Phonological influences in syntactic alternations

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1 INTRODUCTION

A foundational observation in modern phonological study is that multiple heterogeneous repairs conspire to satisfy conditions set forth by phonological constraints (Kisseberth 1970; Prince & Smolensky 1993, 2004; a.o.). These repairs typically take the form of phonological processes (e.g., phone deletion, fusion, assimilation, dissimilation) that optimize the output of phonological conditions, but extra-phonological repairs exist as well. Amongst the most commonly noted are morphological processes that respond to phonological conditioning: suppletive allomorphy, periphrasis, variable affixation or affix re-ordering, and blocking (Poser 1992; McCarthy & Prince 1993a, 1993b; Raffelsiefen 2004; McCarthy & Wolf 2005; Paster 2006; a.o.).

This paper argues that phonological conditions can be satisfied not only by word-internal morphological and phonological repairs but also by repairs in the inter-word, syntactic domain. The claim that phonology can affect syntax is not itself new. For example, a sizeable literature maintains that Heavy Noun Phrase Shift, in which heavier constituents are licensed in specific syntactic positions, is phonologically conditioned (Zec & Inkelas 1990) and even potentially phonologically optimizing (Zubizarreta 1998; Anttila et al. 2010; though see e.g., Wasow 2002; Grafmiller & Shih 2011 for a discussion of alternative analyses that are not prosodically-driven). Looking beyond Heavy NP Shift, I present here evidence from a greater range of phonologically-conditioned syntactic phenomena. Surveying known cases in the literature, I argue that these instances of phonologically-conditioned syntactic behavior are analogous to the more familiar and common phenomena of phonologically-conditioned morphology. In addition to this survey, two case studies from corpus analyses of spoken American English are presented to further demonstrate that syntactic repairs—specifically, alternations of word order or construction—can be used in satisfying phonological constraints.

The empirical results of the survey and case studies also show that locality and domain affect the ability for phonological conditions to be satisfied by morphosyntactic repairs. Specifically, results suggests that (1) there are fewer effects of phonology across word and syntactic boundaries than within words, and (2) higher-level phonological conditions are more likely to exact influence on larger morphosyntactic behaviors (e.g., word-level or phrasal stress affecting reordering of words and phrasal constituents) than lower-level phonological conditions (e.g., secondary, syllable-level stress does not affect reordering of words and phrasal constituents). This 'decay' in phonology-morphosyntax interaction as the morphosyntactic constituents and boundaries increase suggests that phonologically-conditioned syntactic behavior is simply a more extreme relative of phonologically-conditioned morphology.

That morphosyntactic choices can defer to phonological considerations raises implications for both formal and psycholinguistic models of the morphosyntax-phonology interface that are based on the assumption that there is a strict division between syntactic and phonological encoding (e.g., Zwicky & Pullum 1986; Levelt 1989; et seq.). Many of the illustrative phenomena presented in this paper draw on variable patterns in morphosyntax, with data from naturally-

occurring written and spoken language use. Traditional approaches to the morphosyntax-phonology interface have often maintained a distinction between categorical and gradient patterns, relegating the latter to being external to the 'core grammar' (Pullum & Zwicky 1988; Miller et al. 1997). The approach that I take to grammar here, however, is one in which gradient and categorical patterns should arise from the same grammatical principles (i.e., 'comparative grammaticality'), following the growing practice in phonology (e.g., Anttila 1997, 2002; Zuraw 2000; Goldwater & Johnson 2003; Coetzee 2014), morphology (e.g., Hay & Baayen 2005), syntax (e.g., Manning 2003; Bresnan et al. 2007; Sag & Wasow 2011), sociolinguistics (e.g., Labov 1972), and usage-based approaches to language (e.g., Bybee 2001). Regardless of the underlying grammatical assumptions about gradience and variability, the results presented herein demonstrate that, either in the grammar or in a model of language use (whether they are the same or separate), phonological information has the ability to condition extra-phonological, morphosyntactic behavior. The goal here is simply to amass the increasing amount of evidence for phonological interference in morphosyntax; the spelling-out of a full grammatical implementation of these effects is left for future work.

The paper is organized as follows: §2 presents an overview of phenomena that demonstrate syntactic responses to phonological conditions and compares these phenomena to morphological ones, showing typological similarities. Sections 3 and 4 present two case studies—of genitive and dative construction choices in English, respectively—that examine the role of phonological conditioning in two morphosyntactic alternations. Section 5 concludes with a brief discussion of the ramifications of these empirical findings for models of phonology-syntax interaction.

2 PHONOLOGICALLY-CONDITIONED MORPHOSYNTACTIC PHENOMENA

This section presents an overview of phonologically-conditioned syntactic phenomena that have been previously identified in the literature. These phenomena exhibit—at least, on the surface—empirical similarities to familiar cases of phonologically-conditioned morphology, both in terms of the phonological constraints and the morphosyntactic repairs that are triggered. Phonological conditions that can affect both morphological and syntactic domains include prosodic, metrical, suprasegmental, and segmental constraints that mandate certain syntagmatic phonological configurations. Repairs to these conditions across both morphology and syntax include flavors of blocking (ineffability), periphrasis (and paraphrasing), (re-)ordering of constituents, suppletion (replacement), and deletion (haplology/omission). With these empirical similarities, the crucial difference between phonologically-conditioned morphology and phonologically-conditioned syntax seems to lie instead in the strength of the interactions across morpheme and word boundaries: syntactic phenomena exhibit weaker and often more gradient effects, suggesting that there is a decay in the strength of phonological constraints as boundary size grows. I will return to a discussion of the role of domain in §5.

2.1 PHONOLOGICALLY-CONDITIONED MORPHOLOGY

While the nature of phonologically-conditioned morphology is not itself uncontroversial, the phenomena in which phonology influences morphological processes are of familiar stock (in this

volume: see e.g., Adams; Deal & Wolf; Paster; Yu). Here, I focus on providing a few illustrative cases of phonologically-conditioned morphology, particularly ones that are analogically similar to the phonologically-conditioned syntactic phenomena reviewed in the following section. For more comprehensive surveys of phonologically-conditioned morphology, see e.g., Carstairs-McCarthy 1998; Wolf 2008; Paster 2009b; Embick 2010; Nevins 2011; Inkelas 2014.

Phonological conditions can act upon morphological processes and create blocking-induced gaps—or, *ineffability*. In English, for example, the ineffability of certain suffix-root combinations has been attributed to the avoidance of stress clash (Raffelsiefen 1996, 2004; Plag 1999; Smith 2013; a.o.). As shown in (1a), the suffix *–ize* can attach to words with penultimate stress; however, the presence of final stress (e.g., 1b) blocks *–ize* suffixation to avoid adjacent stress clash.

(1) a. schéma → schématìze
b. secúre → *secúrìze

Such blocking-induced gaps can be left empty (e.g., null parse as the output: Prince & Smolensky 2004:57ff), or in other cases, the gaps can be filled via (morphological) repairs: suppeltion, deletion, periphrasis, reordering.[1] It is unknown at this point which phonologically-conditioned gaps find systematic repairs (as opposed to triggering ineffability): Carstairs-McCarthy notes observationally that gaps in inflectional paradigms are more often systematically repaired than those in derivational morphology (1998:147).

2.1.1 Suppletion

In the case of phonologically-conditioned suppletive allomorphy, two or more distinct, phonologically-unrelated surface forms expone the same semantic material, as dictated by phonological constraints (for surveys, see e.g., Paster 2006; Nevins 2011). Such phonological constraints can be prosodic, as in the Dutch plural allomorphy below (example from Paster 2006:114; citing Booij 1997):

(2)

	Singular	Plural	Gloss
a.	dám	dámm-**en**	‘dam, dams’
	kanón	kanónn-**en**	‘gun, guns’
	kanáal	kanáal-**en**	‘channel, channels’
	lèdikánt	lèdikánt-**en**	‘bed, beds’
	ólifànt	ólifànt-**en**	‘elephant, elephants’
b.	kánon	kánon-**s**	‘canon, canons’
	bézəm	bézəm-**s**	‘sweep, sweeps’
	tóga	tóga-**s**	‘gown, gowns’
	proféssor	proféssor-**s**	‘professor, professors’

As shown, the *–en* allomorph attaches to words with final stress (2a) while the *–s* allomorph attaches to words with penultimate stress (2b). This pattern avoids the lapse violation that would

[1] Phonological repairs are also possible, but those are not the focus of the current discussion.

be incurred if the stressless *–en* suffix attached to words with penultimate stress (e.g., **kánonen*).

Phonological conditions triggering suppletion can also be segmental, as in the allomorphy of Hungarian second person singular forms (data from Paster 2006:41–42; citing Abondolo 1988; Rounds 2001). Where the second person singular form is *–sz* ([s]) following most segments (3a), an *–ol* allomorph appears in sibilant-final contexts (3b), thus avoiding sibilant co-occurrence restrictions (i.e., Obligatory Contour Principle; OCP: Leben 1973; et seq.).[2]

(3)	a.	vág-sz	'you cut'
		vár-sz	'you wait'
		nyom-sz	'you press'
		rak-sz	'you place'
	b.	vouz-ol	'you attract'
		edz-el	'you train'
		hajhász-ol	'you seek'
		föz-öl	'you cook'

2.1.2 Deletion

Phonological conditions can result in the deletion of phonological segments that make up the entirety of a short affix (e.g., Menn & MacWhinney 1984). In English, for example, a sibilant co-occurrence restriction (of the same type as the one at work in Hungarian in example (3) can cause the deletion of one of the sibilants, particularly when the plural and possessive suffixes are both attached: *student* + *–s* [plural] + *–s* [possessive] → *students'* [stʲudn̩ts], *stʲudn̩ts-əz.

2.1.3 Periphrasis

Periphrasis, broadly interpreted, is the use of one construction—usually analytic—to expone the same semantic material as another construction—usually synthetic. For example, the English comparative suffix *–er* alternates with a periphrastic competitor (*more* + adjective), yielding competition between synthetic and analytic forms: e.g., *yellow-er* versus *more yellow*. This competition (be it within the lexicon or between morphology and syntax) has been shown to be in part prosodically conditioned, with shorter words being more likely to allow *–er* suffixation. Longer words are less likely to tolerate suffixation, and an analytic alternative is preferred (Poser 1992; Adams, this volume; see also Adams 2014 and references therein).

(4)	a.	happier	*more likely than*	>	more happy
	b.	intelligenter	*less likely than*	<	more intelligent

[2] Note in Hungarian orthography: *sz* = [s], *z* = [z], *dz* = [dz].

2.1.4 Reordering

Whether phonological conditions can trigger affix order is one of the more contentious phenomena in the realm of phonologically-conditioned morphology. Affix reordering as a repair for illicit phonological configurations is markedly rarer than other repairs—for instance, suppletion Pas-Paster 2005, 2009a, b; a.o.). One example of potentially phonologically-conditioned affix order is the Warlmanpa reflexive. The reflexive suffix *–nyanu* follows most person/number markers (5a), but it precedes the second person suffix *–n* (5b), possibly in order to avoid an OCP violation of adjacent nasals (example from Wolf 2008:228–229; cf. Paster 2009a):

(5)	a.	-na-nyanu	-1P-REFL	
		-lu-nyanu	-PLURAL-REFL	
		-pala-nyanu	-DUAL-REFL	
	b.	-nyanu-n	-REFL-2P	*-n-nyanu

In addition to segmental conditioning, prosody and higher-level phonological factors has also been reported to affect affix order. For example, in Slavey (Rice 2011:183–184), affix ordering flouts semantic scope and is instead apparently conditioned by phonological weight: affixes with less phonological material (e.g., the possessive suffix in 6a, c) surface closer to the stem than affixes with more phonological material (e.g., the diminutive suffix in 6b, c).

(6)	a.	-'ah-ɛ́
		-snowshoes-POSS
		'snowshoes-possessed'
	b.	-'ah-zha
		-snowshoes-DIM
		'small snowshoes'
	c.	-'ah-ɛ́-zha
		-snowshoes-POSS-DIM
		'women's snowshoes'

Other cases of phonologically-conditioned affix order involve variable clitic placement (e.g., Zec & Filipović-Đurđević, this volume), mobile affixation (Kim 2010), and compound ordering (Mortensen 2006). For example, coordinate compounding in Jingpho has been noted to be conditioned by vowel height ordering preferences (Mortensen 2006:222–223):

(7)	a.	lùʔ	+	ʃá	
		drink		eat	
		'food'			
	b.	*ʃá	+	lùʔ	
		eat		drink	

As (7) illustrates, the two elements of the co-compound are ordered according to a vowel height preference where high vowels (e.g., [u]) occur before lower vowels (e.g., [a]).

2.2 PHONOLOGICALLY-CONDITIONED SYNTACTIC PHENOMENA

As with the phonological conditioning of morphology, there are cases in which phonology appears to interfere with larger constituents, beyond the word. Constraints on phonological material can lead to ineffability of certain syntactic configurations: for example, Golston (1995:353–354) shows that center-embedded noun phrases in Ancient Greek are blocked when the process would result in a sequence of surface-identical words. More cases, overviewed below, demonstrate empirical similarities between phonologically-conditioned syntax and morphology, with the same types of phonological conditions trigger similar types of repair processes. There are also, of course, empirical differences: certain types of repairs (e.g., reordering) appear to be more common in the syntactic domain, and the phonologically-conditioned syntactic patterns in general tend to be far more gradient and less robust than the morphological patterns that are found.

2.2.1 Reordering

Despite its rarity in phonologically-conditioned morphology, the reordering of syntactic constituents as a response to phonological constraints is one of the most widely discussed phenomena of phonologically-conditioned syntax.[3]

One of the classic, purported cases of phonological conditioning in syntax is Heavy Noun Phrase Shift, in which "heavier" constituents are licensed to occur phrase-finally. For example, in (8), the theme object, which typically occurs before the recipient, is preferentially licensed after the recipient *John* when it is a heavier phrase (e.g., *some letters from Paris*, as in 8c; example from Zec & Inkelas 1990).

(8) a. Mark showed [some letters]$_{\phi}$ to John.
b. ???Mark showed to John [some letters]$_{\phi}$.
c. ✓Mark showed to John [some letters]$_{\phi}$ [from Paris]$_{\phi}$.

Zec & Inkelas argue that the phenomena of Heavy NP Shift is prosodically-determined: constituents that contain more phonological phrases, as in (8c) (versus 8b), are considered heavy and thereby license shift. Other treatments of the Heavy NP Shift phenomenon have also appealed to phonological explanations. For example, Anttila (2008) and Anttila et al. (2010) propose that because lexical stresses are attracted to the prosodic phrase that receives sentential stress, rightward shift in English of heavy NPs—heaviness defined by Anttila et al. as NPs with more lexical stresses—occurs, as dictated by the rightmost Nuclear Stress Rule. See also Zubizarreta (1998) on phonologically-conditioned syntactic shift.[4]

Insofar as Heavy NP Shift is phonologically-determined, the phenomenon stands as an example of syntactic constituent reordering triggered by phonological conditions—in this case, prosodic conditions on prosodic phrase structure or on the alignment of lexical and phrasal

[3] Not summarized here are cases of prosodically-motivated movement (i.e., *PF-movement*) of prosodically-defined constituents to prosodically-defined positions, largely under focus- and discourse-oriented goals (Zubizarreta 1998; Agbayani & Golston 2010; Agbayani et al. 2011).

[4] Processing effects and syntactic complexity have also been shown to play a large role in determining phrasal "weight," and it is clear from recent quantitative work that Heavy NP Shift is not merely a prosodically-conditioned phenomenon (see e.g., Gibson 2000; Hawkins 1994; Grafmiller & Shih 2011; Shih 2014).

stress. Other phonological constraints have also been shown to trigger such syntactic reordering. In English binomial pairs, for example, numerous phonological conditions ranging from stress lapse avoidance (9) to syllable structure well-formedness (10) affect the choice of binomial orderings (e.g., McDonald et al. 1993; Wright et al. 2005; Benor & Levy 2006; Mollin 2012):

(9) a. compléte and únabridged (preferred)
b. ún**abridged and** cómplete (dispreferred – stress lapse)

(10) a. John and Yoko (preferred)
b. Yok**o a**nd John (dispreferred – vowel-vowel hiatus, with no onset)

Phonotactic constraints have been demonstrated to condition reordering as well. For example, the cross-linguistically well-known *NÇ constraint (e.g., Hayes & Stivers 1996; Pater 1999), which bans sequences of nasals followed by voiceless consonants, has been shown to condition word order choices in Tagalog: adjectives and nouns pairs, which can occur interchangeably in either adjective-noun or noun-adjective order, are partially determined by the avoidance of nasal followed by voiceless stop sequences (Shih & Zuraw 2014). All else being equal, noun-adjective order (e.g., 11a) is found to be more frequent than the alternative adjective-noun order (e.g., 11b) when the latter exhibits an illicit [ŋp] sequence across the adjective-noun boundary.

(11) a. péra-ŋ nakalaán (preferred; more frequent)
money-LINK dedicated
'dedicated money'

b. nakalaá-**ŋ** **p**éra (dispreferred; less frequent)
dedicated-LINK money
'dedicated money'

Long-distance phonotactic preferences can also participate in determining word order. As with Jingpho co-compounding order discussed in §2.1.4 (example 7), vowel height-based preferences play into word order in English, with high vowels ordered before lower vowels (Cooper & Ross 1975; a.o.):

(12) a. *spic and span* [ɪ] > [æ] ???span and spic
b. *teeny tiny* [i] > [aɪ] ???tiny teeny

2.2.2 Paraphrasing

In phonologically-conditioned morphology, one response to illicit phonological configurations is periphrasis, in which an analytic form can be used in substitution of a synthetic form (see discussion in §2.1.3). A more general form of periphrasis is paraphrasing, which is also a viable repair option, especially if the desire to express a given communicative intent is sufficiently strong. The line between periphrasis and paraphrasing is a thin one: the two concepts are separated perhaps only by the distinction that periphrasis involves regularized and systematic alternatives of forms

or rules (and perhaps synthetic alternatives). Paraphrasing, on the other hand, has no such restriction of systematicity. If we consider paraphrasing as a generalized type of periphrastic repair, then the parallels between phonologically-conditioned morphology and phonologically-conditioned syntax crystallize even further: in the syntactic domain, truly systematic periphrastic alternatives are not common, but we do regularly find paraphrases to be legitimate competitors.

Schlüter (2005) presents an example case of phonological conditioning that leads to a paraphrased repair in English. . Stress-final, prenominal *a*-initial adjectives are dispreferred because they lead to stress clash (13a):

(13) a. ?the a**sléep pér**son
b. the pérson who was asléep

Thus, rhythmic considerations result in the morphosyntactic preference for a syntactic paraphrase (13b) that avoids clash.[5]

2.2.3 Deletion

Deletion of whole words, as with morphemes (cf. §2.1.2) is another possible repair to problematic phonological structures. Based on evidence from a corpus study of American English, Wasow et al. (2012) argue that the probabilistic use of *to* in the *do be (to)* construction (14) is in part conditioned by rhythmic factors.

(14) a. All I want to do **ís __ repórt** my work.
b. All I want to do **ís to repórt** my work.

Under the assumption that the copula *be* must carry stress because it cannot be reduced in this specific context (e.g., *All I want to* ****do's***), *to* is elided (14a) to avoid stress lapse (14b).
Similarly, *that* complementizer optionality has also been argued to be rhythmically conditioned. For example, *that* is more likely deleted when it would avoid stress lapse: *Henry* ***knéw (that) Louíse*** *read books* (Jaeger 2006; Lee & Gibbons 2007).

2.2.4 Suppletion

One potential syntactic parallel to suppletion is the use of a phonologically unrelated synonym. As in morphology inside a word, it is possible for such suppletive choices across words to be conditioned phonologically. A narrow example of such phonologically-conditioned word choice is the case of forename-surname pairs, which have been shown in English to be constrained by phonological factors similar to those that trigger other types of syntactic repairs, as discussed above (Shih 2014). For example, a corpus study of English names demonstrates that name pairs avoid stress clashes: thus, a name with alternating stressed and unstressed syllables such as *Súsan Smíth* is more common than *Suzánne Smíth*, which incurs a stress clash. There are also pho-

[5] I set aside here the question of semantic equivalency in syntactic competition, though elsewhere, it has been argued that syntactic outputs with minimally different LF interpretations can compete (Legendre et al. 1998; et seq.).

notactic restrictions, including OCP-type effects: *Josh Smith* [ʃ-s] being less likely than *Jack Smith* [k-s] as a full name.

2.3 SUMMARY

To what extent are phonology-syntax effects of the same stock as phonology-morphology interactions? As evidenced above, similar types of repairs to blocked structures are involved—periphrasis, re-ordering, deletion, suppletion—and similar phonological constraints can condition both morphological and syntactic effects—e.g., metrical, phonotactic, prosodic conditions.

A crucial difference between phonologically-conditioned morphology and phonologically-conditioned syntax seems to lie in the strength of the interactions across morpheme and word boundaries. Phonologically-conditioned syntactic phenomena are observationally rarer than phonologically-conditioned morphological phenomena and the effects are weaker as well. The increased boundary size between syntactic constituents leads to less likelihood of phonological interactions across the boundaries to affect morphosyntactic processes. Phonologically-conditioned syntactic phenomena also exhibit weaker, more gradient, non-categorical effects than their morphological counterparts.[6] Similarly, the strength of phonological conditions has been shown in the previous literature to decay gradiently across morpheme boundaries within words (e.g., Martin 2005, 2011; McPherson & Hayes 2013). Extending this pattern provides the hypothesis that the strength of phonological conditions can further propagate and decay across word and syntactic phrase boundaries. Poser (1992:18–19) points out that periphrastic alternations appear to be limited to "small categories" in the syntax—that is, categories that dominate zero-level projections. The hypothesis here is thus that the potency of phonological conditioning will scale with the domain of morphosyntactic structures involved.

The following two case studies introduce additional evidence of phonological conditioning of syntactic alternations in English. Moreover, they will demonstrate another way in which decay caused by locality and domain size affects potentially phonologically-conditioned morphosyntactic behavior. With the survey cases presented above, we saw that domain boundary size can weaken phonological conditioning. In the following case studies, we will see that smaller phonological conditions can only affect processes that involve smaller syntactic constituents. Likewise, processes involving larger syntactic conditions appear to be most sensitive to well-formedness conditions on higher-level phonological and prosodic domains.

3 CASE STUDY 1: GENITIVE ALTERNATION IN ENGLISH

English has two syntactically distinct constructions for expressing a possessor-possessum relationship: the *s*-genitive (15a) and the *of*-genitive (15b).[7]

[6] In some cases, however, there is evidence of potential ungrammaticality in phonologically-conditioned syntax: for example, when a non-shifted heavy NP results in a nearly unacceptable structure that must be obligatorily repaired by use of an alternative syntactic structure: **[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]$_{NP}$'s [attitude]$_{NP}$* (example from spoken language corpus; see §3.1).

[7] Work presented in this section (including study design, data collection and coding, and quantitative analysis and interpretation) was done jointly with Jason Grafmiller, Richard Futrell, and Joan Bresnan. See e.g. Shih et al. 2015

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

The alternation between the two genitive constructions in English can be viewed as a near-systematic relationship between a clitic construction (i.e., the *–s* possessor clitic for the *s*-genitive construction) and an analytic construction (i.e., the prepositional phrase headed by *of* in the *of*-genitive construction). The goal here is to demonstrate that—just as with phonologically-conditioned morphology—this type of syntactic alternation, which exists at a word-external level, can be phonologically-conditioned, by both prosodic and phonotactic constraints.

3.1 DATA

Data for this study comes from a conversational corpus of American English, from the Penn Treebank portion of Switchboard (Marcus et al. 1993; Godfrey & McDaniel 1992). Because we are interested here in potential re-orderings conditioned by phonological constraints, only reversible and interchangeable genitives were used, as in previous work (Rosenbach 2002; Kreyer 2003; Hinrichs & Szmrecsányi 2007; Szmrecsányi & Hinrichs 2008; a.o.): e.g., *the doctor's patients* ≈ *the patients of the doctor*. Non-interchangeable genitives were excluded, following previously-identified criteria (Quirk et al. 1985; Biber et al. 1999; Rosenbach 2002, 2005; Kreyer 2003; a.o.). Using a combination of automatic and manual coding, genitives were chosen from the Switchboard corpus.[8] The dataset includes 1107 genitives, with 653 instances of the *of*-construction and 454 instances of the *s*-construction (59 versus 41%, respectively).

3.2 PREDICTORS

Two phonological conditioning factors were investigated in this study on genitive construction choice: phonological rhythm and the OCP avoidance of adjacent sibilants. Each conditioning factor and how it was operationalized is presented below (§§3.2.1–3.2.2), along with a summary of eight control predictors in §3.2.3.

3.2.1 Rhythm

Linguistic rhythm has two basic organizational properties: [1] regularity in rhythmic distribution, and [2] hierarchical structure (Liberman & Prince 1977; Hayes 1995; a.o.). Rhythmic regularity denotes the recurring and regular alternation between strong and weak beats, usually in a binary pattern, as in (16a). Irregular alternation results in lapses (16b) or clashes (16c).

for a previous version. Results and analysis presented herein have been updated since Shih et al. 2015 by the first author (see also Shih 2014).

[8] For specifics on how the genitives corpus was collected and annotated, please see Shih et al. 2015

(16) a. *Mìssisípi múd* ✓
s w s w s
b. *Míllington's regrét* × lapse
s w w w s
c. *thirtéen mén* × clash
s s

It is hypothesized, under "The Principle of Rhythmic Alternation," that languages are rhythmically organized, with a propensity for the regular recurrence of strong and weak elements and the avoidance of lapses and clashes (Sweet 1876:12; Liberman 1975; Selkirk 1984; a.o.).

The avoidance of lapses and clashes has been demonstrated to condition a range of repairs, from phonological (e.g., the Rhythm Rule: Liberman & Prince 1977; Hayes 1984; Kager & Visch 1988; Nespor & Vogel 1989; a.o.) to morphological, including the aforementioned suppletive allomorphy in Dutch (see example 2, §2.1.1). Rhythmic alternation has also been suggested, as discussed in §2.2.1, to influence syntactic ordering (e.g, Schlüter 2005; Temperley 2009)—for instance, in English binomial pair ordering (McDonald et al. 1993; Wright et al. 2005; Benor & Levy 2006). Here we investigate whether rhythmic factors can condition the choice of alternative syntactic constructions, between the *s*- and *of*-genitives.

The dataset was annotated with lexical stress information using automatic and manual annotation of primary and secondary lexical stress. Automatic annotation used information based on the Carnegie Mellon University (CMU) Pronouncing Dictionary (Weide 1993).[9] To measure rhythmic well-formedness, we use *Eurhythmy Distance* (ED), developed in Shih et al. 2015. Eurhythmy Distance measures how far from perfectly alternating binary rhythm an interstress interval is:

(17) Let $\{P, Q\}$,

$$ED_{s,of} = | N_{s,of} - 1 |,$$

where P = possessor; Q = possessum;
s = *s*-genitive construction: *P's Q*;
of = *of*-genitive construction: *Q of P*;
$ED_{s,of}$ = Eurhythmy Distance of *s* or *of*;
N_s = number of syllables between rightmost stress of P and leftmost stress of Q in *s*;
and N_{of} = number of syllables between rightmost stress of Q and leftmost stress of P in *of*.

ED considers the number of unstressed syllables at the boundary between the possessor and possessum NPs in the *s*- or *of*-genitive construction. In binary rhythmic alternation, the ideal number of unstressed syllables between adjacent stressed syllables is one, and ED here normalizes between clash (i.e., no unstressed syllables between adjacent stresses) and lapse (i.e., two or more unstressed syllables between adjacent stresses) by using the absolute value of number of unstressed syllables minus one (see Shih 2014; Shih et al. 2015 for further discussion). Thus, distance away from ED=0 indicates how arrhythmic a given construction is. Here, we calculate two

[9] Using dictionary-listed lexical stress provides a way to approximate speakers' stored lexical information about a word' s phonological properties independent of other phonetic and syntactic effects in the surface speech stream. A study of rhythmic patterning based on the phonetic stream of Switchboard conversations is left to future research.

ED measures: ED_s for the Eurhythmy Distance of the *s*-genitive alternative, and ED_{of} for the Eurhythmy Distance of the *of*-genitive alternative.

We also tested a combined form of ED measure, *Comparative Eurhythmy Distance* (CED). Comparative Eurhythmy Distance compares the ED measures of a pair of *s*- and *of*-genitive constructions, thus compressing two factors into a single measure. This compression is particularly convenient for small *n*, large *p* regression-based studies, in order to avoid overfitting of the data; however, it should be noted that collapsing the two ED measures will obscure some details, as will be discussed in following sections. The CED formula is provided in (18).

(18) $CED = | ED_{of} - ED_s |$

The measure results in a scale wherein more positive CED measures indicate that the *s*-genitive is more eurhythmic than the *of*-genitive, and more negative CED scores indicate that the *of*-genitive is the more eurhythmic alternative.

The hypothesis here is that rhythm will condition the choice of genitive construction: more eurhythmic genitives will be preferred over less eurhythmic alternatives.

3.2.2 OCP

English has a noted OCP avoidance effect that bans a sequence of adjacent sibilants, including [s, z, ʃ, ɸʃ, ʒ, ʤ] (Menn & MacWhinney 1984; Zwicky 1987; a.o.). The *–s* possessive clitic in the English genitive exhibits at least two possible repairs when it abuts a sibilant-final possessor (e.g., *the veterans* + *-s* + *descendants*): haplology (e.g., *the veterans' descendants*) or the use of the alternative *of*-construction (e.g., *the descendants of the veterans*). The latter repair is a potential instance of phonologically-triggered syntactic choice. In previous work, Hinrichs & Szmrecsányi (2007) report that the presence of a final sibilant on the possessor NP significantly reduces the likelihood of the *s*-genitive construction in both spoken and written data. Here, we coded for the presence of a final sibilant on the possessor NP automatically using phonological segment information from the CMU Pronouncing Dictionary and manually for lexical items that were not available in CMU.

3.2.3 Control predictors

Eight control predictors, including syntactic, semantic, psycholinguistic, and sociolinguistic factors, were drawn from previous state-of-the-art models of English genitive construction variation:

- Animacy of possessor;
- Semantic relation between possessor and possessum;
- Thematicity of possessor;
- Givenness of possessor;
- Persistence of construction;
- Weight of possessor versus possessum;
- Speaker age; and

- Speaker gender

Each of these predictors have been shown in previous research to be linked to predicting genitive construction choice. Due to space constraints in the current paper, please refer to Shih 2014 and Shih et al. 2015 for background and operationalization details for each of the control predictors.

3.3 MODELING AND ANALYSIS

The effects of phonological factors in conditioning genitive construction choice were investigated using logistic regression. To alleviate potentially harmful effects of multicollinearity and to aid data interpretation, binary predictors were centered by subtracting the mean, and numerical predictors were centered and standardized by dividing by twice the standard deviation, following Gelman 2008; a.o.

The model testing the Eurhythmy Distance measures and the effect of adjacent sibilant avoidance is provided in (19).

(19) Regression estimates: Ratios represent the relative chances of *s*- over *of*-genitive

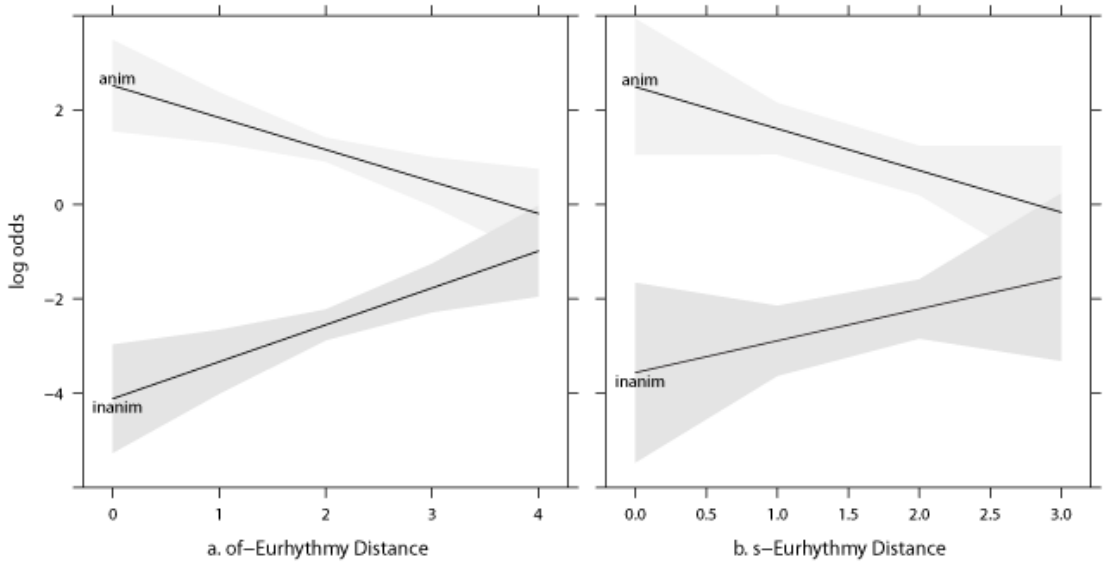
Factor	Estimate	Std. Error	Z value	Pr (>|z|)	
Intercept	-0.6863	0.1031	-6.66	<0.0001	***
P'or animacy = inanimate	-3.7161	0.2116	-17.56	<0.0001	***
Word count (log diff)	-3.3216	0.5578	-5.96	<0.0001	***
Semantic relation = prototypical	1.042	0.3044	3.42	0.0006	**
Final sibilant = Y	-1.1525	0.3075	-3.75	0.0002	**
s-ED_{ph}	-0.1823	0.658	-0.28	0.7818	
of-ED_{ph}	0.066	0.2333	0.28	0.7774	
P'or givenness = not given	0.4483	0.259	1.73	0.0835	
Thematicity (P'or log freq)	-0.0262	0.233	-0.11	0.9104	
Persistence	0.3568	0.2186	1.63	0.1025	
Speaker birthdate	0.0037	0.0018	2.08	0.0375	.
Speaker sex = M	-0.3433	0.1933	-1.78	0.0757	
Interactions					
s-ED_{ph} * animacy = inanim	2.6076	1.2856	2.03	0.0425	.
of-ED_{ph} * animacy = inanim	1.9599	0.4663	4.2	<0.0001	***
N	1107	*of* (653) / *s* (454)			
model χ^2	748.81	R^2		0.663	
Dxy	0.839	%correct (%baseline)		92 (69.53)	
κ	1.797053	AIC_c		778.2298	

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

All else being equal, the results show that the OCP avoidance of adjacent sibilants in the possessor significantly affects syntactic word order, in line with results from previous quantitative studies of genitive construction choice (e.g., Szmrecsányi & Hinrichs 2008): when a possessor ends with a sibilant, the likelihood of using an *s*-genitive construction decreases.

For rhythm, the model shows that rhythmic well-formedness interacts significantly with the semantic conditioning factor of animacy. This interaction is illustrated in the partial effects plot of the interaction below:

(20) Partial effects of ED measures by Possessor Animacy (all other predictors held constant)



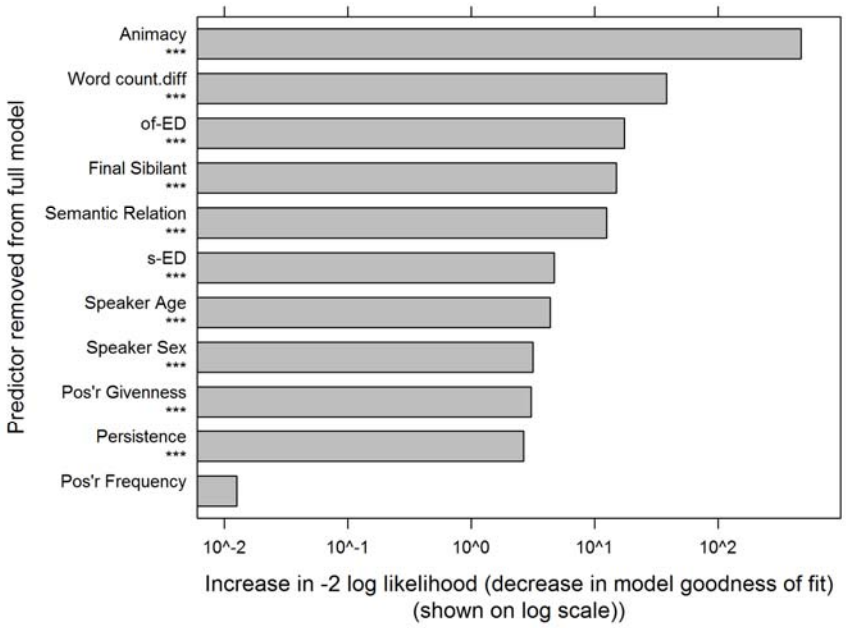
For ED_{of}, we predicted a positive slope based on the hypothesis that as ED_{of} increases—that is, the farther away from eurhythmy the *of*-genitive gets—the more likely an *s*-genitive should occur, to avoid rhythmic violations. The cumulative effect of ED_{of} and its interaction with animacy has a positive slope in genitives with inanimate possessors, as seen in (20a). For genitives with animate possessors, however, ED_{of} does not have a reliable predictive value.

The interaction between ED_s and animacy is marginally significant, and the effect is in the expected direction—mirroring ED_{of}. 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 ED_{of}, there is a slightly positive slope of ED_s amongst inanimate possessors, but this upward trend is not significant, which is graphically evident from the wide and over-lapping confidence intervals.

Animacy is such a strong predictor of the genitive alternation, as has also been shown in previous work (e.g., Rosenbach 2005, 2008), that it heavily influences the effect of rhythmicity on construction choice. Other research has also shown close ties between semantic factors and rhythmic alternation (e.g., Hanssen et al. 2013), suggesting that the interaction between these two domains is non-trivial. Furthermore, the interaction between rhythm and animacy here contributes to an explanation of the relative rarity and weakness of phonological conditions on syntactic phenomena: because phonological factors must compete alongside higher-order conditioning factors, we would naturally expect their effects to be small in comparison. That is, given greater weighting of the importance of higher-order factors in the syntactic domain, the cost is lower if a phonological constraint such as rhythm has to be violated in the effort to satisfy, for example, semantic preferences like animacy.

We can compare the relative importance of the various predictors of genitive construction choice using a drop-one, -2 log likelihood test:

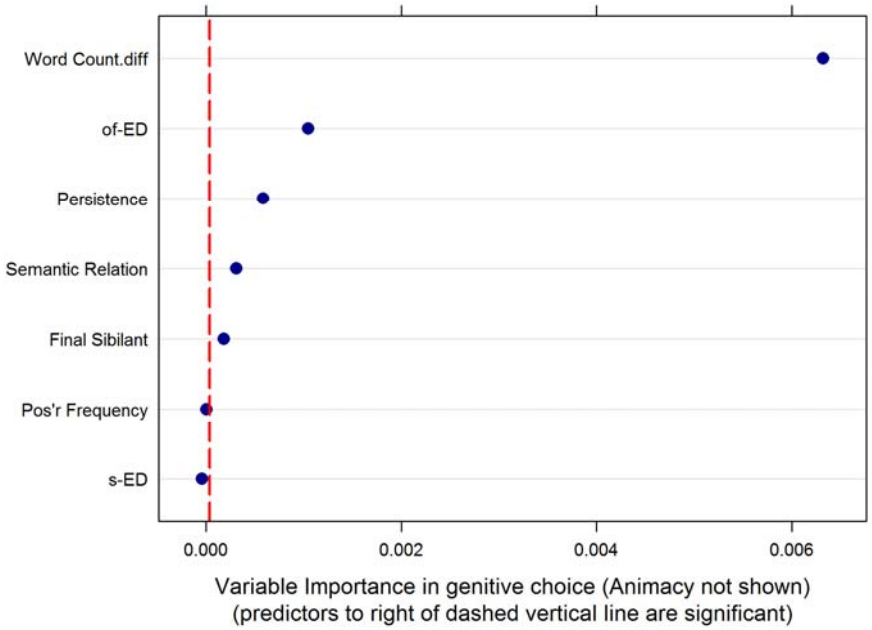
(21) Increase in -2 log likelihood (decrease in model goodness-of-fit) if factor removed



As expected, animacy holds the most explanatory power for the data. Eurhythmy distance (ED_{of}) and sibilant avoidance also rank highly with respect to the other predictors, demonstrating that these factors make significant contributions to predicting genitive construction choice.

The results of the regression analysis were verified using variable importance comparisons in conditional random forest analysis, which allows for robust testing of individual predictor contributions via randomized and conditional permutation tests over forests of classification trees (Breiman 2001; Strobl et al. 2008; Strobl, Hothorn, et al. 2009; Strobl, Malley, et al. 2009; Hothorn et al. 2013; et seq.). Variable importance comparisons are shown in (22) (for clarity, animacy is not shown below because it dwarfs the other predictors in importance):

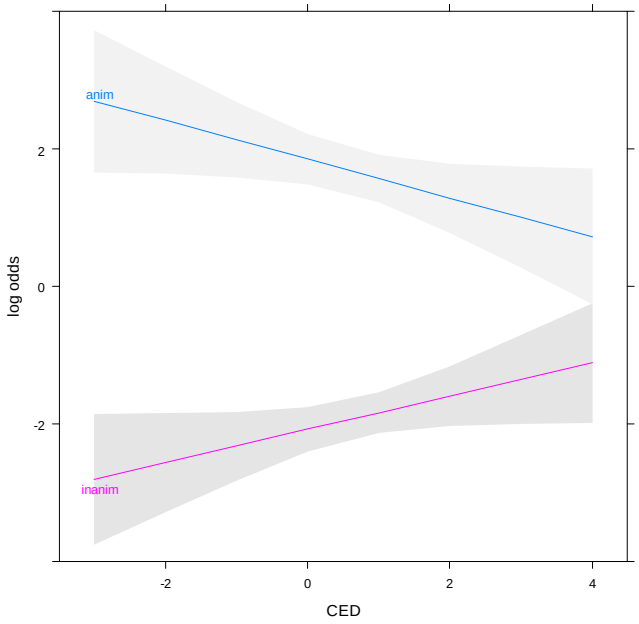
(22) Variable importance in genitive choice (animacy not shown)
(Predictors to the right of dashed vertical line are significant)



As shown in (22), the phonological factors of rhythm (ED_{of}) and OCP (sibilant avoidance) are important predictors in the model of genitive construction choice given the current spoken language dataset. Similar results of rhythmic and phonotactic conditioning of genitive construction choice has been shown for written data by e.g. Grafmiller 2014.

Comparative Eurhythmy Distance is a measure that collapses both ED_{of} and ED_{s}, to directly compare one alternative against the other. As with the ED measures, a model with CED exhibits a significant interaction between rhythm and animacy (β=1.109, z=2.84, p=0.005). The partial effects plot for the CED and animacy interaction is given in (23).

(23) Partial effects plot of CED by Possessor Animacy (all other predictors held constant)



The cumulative effect of the CED and animacy interaction produces a positive estimate slope in genitives with inanimate possessors (0.102+1.109=1.211), indicating that amongst animate possessors, speakers are more likely to choose the *s*-genitive form as CED increases and the *of*-genitive form as CED decreases.

In essence, the ED and CED measures are similar, both based on the number of rhythmic violations that a given genitive construction incurs. Diverging from the simpler ED measure, CED is a relative quantification that attempts to characterize the choice of a more rhythmically optimal construction over a less rhythmically optimal one. However, CED, in collapsing the two ED measures, obscures differences in animacy interaction with ED_s and ED_{of}. What we see in using separate ED measures is that animacy constrains the consideration of certain phonological effects like rhythm: only in cases where animacy does not strongly favor the *s*-genitive (i.e., for inanimate NPs) do we see the effect of rhythmic conditions emerge.

4 CASE STUDY 2: DATIVE ALTERNATION IN ENGLISH

The genitive alternation case study in §3 showed that rhythmic and phonotactic conditions are capable of influencing systematic syntactic choices within noun phrases, specifically between the *s*- and *of*-genitive alternatives. This section examines whether rhythmic conditions can extend beyond the NP in larger syntactic constituents, specifically the English dative alternation.

The English dative alternation is a choice between the double object construction (24a) and a prepositional construction (24b):

(24) a. *give the dog the bone*
b. *give the bone to the dog*

The dative alternation has been well-studied for numerous non-phonological factors. Existing models based on frequency, semantic, and sociolinguistic predictors can achieve very high accuracy in determining speakers' choices of prepositional versus double object datives (e.g., 92% in Bresnan et al. 2007:80).

Some previous research has also suggested that the dative alternation is conditioned in part by prosodic or phonological factors, particularly with respect to "weight" and Heavy NP Shift (cf. §2.2.1). But, as discussed above, "weight" is a notion confounded by syntactic and psycholinguistic factors, as does not easily translate into a direct test of phonological influences on dative choice (Szmrecsányi 2004; Grafmiller & Shih 2011).

Here instead, I present a test of whether rhythmic regularity, which we saw to be important in the genitive alternation, affects dative choice, as a better-suited test of syntactic sensitivity to phonological information. Two rhythmic predictors are examined here. It will be shown that because the dative alternation involves larger syntactic constituents (e.g., alternating NPs) than the genitive alternation, the phonological sensitivity also differs. Higher-level, word and phrasal phonological information is shown to be more relevant to the syntactic alternation of larger syntactic constituents.

4.1 DATA

The dataset used here comes from previous work on the dative alternation by Bresnan et al. 2007; et seq. using the Switchboard corpus of conversational American English (Marcus et al. 1993; Godfrey & McDaniel 1992). The set of datives was already coded for a number of predictors, as discussed below in §4.2.2. As with the study of genitives above, dative constructions involving pronominal objects were excluded from the current study due to their near-categorical behaviors in conditioning word order. In sum, the data examined here involves 410 dative constructions, with 227 direct object datives (55.4%) and 183 prepositional datives (44.6%).

4.2 PREDICTORS

4.2.1 Rhythm

Because of the small size of the dataset, comparative eurhythmy measures (= $ED_{prepositional} - ED_{double\ object}$) are used here, to limit the number of independent parameters in the analysis. Two comparative eurhythmy distances are tested: one based on rhythmic alternation between stressed syllables (primary and secondary alike) and unstressed syllables, and one based only on alternation between primary stressed syllables and all other syllables. In the former measure, primary and secondary stresses are assessed equally as contributing to rhythm; for example, both the direct object and the prepositional datives in (25a) have one unstressed syllable at the verb-NP boundary:

(25) a. **ówe the fá**mily respònsibílity ≈ **ówe respòn**sibílity to the fámily
b. **ówe the fá**mily responsibílity ≠ **ówe responsibílity** to the fámily

For a CED measure that only counts primary stresses, the difference between direct object and prepositional dative constructions in (25b) becomes apparent, with a long lapse in the prepositional alternative. The two CED measures allow us to test the sensitivity of syntactic choices to phonological information: as the syntactic domains become larger, we expect that phonological conditions at lower levels (e.g., syllable-level stress) will influence syntactic choices less than ones at higher levels (e.g., word-level, phrase-level stress). Word-level stress, in particular, is distinct from lower-level stresses (e.g., secondary stress) because it can be strengthened to bear phrasal stress (Truckenbrodt 2006, 2007); thus, because higher level stress can provide relevant processing cues and information about syntactic structure whereas lower level stress cannot.[10]

4.2.2 Control predictors

Control predictors included in the analysis here were ones found to be consistently important in predicting dative alternation, culled mostly from recent experimental work by Bresnan & Ford (2010):

- Animacy of recipient;
- Definiteness of theme and of recipient;
- Number of theme;
- Givenness of theme and of recipient; and
- Weight of theme versus recipient;

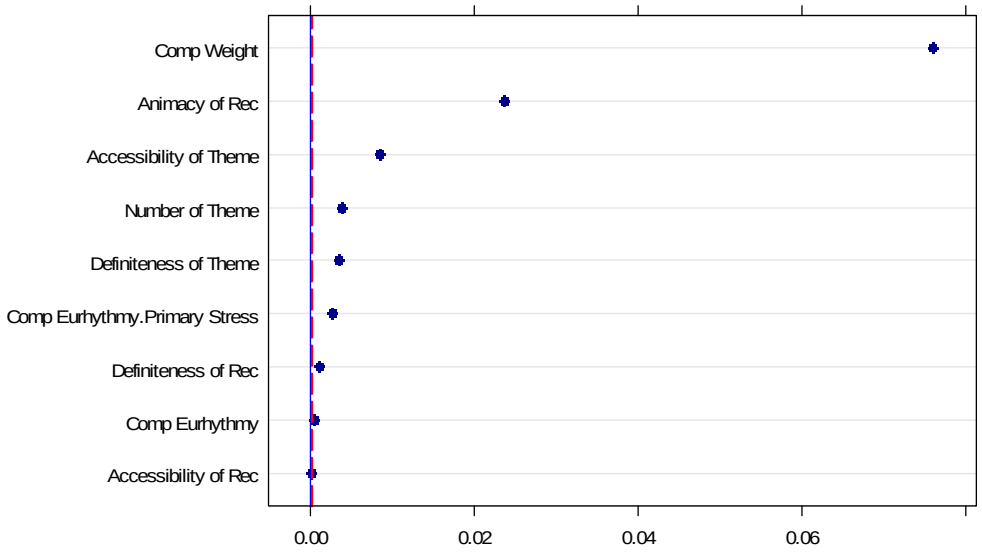
Coding for all of the control predictors, with the exception of weight, was done by previous researchers who developed the corpus (Bresnan et al. 2007). The author and a collaborator (Jason Grafmiller) coded the weight predictor; see e.g., Grafmiller & Shih 2011 for details.

4.3 MODELING AND ANALYSIS

The influence of rhythmic regularity in dative construction choice was investigated here using conditional random forest analysis, which is well-suited for handling small datasets with highly collinear predictors (for discussion of random forest analyses for linguistic data, see e.g., Tagliamonte & Baayen 2012; Grafmiller & Shih 2011; Shih 2014). Variable importance rankings for each of the predictors are shown in (26).

[10] Thank you to an anonymous reviewer for pointing out this reasoning.

(26) Variable importance in dative choice (animacy not shown)
(Predictors to the right of dashed vertical line are significant)



The results of the conditional random forest analysis show that the influence of rhythmic conditioning on dative construction choice is present but small, especially when compared to most of the non-phonological predictors. Comparing the two measures of rhythm, we see that primary stress alternation (CED-Primary Stress) is significantly more important in predicting dative construction choice than syllable-level stress alternation (CED). This result suggests a locality effect at play: that larger syntactic domains such as entire NP's in the dative alternation may be less sensitive to lower-level phonological information than smaller domains such as within-NP constituents in the genitive alternation (see §3).

5 RAMIFICATIONS FOR PHONOLOGY-SYNTAX INTERACTION

The two case studies presented above have demonstrated that, as with phonologically-conditioned morphology, phonological conditions can influence syntax-level alternations: illicit phonological configurations (e.g., stress lapse, clash) are repaired via syntactic means, by choosing alternative syntactic constructions. Furthermore, differences between the genitives and datives reveal a scaling effect on sensitivity to phonological information. The genitive alternation, located within a noun phrase, was shown to be sensitive to syllable-level rhythm and phonotactics. On the other hand, the dative alternation, which involves larger structures (VP, NPs), was only sensitive to word-level rhythmic information.[11] Taken together, the results of the corpus studies and survey presented in §2 suggest that boundary size and domain determine the occurrence and the strength of phonological conditioning in morphosyntactic phenomena. Whether phonology can condition morphosyntax and how it does so depends on the size of the interven-

[11] Whether phonotactic constraints (e.g., OCP) affect dative construction choice is left for future investigation. It should be noted, however, that no such phonotactic constraints on dative choice have been noticed in the previous literature. In comparison, adjacent sibilant avoidance is a robust and known effect in the long-running literature on English genitive construction choice (e.g., Behaghel 1909).

ing domain boundary and the locality-based restrictions of the size of the morphosyntactic domains involved.

Such phonological conditioning of syntactic phenomena and its parallels to phonologically-conditioned morphology raise the architectural issue of the relationship between phonology and the morphosyntax. One common assumption followed by feed-forward models of the interface is that of Phonology-free Syntax, which disavows forward knowledge of phonological information in the syntactic component of grammar (e.g., Zwicky & Pullum 1986; Vogel & Kenesei 1990; Bock & Levelt 1994; Ferreira & Slevc 2007). Given the one-way flow of linguistic information from syntax to phonology under these models, phonological information should, under this view, have no role in syntactic encoding. The empirical consequence of Phonology-free Syntax has been the position that phonologically-conditioned syntactic phenomena are not attested in natural language (cf. Pullum & Zwicky 1988; Miller et al. 1997). Due to this assumption, effects of phonological interference with syntax—however small—are not typically sought: only a comparatively small minority of the literature has focused on uncovering these cases. Nevertheless, such phenomena—even gradient ones, given contemporary quantitative linguistic models—represent crucial information in understanding the architecture of grammar. The goal in this paper has been to offer additional empirical evidence towards considering the fundamental assumptions of how the components of language can interact.

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