Calculating a Pattern's Competitive Strength

Competition between /æ/ and /ʌ/ in Irregular Simple Pasts and Past Participles in English

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Abstract

This article proposes a measure of the competitive strength of two rival patterns in the domain of a subgroup of irregular verbs in English. There is competition between simple pasts built on the vowels /æ/ and /ʌ/, and the same competition is found in the domain of past participles. As a result of such competition, the past tense *stang* (from *sting*) was replaced with *stung*. The /ʌ/ forms are more competitive than the /æ/ forms (Bybee & Slobin 2007, Bybee & Moder 2007). To understand this, we counted the number of types for /æ/ (such as *sang, rang*) and /ʌ/ (such as *stung, stuck*) in the irregular simple past and did the same in the irregular participle (such as *sat, had* and *sung, done*). We calculated a measure of competitiveness for these two patterns incorporating type frequency and token frequency. This measure was used to explain why /ʌ/ forms are more competitive than /æ/ forms.

Key words: type frequency, token frequency, log scaling, competition, English irregular verbs

1. Competition and Change

Linguistic change characteristically involves a stage of variation, or competition between two competing patterns (groups) of forms (Mufwene 2008:4; Aronoff 2016, among others). A pattern is a group of forms exhibiting a similarity. The outcome of competition involves many factors, including sociological preferences for a given form or group of forms. An important factor affecting the outcome of competition is the competitive strength of rival patterns from a psycholinguistic point of view. The competitive strength of a given pattern of forms is known to be related to the frequency of the forms participating in the pattern (Zipf 1935, 1949; Bybee 2007:23 [Hooper 1976] and others). A pattern's competitive strength thus correlates with:

1. The frequency of the individual forms belonging to the pattern (token frequency)
2. The number of forms belonging to the pattern (type frequency)

Frequency of individual forms can be measured by counting them in a corpus. In this way, frequency provides sociolinguistic information about the use of words in a particular group of speakers. In addition, frequency also provides psycholinguistic information about the cognitive neural network representing language. A word's frequency is a reliable measure of the strength of its neural representation (Bybee 1995:452; Versloot & Hoekstra 2016:1225-1226 and others), since frequent items are accessed and processed faster and more reliably (Diessel 2007). In the competition between linguistic variants of any sort, frequency of occurrence adds to competitive strength (Krott, Baayen, & Schreuder 2001). It has, for example, been shown that words from Dutch dialects with a low frequency are more prone to levelling by Standard Dutch than high frequency words (Hinskens 1996; Wieling, Nerbonne, & Baayen 2011,

among others). Hence we will focus on the role of type and token frequencies as a factor in the process of linguistic competition and change.

This paper is organized as follows. Section 2 presents three types of empirical evidence which indicate that /ʌ/ forms are more competitive than /æ/ forms in English past tense / past participle forms. Section 3 relates these facts to a formal measure of competition. Competitiveness will be computed by summing the logged token frequencies of types belonging to the /ʌ/ pattern and the same is done for the /æ/ pattern. Section 4 concludes this paper.

2. Empirical Evidence Showing that the /ʌ/ Pattern is More Competitive than the /æ/ Pattern

2.1. Historical Evidence

Diachronically, irregular verbs in English tend to lose the formal expression of the distinction between simple past and past participle (Jespersen 1942: 49-53; Bybee and Slobin 2007:117; Anderwald 2009: 8-9). The verb *to sting*, for instance, underwent the following change:

(1) *sting – stang – stung* > *sting – stung – stung*

The simple past *stang* was found in Old English and Middle English, whereas Modern English has the simple past *stung*, which is homophonous to the participle (McSparran et al. 2006). Various subclasses of irregular verbs have been affected by the tendency to conflate simple past and past participle (see other examples in (2) below). This change has progressed slowly for centuries and continues up to the present (Bybee & Slobin

2007:117; Bybee 2010:68). As a result, the number of verbs conflating the simple past and the past participle has increased over time. The change exemplified in (1) will be referred to as Jespersen's Change, and the output of Jespersen's Change yields a Jespersen verb (in honour of Jespersen 1942), that is, a verb in which the simple past and past participle are homophonous.

However, Jespersen's Change does not predict the direction of change: from simple past to participle or vice versa. As far as Jespersen's Change is concerned, **sting – stang – stang* could just as well have been a possible outcome. Bybee & Slobin (2007:11) note that the direction of change is fixed: when the simple past and the past participle are conflated, the /ʌ/ pattern is more successful than the /æ/ pattern. The following list presents all verbs which were attracted to the /ʌ/ - /ʌ/ pattern since the Old English period in Standard English, according to Jespersen (quoted in Bybee 2010: 68):

(2) Verbs that have adopted the /ʌ/ - /ʌ/ pattern in Standard English:
sling, sting, string, fling, hang, strike, stick, dig

The list in (2) supports the claim that the pattern with /ʌ/ somehow has a competitive edge over that with /æ/. Bybee & Slobin (2007:117) note, "The question we cannot answer at this point is why … the form in /ʌ/ is the one that survives when the distinction [between simple past and participle] is lost." It is exactly this conundrum that we try to solve in this paper.

2.2. Evidence from Dialects

The historical tendency towards expansion of /ʌ/ forms ties in with Anderwald's (2009:9) finding that "in non-standard dialect systems this pattern acts as a powerful attractor for a range of irregular verbs". That is, dialects of British English likewise feature new additions to the /ʌ/ class in the simple past: *done, drunk, come, run*. Such changes are the result of the interaction between the tendency to conflate the simple past and the past participle, and the greater competitiveness of the /ʌ/ pattern over the /æ/ pattern, which determines the direction of this tendency (favouring /ʌ/). The tendency exhibited by British English dialects can also be observed in varieties of American English. They have developed new additions to the /ʌ/ pattern, such as *brung* (for *brang*), *snuck* (for *sneaked)*, *shuk* (for *shook*), *drug* (for *dragged*) and *thunk* (for *thought*) (Bybee 2010:68; also Bybee & Slobin 2007:115-116).

2.3. Evidence from Errors

There is additional evidence in support of the competitiveness of the /ʌ/ pattern, based on an analysis of 'mistakes' made by adults in the simple past (Bybee & Slobin 2007:115). They used a written elicitation test for the production of irregular simple pasts. They tested verbs with an infinitive in /ɪ/ which undergo a vowel change to /ʌ/ or to /æ/ (examples: *ring - rang - rung*, *fling - flung - flung*). They reported more 'mistakes' favouring /ʌ/ than favouring /æ/:

Table 1

Verbs incorrectly given an /æ/ past or an / ʌ / past by adults.

Type of mistake	*N*
Verbs 'incorrectly' given an /æ/ past	6
Verbs 'incorrectly' given an / ʌ / past	32

The word 'mistake' has been put in scare quotes as it is unclear whether to view such forms as errors or as nonstandard forms. However this may be, many more verbs were 'incorrectly' rendered as a simple past in /ʌ/ than in /æ/.

The historical, dialectological, and psycholinguistic evidence presented above show that /ʌ/ is clearly more competitive than /æ/. To answer the question why this should be the case, in the next section we will examine the frequency of simple pasts in /ʌ/ and in /æ/, and compare these with the frequency of past participles.

3. The Calculation of Competitive Strength

3.1. Type Frequency and Token Frequency

Our data consists of the set of irregular verbs listed in Grabowsky & Mindt (1995). This list is based on the BROWN Corpus of American English and the LOB Corpus of British English. These data involve written standardized language. Some verbs show competition between a regular form and an irregular one, but Grabowsky & Mindt only included irregular forms if they were more frequent than their regular competitors. For example, there were 188 instances of *spelled* and 13 instances of *spelt*. The verb *spell* was therefore counted as a regular verb and not included in the list. For more details on

the process of selection, see Grabowski & Mindt (1995:6-12). Their selection process resulted in a list of 160 verbs. From the list, we selected all verbs which displayed /æ/ or /ʌ/ in the simple past or the past participle. This yielded two patterns (/æ/, /ʌ/) competing in two morphological categories (simple past, participle):

1. Simple past verb forms in /æ/
2. Simple past verb forms in /ʌ/
3. Past participles in /æ/
4. Past participles in /ʌ/

We counted the number of pasts and participles containing a /ʌ/ or an /æ/. This resulted in the numbers presented in the following table. Table 2 shows that the /ʌ/ patterns cover more types than the /æ/ pattern:

Table 2

Number of irregular pasts and participles containing /ʌ/ or /æ/

	Simple past	*Past participle*	*Total*
/ʌ/ pattern	17	30	47
/æ/ pattern	13	3	16

These numbers are based on a count of the items in the following four exhaustive lists:

1. Simple past containing /ʌ/

cut won struck hung swung stuck shut dug thrust clung spun flung strung stung slung wrung slunk

2. Simple past containing /æ/

had began ran sat sang drank swam rang sank sprang spat shrank stank

3. Past participle containing /ʌ/

done come begun run cut won sung struck hung drunk swung swum stuck shut rung sunk

overcome sprung dug thrust clung spun flung shrunk strung stung slung stunk wrung slunk

4. Past participle containing /æ/

had sat spat

The general picture emerging from a type count (see Table 2) is that the two rival patterns almost balance each other out in the domain of the simple past, whereas /ʌ/ outranks /æ/ by a wide margin in the domain of the past participle. As a result, /ʌ/ also outranks /æ/ in the joined domain of simple past and past participle, as shown in the last column of Table 2. In section 2.1., we mentioned that a number of verbs had been attracted to the /ʌ/ pattern since the Old English period: *sling, sting, string, fling, hang, strike, stick, dig*. Likewise, the /ʌ/ pattern was shown to be a powerful attractor for innovations within English and American dialects (section 2.2). And finally, error analysis proved that the /ʌ/ pattern was more competitive than the /æ/ pattern. These data can all be related to the difference in type frequency between these two patterns.

However, it is not enough to propose an account of competitive strength relying on type frequency only, since this does not take the differences between individual verb paradigms with respect to token frequency into consideration. A verb paradigm which is frequent contributes more to the competitive strength of a pattern to which it belongs than a verb paradigm which is infrequent. Similarly, more frequent tokens (words) exert

more influence than less frequent ones. So we must take into account token frequency effects as well (see also sections 1 and 3.2).

This in turn raises the question whether token frequencies of individual forms are relevant here or lemma token frequencies. Lemma token frequency is often a better predictor for frequency effects than token frequency of individual forms (Jescheniak and Levelt 1994; Gahl 2008; but cf. Phillips 2006; Brysbaert & New 2009 who claim that there is no significant difference). A lemma is a shorthand for a paradigm, that is, a group of forms sharing the same semantic core and sharing conspicuous phonological and syntactic similarities. Psycholinguistic research shows that activation of one form of a lemma leads to secondary activation of the other forms of the lemma as a result of these similarities (Jescheniak & Levelt 1994). In this way, lemma frequency is a better predictor for frequency effects than token frequency, so we will work with lemma frequencies. We use lemma token frequencies for irregular verbs that are provided in Grabowski & Mindt (1995).

3.2. A Formalisation of the Relation between Type Frequency and Token Frequency

In the literature, competitiveness is implicitly or explicitly defined as type frequency (Wright 2004 among others), token frequency (Wedel, Kaplan & Jackson 2013 among others) or it is claimed to depend on both (Berg 2014 among others). The choice which is made depends on the phenomenon which is studied. In case competitiveness is claimed to depend on both type and token frequency, the connection between type and token frequency is usually left unspecified, or rather unformalized. In this section we will propose a calculation of the competitive strength of the /æ/ forms and of the /ʌ/

forms, in which the connection between type and token frequencies is derived from a mathematical operation on token frequencies.

Because human perception is logarithmic (Dehaene 2003), it is customary to scale down token frequencies logarithmically. The competitive strength of /ʌ/ versus /æ/ was calculated by summing the log frequencies of the verbs belonging to each of these two patterns (see section 3.3. below). A priori, it is also possible to calculate competitive strength by first summing the token frequencies and only taking the log afterwards. There is a huge difference between these two options. In the latter case (sum first, log later), competitive strength exclusively depends on token frequency and type frequency is predicted to be irrelevant. In the former case (log first, sum later), competitive strength incorporates both token frequency and type frequency. A simple hypothetical example will make this clear. Consider two rival patterns, as below:

(3) Pattern A: verb1 has a frequency of 1000

Pattern B: verb2, verb3 and verb4 each have a frequency of 100, totalling 300

If we first do the sum, and subsequently the log transformation, and consider this to be a measure of competitive strength, then , the competitive strength of pattern A will be *higher* than the competitive strength of pattern B:

(4) Competitive strength defined as: LOG (SUM (token frequency of every type))

Pattern A: LOG (1000) = 3

Pattern B: LOG (100 +100+100) = 2.48

However, if we first log transform the token frequencies, and then start summing, the competitive strength of pattern A will be *lower* than the competitive strength of pattern B:

(5) Competitive strength defined as: SUM (LOG (token frequency of every type))

Pattern A: LOG(1000) = 3

Pattern B: SUM (LOG 100 + LOG 100 + LOG 100) = 2 + 2 + 2 = 6

Taking the log first has the effect that low frequency items become relatively more important, whereas high frequency items become less important. Put differently, scaling down numbers logarithmically hits high numbers harder than low numbers: 1000 gets reduced to 3, but 10 still gets a 1. Hence the competitive strength of a pattern thus calculated not only depends on high token frequency but also on the number of items covered by the pattern (type frequency). Thus, logging before summing incorporates the linguistic insight that type frequency, the number of forms belonging to a pattern, adds to its competitive strength. If a pattern is based on many types, it can more easily attract new types by analogy, even if the token frequencies of the types are low (Phillips 2006). So it is desirable to use a calculation of competitive strength that is sensitive both to the number of types participating in the pattern (type frequency) and to the token frequencies of those types. Such a calculation requires that the log needs to be taken before the sum, as in (5).

The proposal presented here is not original in claiming that type frequency and token frequency are both relevant. What is new, to the best of our knowledge, is the

formalisation in which the sum of log token frequencies is taken, which makes sure that type frequency is indirectly incorporated (cf. the example in (5)).

3.3. Calculating the Competitive Strength of the /æ/ Pattern and the /ʌ/ Pattern

We will now calculate the competitive strength of the /æ/ pattern and the /ʌ/ pattern, both in the class of simple pasts and in the class of past participles, using the procedure we proposed in the previous section. Table 3 (see Appendix A) lists all verbs with a simple past containing the vowel /æ/. The verbs have been sorted according to decreasing lemma token frequency. The first column lists the forms of the simple past. The second column lists the absolute frequencies and the third column the log frequencies. The table shows that the type frequency of simple pasts with /æ/ is 13, and that the sum of the log frequencies of the forms subsumed by the pattern is 29.12. Table 4 (see Appendix B) lists all verbs with a simple past containing the vowel /ʌ/. The table shows that the pattern size of simple pasts with /ʌ/ is 17, and that the sum of the log frequencies of the forms subsumed by the pattern is 28.31. Table 5 summarises the summed log frequency scores of the two rival vowels in the simple past in the form of a percentage.

Table 5

Competitiveness of /æ/ and /ʌ/ in the simple past based on lemma token frequency.

	/æ/ simple past		/ʌ/ simple past	
	Summed Log	Perc	Summed Log	Perc
Scores for competitiveness	29.12	50.7%	28.31	49.3%

The summed log frequencies indicate that the two rivals differ only marginally with respect to their competitiveness as competing markers in the simple past. There are slightly more simple pasts with /ʌ/ than with /æ/, but this is compensated for by the higher token frequencies of forms in /æ/. The data from the simple past therefore do not provide us with an answer to the question why forms in /ʌ/ should be more competitive than forms in /æ/.

Let us now turn to the data from the past participles. Tables 6 and 7 (see Appendices C and D) list all verbs with past participles containing the vowels /æ/ and /ʌ/. Table 8 below summarises the summed log frequency scores of the two rival vowels in the past participle as a percentage.

Table 8

Competitiveness of /æ/ and /ʌ/ in the past participle based on lemma token frequency.

	/æ/ past participles		/ʌ/ past participles	
Scores for competitiveness	8.70	13.0%	58.06	87.0%

Where past participles are concerned, the results show that the forms in /ʌ/ are much more competitive than those in /æ/. This is the key to an understanding of the direction of Jespersen's Change. The measure of competitiveness proposed here correctly predicts the direction of Jespersen's Change, that is, it predicts that the /ʌ/ pattern is more successful than the /æ/ pattern.

4. Concluding Remarks

The /ʌ/ pattern has a competitive edge over the /æ/ pattern when simple past and participle are conflated. To understand this, we analysed the token frequencies of verb forms in /æ/ and /ʌ/ in the simple past and in the past participle. We established a specific measure of competitive strength by taking the sum of the log frequencies. This measure correctly described the greater competitiveness of the /ʌ/ pattern over the /æ/ pattern, as reflected in the data reported in this paper. Our study emphasized the importance of calculating competitive strength by summing log frequencies of the individual forms belonging to a pattern rather than summing token frequencies and taking the log afterwards. Calculating type frequency by adding up logged frequencies has the empirically desirable result that it indirectly incorporates type frequency, a property that is not captured by taking the log of summed token frequencies.

This raises the question in which ways the measure of competitiveness proposed here can be extended to other domains of research. As was mentioned above, there have been analyses of phenomena relying on a view in which competitiveness relies solely on token frequency. Can they be recast in terms of this view of competitiveness? The same question arises for analyses defining competitiveness exclusively in terms of type

frequency. The virtue of our approach is that it proposes a unified analysis of type and token frequency, but it remains to be seen whether it is empirically correct. The proposed measure of competitive strength can be tested in domains in which there is competition between patterns across lemmas. Some examples where this measure could be tested further are presented below.

First, there is an interesting difference between irregular participles in Modern English and Modern Dutch. English features far fewer irregular participles in *-en* than Dutch. English has 30 out of 160 (18.8 %) whereas Dutch has 187 out of 207 (90.3%) (see the list of Dutch irregular verbs in Haeseryn, Romijn, Geerts, De Rooij, & Van den Toorn 1997: 85-100). This may be related to the fact that *-en* never occurs in the simple past in English, whereas it is the marker of the plural of the simple past in Dutch. This example appears to be a good testing ground for our hypothesis.

Second, if the reasoning in the preceding paragraph is correct, then German should behave like Dutch in exhibiting a large number of participles in *-en* due to their systematic near-homophony of the participle with the plural.

Third, Frisian has a complex verb system containing two classes of weak verbs alongside the class of irregular verbs (Eisma & Popkema 2006). This implies that the weak verbs are not as competitive in Frisian as in other Germanic languages, because they are not subsumed by one pattern but by two. This might be related to the fact that Frisian weak participles in -t and -d are currently undergoing a change. The marker *-en* is appended to such participles. An example is given below:

(6) Change in Frisian irregular participles in -t or –d.

sette	*sette/setten*	*set*	=>	*sette*	*sette/setten*	*setten* (‘put’)
INF	PST.SG/PST.PL	PTCP		INF	PST.SG/PST.PL	PTCP

This change obliterates the distinction between strong and weak verbs by creating weak verbs with strong participles, and would also appear to be an interesting testing ground for our measure of competitiveness. Needless to say, while these examples look promising, these cases require further research before definite conclusions can be drawn.

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Appendix A

Table 3

List of simple pasts containing the vowel /æ/. N = 13.

Simple Past in /æ/	*Absolute Fq*	*^{10}Log fq*
had	26047	4.42
began	1072	3.03
ran	754	2.88
sat	648	2.81
sang	203	2.31
drank	186	2.27
swam	115	2.06
rang	79	1.90
sank	78	1.89
sprang	62	1.79
spat	30	1.48
shrank	28	1.45
stank	7	0.85

Summed log frequencies: 29.12

Appendix B

Table 4

List of simple pasts containing the vowel /ʌ/. N = 17

Simple Past in /ʌ/	*Absolute Fq*	*^{10}Log fq*
cut	433	2.64
won	289	2.46
struck	199	2.30
hung	198	2.30
swung	123	2.09
stuck	103	2.01
shut	93	1.97
dug	60	1.78
thrust	56	1.75
clung	53	1.72
spun	48	1.68
flung	39	1.59
strung	13	1.11
stung	13	1.11
slung	9	0.95
wrung	7	0.85
slunk	1	0

Summed log frequencies: 28.31

Appendix C

Table 6

List of past participles containing the vowel /æ/. N = 3.

Participle in /æ/	*Absolute Fq*	*^{10}Log fq*
had	26047	4.42
sat	648	2.81
spat	30	1.48

Summed log frequencies: 8.70

Appendix D

Table 7

List of past participles containing the vowel /ʌ/. N = 30.

Participle in /ʌ/	*Absolute Fq*	*[10]Log fq*
done	8718	3.94
come	3174	3.50
begun	1072	3.03
run	754	2.88
cut	433	2.64
won	289	2.46
sung	203	2.31
struck	199	2.30
hung	198	2.30
drunk	186	2.27
swung	123	2.09
swum	115	2.06
stuck	103	2.01
shut	93	1.97
rung	79	1.90
sunk	78	1.90
overcome	77	1.87
sprung	62	1.79
dug	60	1.78
thrust	56	1.75

clung	53	1.72
spun	48	1.68
flung	39	1.59
shrunk	28	1.45
strung	13	1.11
stung	13	1.11
slung	9	0.95
stunk	7	0.85
wrung	7	0.85
slunk	1	0

Summed log frequencies: 58.06