibility and interchangeability of the *s*-and *of*- genitive constructions. Following previous work on genitive construction choice (Rosenbach 2002; Kreyer 2003; Hinrichs and Szmrecsányi 2007; Szmrecsányi and Hinrichs 2008; a.o.), we only included constructions whose alternatives were equivalent and possible paraphrases: e.g., *the doctor's patients ≃ the patients of the doctor*/. Excluded, then, were constructions where the *s*- and *of*- alternatives were not interchangeable, all of which have been previously identified and include the following (Quirk et al. 1985; Biber et al. 1999; Rosenbach 2002, 2006; Kreyer 2003):

- Post-genitives: *We meet at Bill's ≠ *We meet at of Bill.*
- Genitives without noun heads: *the cost of providing the startup ≠ *providing the startup's cost*
- Quantitative constructions: *a cup of soup ≠ a soup's cup*
- Qualitative constructions: *this kind of work ≠ *this work's kind*
- Material constructions: *a crown of gold ≠ *gold's crown*
- *Of*-constructions with premodifying quantifiers: *most of the people ≠ *the people's most*
- Descriptive genitives: *women's magazines ≠ the magazines of {the|some} women*
- Indefinite possessums: *a book of a teacher ≠ a teacher's book*
- Fixed expressions: *arm's reach ≠ the reach of the arm*

Additionally, Rosenbach (2002) notes that pronominal possessors appear nearly categorically in the *s*-genitive form; thus, for the purposes of this study, we did not consider genitives with pronominal possessor or possessum NPs, following previous work (e.g., Hinrichs and Szmrecsányi 2007).

Genitives were chosen from the Treebank Switchboard corpus using a combination of automatic Tgrep2 filtering and manual coding. The four researchers collaborating on this study each coded a portion of the corpus, excluding constructions listed above, and cross-checked their results with the others. Our data was then checked once more for consistency by the second author. Animacy information for each noun was derived from the LINK annotations of the corpus (Zaenen et al. 2004), and demographic information about the speaker of each utterance was extracted using perl scripts from Jaeger (2005). We concluded with 1124 genitives, of which we had to exclude nine more due to missing or incomplete contextual information from Switchboard. In sum, the corpus has 1115 genitives, with 659 instances of *of*-genitives (59.1%) and 456 instances of *s*-genitives (40.9%).

## 3. Predictors

This section presents the conditioning factors coded in our data.

### 3.1 Rhythm

Before being able to examine rhythm in the genitive alternation, we first annotated our dataset with lexical stress information using automatic annotation of both primary and secondary stress based on the Carnegie Mellon University Pronouncing Dictionary (CMU). Since we are interested in the simple alternation between stressed and unstressed syllables, we chose to collapse the distinction between primary and secondary stress; thus, both primary and secondary stressed syllables are, for our purposes, considered stressed syllables, forming a binary distinction between syllables that are stressed and those that are not. Words that were not found in CMU were manually coded by the first author for lexical stress and syllabification, following CMU annotations as closely as possible. Using CMU as the source of our lexical stress annotations provides us with a way to approximate speakers' stored lexical information about a word's phonological properties—in particular, stress—independent of other phonetic and syntactic pressures and effects during the speech act. A study of actual stress patterns utilized in the Switchboard conversations is left to future research. The stressed annotations from CMU were randomly hand-checked for accuracy.

As laid out in §1, we hypothesize that the Principle of Rhythmic Alternation influences the choice of genitive constructions in English. All else being equal, given a pair of possessor and possessum NPs, speakers should, under our hypothesis, choose the more eurhythmic construction, be it the *s*-genitive or the *of*-genitive. Take, for example, the possessor-possessum pair in (3): *the children* and *the voices*.

(3) a. the chíldren's vóices
W S W S W

b. the vóices of the chíldren
W S W W W S W

In (3), we would expect speakers to avoid lapse in the *of*-genitive construction of (3b) and instead prefer the eurhythmic *s*-genitive construction. Conversely, the *of*-genitive construction of the possessor and possessum pair *government* and *response* in (4b) is more eurhythmic:

(4) a. the góvernment's respónse
W S W W W S

b. the respónse of the góvernment
W W S W W S W W

In *the government's response* (4a), there is a lapse of three unstressed W syllables between the S syllables whereas in *the response of the government* (4b), there is only a lapse of two unstressed W syllables. Thus, we would expect that the latter construction is preferred.

Speakers, when producing one of two alternative genitive constructions, must evaluate both the *s*- and *of*- genitive forms for any given possessor-possessum pair. To model this intuition, we developed a measure of *eurhythmy distance* that quantifies how rhythmic each genitive construction is across the local possessor-possessum boundary. Take again the possessor and possessum pair *children* and *voices*. In the *s*-genitive construction (5a), there is one unstressed syllable between the two stressed syllables at the right and left edges of the possessor-possessum boundary:

(5) a. the chíldren's vóices
W S W S W
(S W S: 1)

b. the vóices of the chíldren
W S W W W S W
(S W W W S: 3)

In the *of*-genitive construction for the same possessor-possessum pair (5b), there are three unstressed syllables spanning the possessor-possessum border; that is, there are three weak syllables between the leftmost stress of the possessor and the rightmost stress of the possessum.

Eurhythmy distance takes the number of intervening syllables between stress peaks in the genitive constructions as shown in (5) above and measures how far away from perfectly alternating rhythm a given construction is. We will refer to eurhythmy distance when the possessor and possessum are in the *s*-genitive form as *s*-Eurhythmy Distance (*s*-ED) and when the possessor and possessum are in the *of*-genitive form as *of*-Eurhythmy

Distance (*of*-ED). Eurhythmy distance is calculated by taking the absolute value of the number of unstressed syllables between stress peaks across the genitive border, as formulated in (6).

(6) *s*- ED = | # of unstressed syllables between rightmost possessor stress and leftmost possessum stress – 1 |
*of*-ED = | # of unstressed syllables between rightmost possessum stress and leftmost possessor stress – 1 |

For the possessor-possessum pair of *children* and *voices*, then, the *s*-ED is 0, and the *of*-ED is 2.

In the eurhythmy distance measure, a count of 0 means that the construction exhibits the ideal eurhythmic alternation of S and W syllables, with exactly one W syllable intervening between two S syllables. Thus, any eurhythmy distance that does not equal 0 means that perfectly alternating rhythm is not achieved by the construction, and under our hypothesis, the speaker will not prefer these more arrhythmic constructions (*s*/*of*-ED > 0). Additionally, the eurhythmy distance measure makes no distinction between clashes and lapses. Compare, for example, the constructions in (7).

(7) a. the kíd's vóice
W S S
0
*s*-ED = | 0 – 1 | = 1

b. the géneral's vóice
W S WW S
2
*of*-ED = | 2 – 1 | = 1

The examples in (7) have different numbers of unstressed syllables between their possessors and possessums. Despite this difference, both constructions in (7) are the same distance away from perfect rhythmic alternation (*s*-ED = *of*-ED = 1), which the eurhythmy distance measure captures. Further discussion of rhythmic clashes and lapses occurs in §5.

## 3.2 Other predictors

FINAL SIBILANCY. Speakers tend to avoid immediately adjacent sibilants, including [s], [z], [ʃ], [tʃ], [ʒ], and [dʒ], in an OCP-type ban on neighboring sibilant sounds (Menn and MacWhinney 1984; Zwicky 1987; a.o.). In the *s*-genitive construction, the *-'s* possessive morpheme will sometimes occur next to a final sibilant in the possessor: *the veterans* + *-'s* + *descendents*. Even though repairs such as haplology of the possessive morpheme or [ə] epenthesis exist, speakers tend to avoid the occurrence of sibilants altogether by using the *of*-genitive construction. Hinrichs and Szmrecsányi (2007) find that the presence of a final sibilant on the possessor NP significantly reduces the likelihood of the *s*-genitive in both speech and writing. After manually and automatically[2] coding for the presence of a final sibilant in the possessor NP, we found that there are significantly fewer *s*-genitives with final sibilants in their possessors (34/460) than there are *of*-genitives with final sibilants (133/663)($\chi^2$ = 34.432, $p < 0.0001$).

ANIMACY. The animacy of the possessor is the most important single predictor of genitive construction choice in English. *S*-genitives overwhelmingly have animate possessors while *of*-genitives have inanimate ones, which has been found to be true across all studies on genitive construction choice (see especially Rosenbach 2005, 2008; Hinrichs and Szmrecsányi 2007; Szmrecsányi and Hinrichs 2008; Tagliamonte and Jarmasz 2008; a.o.). For animacy coding, we used the version of the Treebank Switchboard corpus that was annotated for animacy in the Paraphrase Link project (Bresnan et al. 2002). In this version of the corpus, almost all argument noun phrases are annotated for eleven levels of animacy (Zaenen et al. 2004) using a scheme derived from Garretson et al. 2004). We simplified these eleven levels to a binary distinction between animate entities—animals and humans—and all others, including organizations.

There are significantly more animate *s*-genitive possessors (389/460) than there are *of*-genitive ones (78/663)($\chi^2$ = 592.515, $p < 0.0001$). *Of*-genitive possessors are more often inanimate than their *s*-genitive counterparts. The effect of animacy is strong and nearly categorical in our data; hence, the model presented in §4 includes interactions between animacy and other conditioning factors—most notably, rhythm.

SEMANTIC RELATION. As many have noted, the English genitive construction encodes a host different relations between the possessor and possessum (e.g. Taylor 1996: 339-348). Following Rosenbach (2002: 120-123), we collapsed several relations into a single category of 'PROTOTYPICAL' genitives, which favor the *s*-genitive, and all others into a category marked simply as 'NON-PROTOTYPICAL'. Prototypical genitives were any examples that fell into one four subclasses: kinship (*the children of these people*), body-part (*the fish's mouth*), part-whole (*the car's starter*), and physical/legal ownership (*Scotty's bed*). Tokens not fitting one of these four types were classified as non-prototypical, e.g. *an employer's rights, the owner of the store, the bag's contents*. In our data, genitives denoting prototypical relations occur as *s*-genitives (141/460) significantly more often than *of*-genitives (31/663)($\chi^2$ = 129.92, $p < 0.0001$).

THEMATICITY. Osselton (1988) examined the tendency of topical or "thematic" possessors to favor the *s*-genitive even when they are otherwise disfavored. For example, in a textbook on phonology, *sound*, which, as an inanimate possessor, would likely occur in an *of*-genitive elsewhere, would be more likely to occur in the *s*-genitive: e.g., *the sound's feature structure.* Hinrichs and Szmrecsányi (2007) found that Osselton's hypothesis holds true in written English genitives, with thematic possessors occurring more often in the *s*-genitive alternative. Following Hinrichs and Szmrecsányi (2007), we took the log text frequency of the head noun in each possessor, extracted and calculated automatically via a Python script, as a count of thematicity. We do not find a significant effect of thematicity in predicting genitive construction choice ($W = 114680$, $p = 0.992$); therefore, thematicity has been excluded from our final modeling.

GIVENNESS. It has been suggested by some that the information status of the possessor influences genitive construction choice (Biber et al. 1999; Quirk et al. 1985). When a possessor NP refers to a discourse-old entity, it is thought that a speaker is more likely to produce an *s*-genitive construction so as to place given information before new information. We manually coded givenness by looking for reference of any kind to the possessor in the preceding ten line context of each genitive token. In our data, there is a significantly greater proportion of given possessors in *of*-genitives (23%) than in *s*-genitives (12%)($\chi^2 = 12$, $p < 0.001$) in our data.

WEIGHT. There is a well-known tendency in English for speakers to place "heavier" (i.e., longer and more complex) constituents after "light" (i.e., shorter) ones (Behagel 1909; Quirk et al. 1985; Hawkins 1994; Wasow 2002; Bresnan et al. 2007; a.o.). Following much work on genitives and other English constructions (e.g., Rosenbach 2005; Bresnan et al. 2007; Hinrichs and Szmrecsányi 2007; cf. Anttila et al. 2010), we measured the weight of each possessor and possessum NP by the number of orthographic words, which has been found to so highly correlate with theoretical measures such as syntactic node count that there is little advantage to using the latter (Wasow 2002; Szmrecsányi 2004). We predict that the heavier the possessor NP is, the more likely it will follow the possessum and occur in the *of*-genitive form, as in the extreme example in (8).

(8) a. ✓[the attitude]$_{\text{possessum}}$ of [people who are really into classical music and feel that if it's not seventy five years old, it hasn't stood the test of time]$_{\text{possessor}}$
b. ???[people who are really into classical music and feel that if it's not seventy five years old, it hasn't stood the test of time]$_{\text{possessor}}$'s [attitude]$_{\text{possessum}}$

The *of*-genitive in (8a)—a token from our data—exemplifies the end weight effect, with an unusually long possessor (24 words) following a short, one-word possessum. In (8b), which is a construct, the longer possessor precedes the one-word possessum, making this alternative dispreferred.

It is important to note here that our measure of end weight is neither a strictly syntactic nor a strictly phonological measure. Some researchers have framed end weight as a phonological property, using, for instance, the number of syllables for constituent weight (e.g., McDonald et al. 1993) or the number of lexical stresses as a measure of phonological and prosodic complexity (e.g., Anttila et al. 2010). Others have assumed weight effects to be driven by the demand of processing complex syntactic structures and measure weight in terms of the number of syntactic nodes or dependencies (e.g., Hawkins 1994; Gibson 2000; Temperley 2007). In a study comparing different phonological, processing, and syntactic measures of weight, Grafmiller and Shih (2011) present evidence suggesting that weight measured in orthographic words is a less ideal proxy for either phonological or syntactic notions of weight, especially in the English genitive alternation. They note, however, that absolute differences in the explanatory power of the different weight measures investigated are small, and the ranking of the weight factor relative to other factors in their models did not change regardless of which weight measure was implemented. They conclude that any differences in the predictive power of word count versus other measures are likely to be of little import to studies focusing mainly on other factors, including the present one. Since orthographic word count is by far the simplest measure to operationalize, we follow the precedence in construction choice studies by using word count in this study instead of other measures of end weight (see also Szmrecsányi 2004).

As expected, we find that the mean number of words in the possessor is significantly lower among *s*-genitives (*mean* = 1.8, *SD* = 0.62) than among *of*-genitives (*mean* = 2.62, *SD* = 2.31)($W = 114680$, $p < 0.0001$).

PERSISTENCE. Persistence describes a possible priming effect of one structure on subsequent construction choices. For example, in genitive construction choice, the presence of an *s*-genitive may prime the choice of another *s*-genitive the next time the speaker has to choose between constructions. Previous genitive research (Szmrecsányi 2006; Hinrichs and Szmrecsányi 2007) has found persistence to be a significant but small effect in both spoken and written English. While we excluded pronominal genitives (see §2), which meant that we could only easily calculate persistence based on genitives without pronouns, we nevertheless found a significant difference in the proportions of *s*-genitives (32.2%) and *of*-genitives

(18.2%) that are immediately preceded by another *s*-genitive in our data ($\chi^2$ = 28.35, $p < 0.0001$).

SPEAKER AGE AND GENDER. Since around the 16th century, the frequency of the *s*-genitive has been steadily increasing (Rosenbach 2007: 154), and this trend has continued through the latter half of the 20th century in both American and British English (Hinrichs and Szmrecsányi 2007). Because of its French origins and predominance prior to the 16th century, the *of*-genitive form is often regarded as having formal connotations (Rosenbach 2002; Tagliamonte and Jarmasz 2008). This has led some to hypothesize that women, who have been found in sociolinguistic studies to utilize formal structures more frequently than men, along with people with higher education in general, are more likely to use *of*-genitive constructions. In their study on spoken genitives in Toronto English, Tagliamonte and Jarmasz (2008) show a correlation between older age and the use of more *of*-genitives but do not find significant effects of speaker gender or education. We utilize the speaker sex and age information available with the Switchboard data. Speaker ages ranged from 19 to 67, with a median age of 35. Speaker education was excluded due to missing educational information for some of the subjects.

## 4. Modeling and analysis

In this section, we present a model of genitive construction choice in spoken English using a logistic regression analysis and the conditioning factors presented above[3]. In addition to the final model presented below, three mixed-effects models containing combinations of speaker and conversation as group levels (random effects) were also tested: speaker only ($N = 922$), conversation only ($N = 461$), and both speaker and conversation. In none of the mixed effects models did any of the grouping factors account for a significant portion of the variance in our data. This is likely due to the fact that the large majority of individual speakers are represented by only one or two genitive tokens in our dataset (52% and 28%, respectively). Individual conversations are similarly underrepresented, with 80% contributing three or fewer tokens. We therefore considered the use of a simpler single-level model for our final analysis to be justified, following other recent work (e.g., Hinrichs and Szmrecsányi 2007; Tagliamonte and Jarmasz 2008).

Factors in the final model were selected via stepwise backward elimination in which insignificant factors were removed sequentially from the full model containing all of the previously described factors in §3. The criterion for removal of predictors was if and only if the absolute value of the coefficient was less than twice the standard error. For all models, binary predictors were centered by subtracting the mean and numerical predictors were centered and standardized by dividing by twice the standard deviation. Centering and standardizing predictors protects against harmful effects of data multicollinearity, and normalizing numerical predictors by two standard deviations allows us to directly compare their model coefficients with those of binary predictors (Gelman 2008).

*Table 1*. Logistic regression estimates: Ratios represent the relative chances of *s*-genitive over *of*-genitive

| **Factor** | **Odds Ratio** | **Estimate** | **Std. Error** | **Z value** | **Pr (>\|z\|)** | |
|---|---|---|---|---|---|---|
| Intercept | 0.452 | -0.795 | 0.115 | -6.92 | 0.0000 | *** |
| Possessor animacy = inanimate | 0.021 | -3.879 | 0.221 | -17.56 | 0.0000 | *** |
| Possessor word count | 0.415 | -0.880 | 0.135 | -6.53 | 0.0000 | *** |
| Final sibilant | 0.308 | -1.178 | 0.318 | -3.71 | 0.0002 | ** |
| Semantic relation = prototypical | 0.333 | 1.100 | 0.323 | 3.41 | 0.0007 | ** |
| *s*-Eurhythmy distance | 0.578 | -0.549 | 0.341 | -1.61 | 0.1082 | |
| *of*-Eurhythmy distance | 1.177 | 0.163 | 0.240 | 0.68 | 0.4959 | |
| Possessor givenness = not given | 1.795 | 0.585 | 0.257 | 2.27 | 0.0230 | . |
| Speaker birthdate | 1.393 | 0.004 | 0.002 | 1.96 | 0.0500 | . |
| *Interactions* | | | | | | |
| *s*-ED * animacy = inanim | 3.506 | 1.255 | 0.686 | 1.83 | 0.0675 | |
| *of*-ED * animacy = inanim | 8.565 | 2.148 | 0.481 | 4.47 | 0.0000 | *** |

| | | | |
|---|---|---|---|
| *N* | 1111 | adjusted Nagelkerke $R^2$ | 0.675 |
| model $\chi^2$ | 366.83 (df = 10)*** | % correct (%baseline) | 95.16 (69.6) |
| adjusted *Dxy* | 0.845 | $\kappa$ | 1.709 |

. significant at $p < 0.05$, * significant at $p < 0.01$,
** significant at $p < 0.001$, *** significant at $p < 0.0001$

Our model accurately predicts 95.16% of the data and accounts for more than two-thirds of the variance in the dependent variable (adjusted $R^2$ = 0.675). The model exhibits low multicollinearity ($\kappa$ = 1.709), indicating that there is no harmful overlap amongst multiple predictors with respect to the variance that each explains. In general, $\kappa$ values below 6 suggest little to no multicollinearity (Baayen 2008: 182).

The models were verified using a step-up method where each predictor, beginning with those previously identified as significant in the literature, was added one at a time until no further improvement of the models occurred. We then tested the model for over-fitting using bootstrap resampling (*N* runs = 1000) in which the model was fit to random resamples of the dataset. Table 1 provides the results of the model.

Table 1 above reports only the size and direction of the predictor effects in the model. Figure 1 shows the explanatory power that each predictor has in the model, measured by the difference in -2 log likelihoods between two nested models. To calculate each predictor's explanatory power, we removed each predictor from the full model. The decrease in the model's goodness-of-fit (increase in -2 log likelihoods) was recorded with each predictor removed in turn.

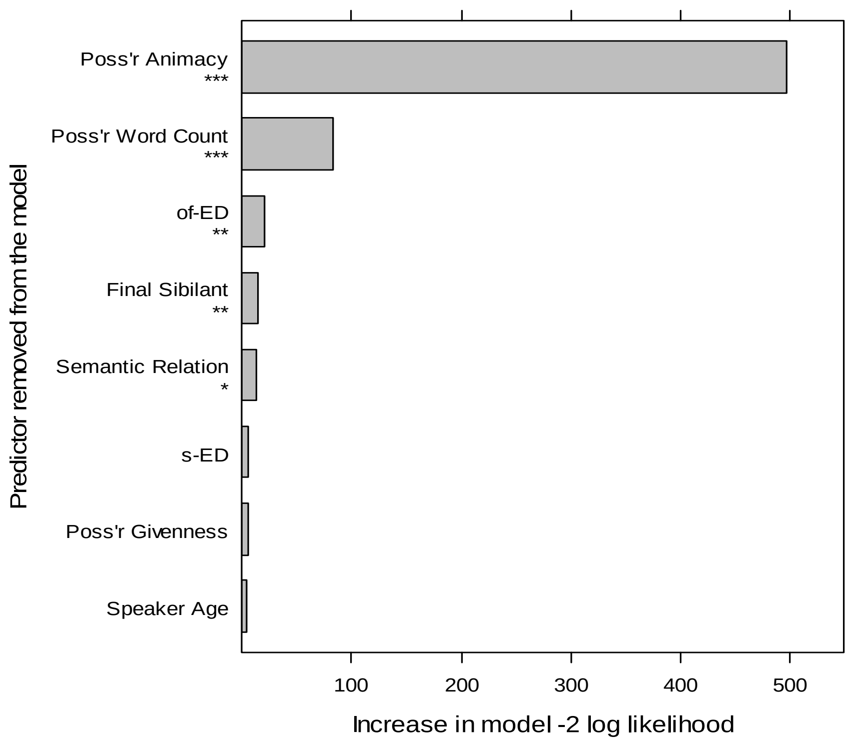


*Figure 1*. Increase in -2 log likelihood (decrease in model goodness-of-fit) if factor removed

As is evident from Figure 1, animacy holds the most explanatory power for our data. The explanatory power of the next most important predictor—possessor weight—follows far behind the power of animacy in predicting genitive construction choice. Eurhythmy distance in the *of*-genitive form, final sibilants in the possessor, and semantic relation each independently make significant, though minor, contributions to the model, while possessor givenness, *s*-ED, and speaker age make no contribution to the model fit.

This finding parallels the results of other recent work on genitive construction choice (Hinrichs and Szmrecsányi 2007; Szmrecsányi and Hinrichs 2008; Taglaimonte and Jarmasz 2008) that found possessor animacy, possessor length, and final sibilants on the possessor NPs to be reliable predictors in their models . We find that semantic relation, the age of the speaker (by birthdate), and the givenness of the possessor also reliably predict genitive choice in our data. Figure 2 shows the partial effects plots of all our predictors, with the exception of rhythm, which is discussed separately below. In each graph, a greater log odds value (*y*-axis) indicates an increased probability of an *s*-genitive for the given value of that predictor (*x*-axis) when all other predictors in the model are held constant.

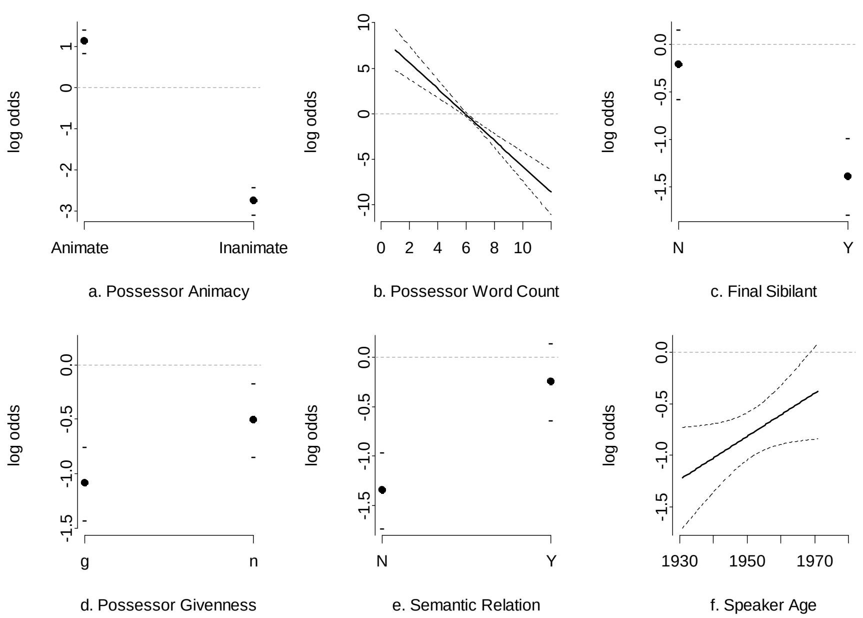


*Figure 2*. Partial effects of model predictors

All else being equal, we find that inanimate possessors are 2% as likely as animate possessors to occur in the *s*-genitive (Figure 2a). Also in our data, we find a roughly 40-percent decrease (odds ratio = 0.414) in the likelihood of an *s*-genitive as the possessor word count increases from one word to six or more (two standard deviations of word length). This effect of possessor length is reflected in Figure 2b. Figure 2c demonstrates that the OCP avoidance of adjacent sibilants in the possessor significantly affects syntactic word order. When a possessor ends with a sibilant, the *s*-genitive alternative is only about 30-percent (odds ratio = 0.304) as likely as the *of*-genitive. In accord with our analysis of the relative frequencies of given possessors across the two constructions, we find that there is a weak but significant tendency for discourse-given possessors to favor the *of*-genitive construction (Figure 2d). Semantic relation (Figure 2e) also plays a role: prototypical genitives are over three times as likely to occur in the *s*-genitive. Finally, speaker age (Figure 2f) behaves as hypothesized: younger subjects tend to use the *s*-genitive form more than older subjects, as is evident the increase in log odds as the birth date becomes more recent.

Finally, we come to the effects of eurhythmy distance. Figure 3 provides the partial effects plots of the interaction of eurhythmy distance with possessor animacy, with all other predictors in the model held constant. *Of*-ED exhibits a significant interaction with animacy, indicating that the animacy of the possessor has a significant effect on the influence of rhythmicity in determining genitive choice. The interaction of *s*-ED and animacy is not significant, but it did not meet our criterion for removal from the model. Both are discussed in turn.

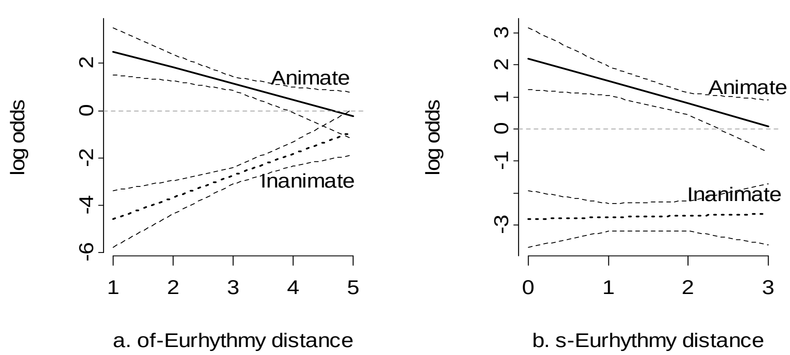


*Figure 3*. Log odds of ED measures by Possessor Animacy

For *of*-ED, we predicted a positive slope based on the hypothesis that as *of*-ED increases—that is, the further away from eurhythmy the *of*-genitive gets—the more likely an *s*-genitive should occur to avoid rhythmic violations. The cumulative effect of *of*-ED and its interaction with animacy has a positive slope in genitives with inanimate possessors (0.165 + 2.148 = 2.313), as seen in Figure 3a. However, we find that in genitives with animate possessors, *of*-ED does not have a reliable predictive value. This is reflected graphically in Figure 3a, in which the confidence interval of the predicted odds in *of*-ED with animate possessors crosses 0, thus indicating an even chance for the choice of either construction. *Of*-ED, therefore, is a reliable predictor of genitive construction choice only when the possessor is inanimate.

While the interaction between *s*-ED and animacy is not significant, the pattern trends in the expected direction. Amongst animate possessors, as the distance from perfectly alternating rhythm grows in the *s*-genitive construction, there is a trend away from the *s*-genitive; however, we find that the confidence interval crosses 0, indicating that the model does not reliably predict an outcome for this factor. As with *of*-ED and animate possessors, there is a slightly positive slope of *s*-ED amongst inanimate possessors, but this upward trend is towards the *s*-genitive is not significant, which is graphically evident from the wide and over-lapping confidence intervals.

Animacy is clearly such a strong predictor of the genitive alternation that it dampens the effect of rhythmicity on construction choice. We should note that, given more data, we might and expect to see the emergence of a stronger effect of *s*-ED as well as animacy-independent effects of rhythm. The interaction between animacy and the eurhythmy distance measures will be further discussed in the next section.

## 5. Discussion

In §4, we presented our model of genitive construction choice in English using *s*- and *of*-eurhythmy distance to quantify rhythm (henceforth Model I). In this section, we discuss the efficacy of our eurhythmy distance measure in comparison to more standard and separate rhythmicity measures of clash and lapse (§5.1). Then we consider the differences between *s*-ED and *of*-ED (§5.2). In §5.3, we present a study of a *comparative eurhythmy distance* measure that combines both *s*-ED and *of*-ED into a single predictor and argue for the necessity of both eurhythmy distance measures.

## 5.1 Eurhythmy Distance vs. Clash and Lapse

One departure of our eurhythmy distance measure presented here from previous treatments of rhythmicity (e.g., Anttila et al. 2010) is the collapsing of the clash versus lapse distinction in the ED count. ED does not differentiate between clash and lapse: both are considered one step away from perfectly alternating rhythm (*s*/*of*-ED = 1). In the previous literature, however, it is a common hypothesis that stress clash is more grave a violation of the Principle of Rhythmic Alternation than stress lapse. Nespor and Vogel (1989) state: "while there is a strong tendency to eliminate lapses, they are not felt to be quite as disturbing as clashes" (87). This suggests that the loss of distinguishing clash and lapse should be a costly one.

We can examine the actual effect of clash and lapse by substituting these measures for ED in an otherwise identical model of genitive construction choice (henceforth Model II). Model II includes clash in the *s*-genitive form (no unstressed syllables intervening between stressed syllables at the possessor-possessum border); *s*-genitive lapse (the distance away from perfectly alternating rhythm if there are two or more unstressed syllables between stress peaks at the possessor-possessum border); and *of*-genitive lapse (the distance away from perfectly alternating rhythm if there are two or more unstressed syllables between stress peaks at the possessum-possessor border). Clash in the *of*-genitive is unnecessary because *of* is treated as unstressed and as such, *of*-genitives will never have stress clash. The model also includes the interactions of these rhythmic predictors with animacy, as in Model I.

Holding non-rhythmic predictors constant, we find that neither *s*-genitive lapse ($\beta$ = -0.102, $z$ = 0.39, $p$ = 0.699), *of*-genitive lapse ($\beta$ = -0.310, $z$ = 1.19, $p$ = 0.24), nor *s*-genitive clash ($\beta$ = 0.218, $z$ = 1.19, $p$ = 0.35) are good predictors of genitive construction choice on their own. The interactions between animacy and lapse for both *s*- and *of*-genitives were significant (for *s*-genitive lapse: $\beta$ = 1.56, $z$ = 3.01, $p$ = 0.003; for *of*-genitive lapse: $\beta$ = 1.542, $z$ = 3.10, $p$ = 0.002), but the interaction between animacy and *s*-genitive clash is not significant and falls within our criterion for removal from the model ($\beta$ = 0.249, *SE* = 0.466, $z$ = 0.53, $p$ = 0.593).

This result runs counter to the hypothesis that stress clashes are more disfavored than lapses and that, in the event of stress clash, the alternative construction will be chosen. A possible explanation for the unreliability of stress clash as a predictor is that speakers have other repairs available to avoid clash: the Rhythm Rule, for example, in environments where stress shift or retraction may occur. Since our rhythm counts only include dictionary-based lexical stress, there is no way to know for sure without consulting the actual Switchboard sound recordings, which is left for future study. What speakers may be doing in the presence of clash is repairing the clash via stress shift, retraction, or promotion. Lapse, unlike clash, is more difficult to correct since stress insertion on unstressed syllables is an impossible repair. Hence, we see from Model II a clear influence of stress lapse, where longer lapses in stress will result in speakers choosing the alternative construction.

The unreliability of stress clash might also provide an explanation for the low performance of the *s*-ED measure in Model I. The *s*-ED measure incorporates clash as well as lapse. In Model II, we see that clash holds no explanatory power for genitive construction choice; thus, the incorporation of clash in the *s*-ED measure might weaken its effect. The combined ED measure with both clash and lapse, on the other hand, allows us to capture the influence of rhythmicity with fewer degrees of freedom than clash and lapse, thereby preventing over-fitting of the model from too many predictors and potentially high multicollinearity amongst factors.

### 5.2 *s*-ED vs. *of*-ED: prosodic phrasing

The approach to quantifying simple alternating stressed and unstressed syllables utilized in this paper departs from much of the previous literature on rhythm and syntax interaction, which focuses on phrasal and prosodic stress and phonology. Given that the *s*- and *of*-genitives have different prosodic and syntactic structures, we might expect to see these differences reflected in rhythmicity's influence on genitive construction choice—particularly in how strictly the Principle of Rhythmic Alternation applies within different prosodic domains (see esp. Nespor and Vogel 1986; Selkirk 1984; a.o.). Within a single prosodic phrase, language users have been noted to desire greater eurhythmy than across prosodic phrase boundaries. For example, certain stress shifting repairs such as the Rhythm Rule in English operate only within noun phrases and not without. To illustrate, consider the sequence of *thirteen* and *men* in (9).

(9) a. In the room, there were *thirteen men*.
b. When he was *thirteen*, *men* seemed much smarter to him.

In (9a), *thirteen men* is one prosodic phrase; therefore, the Rhythm Rule applies to avoid the stress clash of *thirTEEN* and *MEN*, and the main stress of *thirteen* shifts to the first syllable, forming perfectly alternating stress: *THIRteen MEN*. In (9b), the sequence *thirteen men* does not form a single prosodic phrase, and the stress clash is not repaired via the Rhythm Rule.

The genitive constructions exhibit a difference in prosodic domains (10). The *s*-genitive construction forms a single NP and prosodic phrase.

(10) a. [the car's wheel]$_{\text{P-Phrase}}$ b. [the wheel]$_{\text{P-Phrase}}$ [of the car]$_{\text{P-Phrase}}$

On the other hand, two prosodic phrases form the *of*-genitive (10b). The prosodic phrasing in (10) is independently corroborated by the presence of speaker disfluencies in the Switchboard genitive dataset. We hand-coded for disfluencies, as in (11), intervening between the possessor and possessum of genitive constructions in our spoken data.

(11) a. the norms of, *um*, public behavior
b. the school district's, *you know*, goals

Our data indicates that speakers insert significantly more disfluencies in *of*-genitive constructions (n=79) than in *s*-genitive constructions (n=24)($\chi^2$ = 12.316, $p < 0.001$). The greater number of disfluencies in the *of*-genitive can be taken as evidence for the looser prosodic and phrasal constituency in the *of*-genitive constructions. Conversely, speakers insert fewer disfluencies in *s*-genitives because they have tighter prosodic constituencies.

Because of the difference in prosodic phrasing between the *s*- and *of*-genitives, a phrase-oriented approach would predict that the Principle of Rhythmic Alternation applies more strictly within *s*-genitives, which are singular prosodic units, and for eurhythmy distance in *s*-genitives (*s*-ED) to be the most—and perhaps only—important factor when speakers consider alternative constructions. Our model, however, demonstrates the opposite result: while *s*-ED is not a reliable predictor of construction choice—it only trends in the correct direction—*of*-ED is a reliable predictor, suggesting that, despite a difference in the prosodic phrasing of the genitives, the difference is not reflected in the effect of rhythmicity on construction choice. Irrespective of higher level stress domains, our results show that even the low-level and simple binary alternation of stressed and unstressed syllables influences speaker choice of syntactic ordering.

### 5.3 Eurhythmy Distance vs. Comparative Eurhythmy Distance

In addition to the measure of eurhythmy distance, we also developed a measure of *comparative eurhythmy distance* (CED), which incorporates a comparison between *s*-ED and *of*-ED. Because our hypothesis is that speakers choose the alternative construction when the ED of either the *s*- or *of*-genitive is not equal to 0, we wanted to compare how rhythmically optimal one genitive construction is over the other, mimicking, in a sense, the same (unconscious) decision process that a speaker might undergo when making a construction choice.

To calculate CED, we use the formula CED = *of*-ED – *s*-ED. The resulting measure provides a scale wherein the more positive the CED, the more eurhythmic the *s*-genitive alternative is, and the more negative the CED, the more eurhythmic the *of*-genitive is. The comparative eurhythmic distance measure is an attractive one because, unlike the simpler measure of eurhythmy distance, CED reflects a weighing of the two potential genitive constructions against each other to predict which one the speaker is more likely to choose. This type of approach is not dissimilar to the scale that Kendall et al. (2011) and Bresnan and Ford (2010: 174) develop for comparing the syntactic complexity of themes and recipients in studies of dative construction choice (see also Grafmiller and Shih 2011).

We investigated a model using comparative eurhythmy distance as a measure of rhythmic influence on genitive construction choice in lieu of eurhythmy distance (henceforth, Model III). All other predictors in the model remained the same as in §4. The results of Model III are similar to those in the model presented in §4. Like ED, CED exhibits a significant interaction with animacy ($\beta = 1.109$, $z = 2.84$, $p = 0.005$). The cumulative effect of CED and its interaction with animacy produces a positive estimate slope in genitives with inanimate possessors (0.102 + 1.109 = 1.211), indicating that amongst inanimate possessors, speakers are more likely to choose *s*-genitive forms as CED increases and *of*-genitive forms as CED decreases. Amongst animate possessors, however, the influence of CED on genitive construction choice is unreliable. This result differs from the animacy findings in a model with separate *s*- and *of*-ED measures.

In essence, the eurhythmy distance and comparative eurhythmy distance measures are similar, both based on counting the number of rhythmic violations a genitive construction incurs—that is, how far from perfect rhythmic alternation a given genitive is. Diverging from the simpler eurhythmy distance measure, comparative eurhythmy distance is a relative quantification intended to characterize the choosing of a more rhythmically optimal genitive by speakers. CED collapses the two ED measures, but in doing so, it obscures the disparity in how animacy interacts with *s*- and *of*-ED.

The distinction between *s*- and *of*-ED's predictive value amongst animate and inanimate possessors, respectively, is important because it demonstrates that, in spoken English genitive construction choice at least, low-level rhythmic effects are subservient to stronger semantic predictors like animacy. One might imagine that speakers are predisposed to either the *s*- or *of*-genitive form based on the animacy of the possessor: animate possessors strongly prefer the *s*-genitive construction while inanimate possessors prefer the *of* construction. Rhythmic costs are weighed in terms of these animacy preferences: within genitives with animate possessors, the *s*-genitive is evaluated for optimal rhythm because animate possessors favor the *s*-genitive, and within genitives with inanimate possessors, the *of*-genitive is evaluated for optimal rhythm because inanimate possessors favor the *of*-genitive form. The alternative form surfaces if either the *s*- or *of*-genitives in animate or inanimate constructions, respectively, have stress patterns that are too deviant from perfectly alternating rhythm. Animacy's interactions with eurhythmy distance suggest that the consideration of high-level (semantic) predictors like animacy constrains the consideration of lower-level factors like the Principle of Rhythmic Alternation.

The measure of comparative eurhythmy distance offers us an elegant calculation to quantify a speaker's choice between the rhythm of the *s*-genitive construction and the parallel *of*-genitive construction. The sheer amount of information that comparative eurhythmy compresses into a single count is valuable for logistic regression-based studies, as too many predictors potentially cause harmful over-fitting of the data. In its current state, however, CED fails to encode significant detail and inequalities between *s*- and *of*-genitives and their interaction with animacy in possessors. The measure of ED, in comparison to CED, is simpler and provides more granularity for witnessing the effects animacy and rhythmicity interaction in the two different genitive constructions. Our model presented in §4 suggests that there is independence between the two *s*- and *of*-genitive measures in their interactions with animate and inanimate possessors; thus, two independent measures should be utilized.

## 6. Conclusion

We began this study with two major questions about the role of rhythm in genitive construction choice in spoken English: (1) How good is rhythm as a predictor of genitive construction choice?, and (2) How important are rhythmic influences when combined with other phonological and non-phonological predictors? To answer these questions, we developed a method of quantifying rhythm: eurhythmy distance. Our regression analysis shows that ED plays a significant role in genitive construction choice, but the role that it plays is small in relation to other factors and is conditioned and constrained by the effect of animacy. As Hinrichs and Szmrecsányi (2007) find in their study of written genitive data, animacy, weight, and the presence of a final sibilant in the possessor are the most important predictors of spoken English genitive choice. In addition to these and the possessor's givenness and sociolinguistic factors, rhythm has a much smaller—though crucial—part in the choice between *s*- and *of*-genitive constructions.

The exploration of rhythm in spoken construction choice and the development of the measure of eurhythmy distance in this paper are amongst the first of their kind; therefore, there is great necessity for further work and refinement (see Ehret (2011) and Grafmiller (forthcoming), which build on this approach for written language). In this study, we only consider a local measure of rhythm, looking with limited scope at the boundary between possessors and possessums. This narrow and short-sighted vision of rhythm may be largely inaccurate. Rhythm, from Abercrombie (1967), is the expectation of regularity in evenly spaced stresses, so a more accurate measure of rhythm might be a more global one with wider scope, testing whether the rhythmic regularity expected by the language user is maintained throughout the genitive construction by using one genitive over its alternative form.

We have also utilized idealized, dictionary-based stress annotations for the purposes of this study, which were hypothesized to reflect speakers' stored lexical representations. The actual phonetic pronunciation, however, may or may not follow dictionary approximations. In the actual spoken stream, we might find greater or lesser effects of rhythmicity, especially taking into account repairs of stress violations such as the Rhythm Rule and rapid speech elision of unstressed syllables (Kaisse 1985). The spoken Switchboard data used in this study provides an opportunity for future phonetic verification and investigation of our current results.

There are many further avenues of research that are necessary to better understand rhythm's role in genitive construction choice. For instance, the role of rhythm in spoken and written construction choice may differ due to the natures of spontaneous speech and calculated writing. In writing, speakers have potentially more time to consider the alternatives between *s*- and *of*-genitives resulting in a greater effect of rhythm on construction choice; at the same time, writers may not be as concerned with phonological properties in written work, and rhythm's effect may diminish in comparison to spoken use (Grafmiller forthcoming). Whether the role of rhythm in genitive construction choice has changed throughout the development of English also may provide further understanding of what influences speakers to make the choice of one genitive construction over another (Ehret 2011).

The results of this study clearly demonstrate that rhythm—and more specifically, the Principle of Rhythmic Alternation—should be considered a potential influencer of construction choice in English. Its role is small, especially when compared to some semantic, pragmatic, processing, and other phonological factors, and rhythm, as a dependent on other predictors, does not have complete explanatory power of construction choices. But, though its role may be small, rhythmicity still participates in the decision between genitive construction alternatives. That phonological considerations are active in construction choice has significant import for the issue of grammatical architecture. This finding suggests that phonology may have more interaction with higher-level syntactic and semantic factors than a strictly serial model of grammar allows (e.g., Zec and Inkelas 1990; cf. Zwicky and Pullum 1986; Vogel and Kenesei 1990; a.o.).

**Notes**

1. We thank Arto Anttila, Beth Levin, Paul Kiparsky, Marie-Catherine de Marneffe, Florian Jaeger, Gabe Recchia, Jen Hay, Sali Tagliamonte, the Stanford Spoken Syntax Lab, and an anonymous reviewer for their valuable discussion and comments. Acknowledgements to the Stanford Phonetics and Phonology Workshop; Empirical Syntax Research Seminar; DGfS: *Rhythm Beyond the Word* Workshop; and Berkeley Phonology Phorum participants for their helpful feedback. Special thanks lastly to Ralf Vogel and Ruben van de Vijver for their organization of the DGfS workshop and this volume. This material is based in part upon work supported by the National Science Foundation under Grant Number IIS-0624345 to Stanford University for the research project "The Dynamics of Probabilistic Grammar" (PI Joan Bresnan). Any opinions, 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.
2. Automated coding was done using Python scripts and the phonological segment annotations in CMU.
3. Graphics and statistics were prepared using the R statistical computing platform (R Development Core Team 2010) and the Design library (Harrell 2009).

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