Initial Consonant Mutation in Spoken vs. Written Welsh

Interface phenomena have been of interest since the outset of linguistic inquiry. In many cases, they are easy to characterize. For example, the interaction of sound changes with morphology, such as umlaut, are well-known, and occur at proximal interfaces. Yet, certain interface phenomena are not so easily understood, especially those which cross the levels of the linguistic system which are presumed to interact, such as phenomena at the interface of syntax and phonology. One striking example comes from Welsh initial consonant mutation, which is highly robust and not well-understood. Initial consonant mutations are a series of morphophonological alternations that are conditioned by their syntactic environment, shown in (1). In (1a), the noun *caneuon* "songs" is in a non-mutated context (i.e., in its "radical" form) while (1b) shows it in a mutation-triggering context (the preposition *am* "about").

(1) a. Dw i yn hoffi **c**aneuon.
Am I in liking songs
"I like songs"
b. Dw i yn meddwl am **g**aneuon.
Am I in thinking about songs
"I'm thinking about songs"

The sound change corresponding to the orthographic alternation of *c* to *g* is the difference between the voiceless velar stop and the voiced velar stop ([k] and [g], respectively). Though the change exhibited is undoubtedly phonological in nature, resembling typical phonological alternations widely attested typologically, the conditioning environment is undeniably syntactic, although in a unique way. In general, the conditioning environments for mutations are strictly local, and occur almost exclusively under immediate adjacency between a (typically lexically-defined) trigger and its complement when that complement begins with a mutable phoneme. Thus, adding the definite article *y* to (1b) blocks mutation on *caneuon* causing it to surface as a radical, in (2).

(2) Dw i yn meddwl am y caneuon.

Welsh possesses three classes of mutation, named according to the phonological process which affects them. These are the soft mutation (lenition), the aspirate mutation (spirantization), and the nasal mutation (nasalization). Each affects a slightly different class of consonants, but all three affect /p/, /t/, and /k/. The present analysis will focus only on mutations involving these consonants, since they form an acceptable baseline by which to compare the frequencies of the various mutations and exclude irrelevant factors like the particular acoustics of the remaining class of consonants affected by these mutations. Below is a table showing the phonological alternations undergone by these consonants for each mutation.

	Soft	Aspirate	Nasal
/p/	[b]	[f]	[m̥]
/t/	[d]	[x]	[n̥]
/k/	[g]	[θ]	[ŋ̊]

As Welsh has changed over time, the soft mutation has remained robust in comparison to aspirate and nasal mutations. The soft mutation has by far the largest number of distinct triggering environments, and affects the largest class of consonants. In contrast, a more restricted set of syntactic environments trigger both soft and aspirate mutation, suggestive of a language change in progress that may result in eventual loss of these mutations, as in Welsh's Celtic cousins. One goal of the current analysis is to evaluate whether these qualitative differences across mutation classes translate to quantitative differences in incidences of mutated vs. radical forms for each class.

Another goal of this analysis is to investigate why these mutations have persisted in Welsh. Prescriptive pressures may underlie the preservation of the nasal and aspirate mutations. Wales had a particular bard culture, whose artistry influenced standards of written (literary) Welsh from an early period in the language's history. More recently, newer generations of speakers receive school instruction in a formal variety of Welsh. This renewed focus on formal, “grammatically correct” Welsh, in which grammatical productions use mutated, but not radical, forms, could have driven the continued use of all classes of mutation. If prescriptive constraints are at work, then we might expect mutation to occur more frequently in written compared to spoken form. While written Welsh would certainly respect formal, established rules for consonant mutation, spoken language production introduces other demands on the speaker which often lead to violations of prescriptive rules. Spoken language also occurs in a less formal register, not subject to the demands of expectations for writing. A divergence of this nature has been observed for a syntactically-conditioned phonological phenomenon in French (*liaison avec enchaînement*), where speakers produce liaison substantially less frequently than predicted according to prescriptive French grammar (Durand & Lyche, 2008).

Alternatively, preservation could be due to functional pressures within the language. Sound changes resulting in a loss of contrast between two phonemes are thought to be less likely than contrasts that do not neutralize contrasts (e.g., functional load; King, 1967). In certain cases, aspirate and nasal mutations may help preserve word contrasts; (3) shows that the homophonous mutation trigger *ei* (feminine or masculine) is disambiguated by the aspirate and soft mutations, respectively.

(3)	a.	Prynais	ei char.
		Bought:1sg	her car.
	b.	Prynais	ei gar.
		Bought:1sg	his car.

If functional pressures drive the preservation of mutation, then we would predict little to no difference in the proportion of mutated forms actually attested vs. number of times they ought to have occurred between informal (spoken) and formal (written) Welsh. Functional pressures would be expected to apply to both types of language use. In essence, if mutations are useful to speakers, they would be expected to be preserved in the great number of cases in the spoken language, while if they are more of a burden placed on practitioners of a language transmitted and preserved by education in formal writing, then they would be expected to occur considerably less often in spoken Welsh.

Methods

Materials

We tested these hypotheses by comparing the occurrence of mutated (vs. radical) forms in two sets of corpora, one spoken and one written. The spoken corpora (Siarad and Patagonia) were faithfully transcribed to what was spoken, so transcriptions include whether a word was or was not mutated. The written corpus, the *Cronfa Electroneg o Gymraeg*, “Electronic Corpus of Welsh,” also includes both mutated and radical forms. Given that the sound changes themselves are deterministic, and are conditioned by a closed set of lexically-defined environments that occur strictly locally, a bigram model is a suitable mechanism for capturing the relative frequency of each of these mutations in their respective contexts.

Prior to modeling, decisions were made regarding 1) which mutation triggers (i.e., syntactic environments) should be considered for each mutation type, and 2) selection of a set of nouns to be considered as potential mutation targets. All possible triggering environments were included for both the nasal and aspirate mutations, given the small number of triggering environments for each. For the soft mutation, a subset of triggers were selected to match, as much as possible, the parts of speech represented in the set of nasal and aspirate triggers. Since it was desirable to avoid effects (or, whenever possible, compare effects) of part of speech on the frequency of mutation, only a small set of soft mutation triggers were chosen. The table below includes the triggers used, with the respective part of speech.

Soft	Aspirate	Nasal
o - “of” (preposition)	gyda - “with” (preposition)	yn/ym/yng - “in” (preposition)
ei - “his” (possessive clitic)	ei - “her” (possessive clitic)	fy - “my” (possessive clitic)
dau/dwy - two (numeral)	chewch/chwe - “six” (numeral)	

ar - “on” (preposition)	tri - “three” (numeral)	
dy - “your” (possessive clitic)	a/ac - “and” (conjunction)	
am - “about” (preposition)		

The second pre-modeling decision was selecting the list of words to be considered as potential mutation targets. As mentioned above, we restricted our analysis to mutations on /p/, /t/, and /k/, as these three consonants undergo each of the three classes of consonant mutation, so as to control for segment, place of articulation, and manner of articulation effects. Every word that occurred in all of the corpora at least once was included in the list of candidate words. This was done by building separate word lists of all /p/, /t/, and /k/ initial words for each corpus and taking their intersection, for a total of 764 words. The number of words were not strictly identical for each consonant; there were 426 [k]-initial words, 179 [p]-initial words and 159 [t]-initial words. A further practical addendum is that the words were restricted to nouns only. While certain syntactic environments in the soft mutation, such as the preposition *i* “to” function as an infinitive marker, and so trigger soft mutation on verbs, the bulk of the triggering environments in all mutations are restricted to nouns only. So, while the triggering environments were controlled for part of speech as best as possible, so were the targets. Although this does limit somewhat the extent of the reach of the data, failing to control for these factors would make drawing conclusions for the end result problematic.

Words were also separated into high and low frequency bins in order to consider word level effects on mutation use across corpora. High frequency words were the 1st quartile in log frequency in the corpus, and low frequency words were in the 4th quartile. Words with middling frequency were excluded from the frequency analysis (N = 385) since they do not contrast sufficiently to have any expectation of differing results.

Analysis

For each target corpus, separate bigram models were created for each mutation class in order to facilitate tracking the occurrence of mutation vs. radical forms across these classes (six models). The models searched for instances of each mutation trigger followed by target nouns in either their radical or mutated forms. Results from these three individual models will answer our first research question. Data from the individual models for each corpus were then combined to compare across corpora to answer our second research question. For all bigram models, only numbers of mutated forms observed in proportion to number of times mutation should have occurred were considered (i.e., transition probabilities were not calculated), as our current interest is in proportional frequency of use for mutated forms.

Results

Differences Across Mutation Class

For the written corpus, bigram models for each mutation class reveal differences in occurrence of mutation. The table below summarizes these results. As expected, based on the robustness of the soft mutation within Welsh compared to other mutation classes, nouns almost always undergo mutation when in a soft mutation triggering environment. Aspirate mutations also occur a substantial proportion of the time. Notably, nasal mutation occurs considerably less than both soft and aspirate mutations. As discussed above, nasal mutations occur in a highly restricted set of syntactic environments (only two possible triggers). Combined with this drastic reduction in nasal mutation use, one possibility is that this mutation class will soon disappear from Welsh completely. By contrast, the aspirate mutation is still quite retained in the written corpus. Even though the proportion of mutations in the aspirate is quite low - only about a quarter are performed in the triggering environment - it is twice as frequent as the nasal mutation in the spoken corpus. While this low proportion ultimately means that the aspirate mutation may indeed also be lost to Welsh, its decline is slower than the nasal, likely because it has more and varied triggering environments.

Mutation class	Soft	Aspirate	Nasal
Proportion mutated in written corpus	99.2%	97.7%	68.5%
Proportion mutated in spoken corpus	84.8%	24.1%	12.5%

Differences Across Corpora

In the written corpus, initial consonant mutation occurs 93.8% of the time. This high incidence of mutation (collapsed across class) could reflect either functional or prescriptive pressures for mutation use. Crucially, consonant mutation occurs 65.8% of the time in the spoken corpus. This divergence is substantial, and is especially pronounced when comparing the aspirate and nasal mutation frequencies. These results support the hypothesis that continued use of mutated forms is driven by prescriptive pressures, although it does not rule out a more nuanced view in which the mutations with more salient or obvious functional value are those which mutate more frequently.

As mentioned above, work with other variable interface phenomena, like liaison in French, have found differences in liaison use in spoken French compared to what is predicted by the grammar (Durand & Lyche, 2008). Bybee (2001) argued that use of liaison is preserved for word forms with high frequency, and liaison tends to fall out of use for low frequency word forms. This same analysis may help characterize the difference between mutation occurrence in the written vs. spoken corpora. In the written corpus, unsurprisingly, there is little difference in use of mutated forms for high vs. low frequency nouns (mean proportion mutated forms 92.9% and 98.6%, respectively), and if anything the difference is in the opposite of the predicted direction. Interestingly, this difference is collapsed in the spoken corpus, where mutation is more variable in any case. Words in the low probability bin were mutated 63.5% of the time while words in the high probability bin were mutated 62.3% of the time. Both of these are about average for mutation as a whole in the corpus. This is inconsistent with the expectations based on previous work which finds robust frequency effects in morphophonology, and shows a divergence with the written corpus.

Discussion

Welsh initial consonant mutation is a pervasive morphophonological phenomena that operates at the interface of syntax and phonology. While consonant mutation remains pervasive in Welsh, the process has been gradually phased out of other related Celtic languages. The current corpus analyses revealed that consonant mutation occurs almost all of the time (vs. use of non-mutated, radical forms) in written Welsh. This persistence is somewhat unsurprising given recent focus on formal, written varieties of Welsh in the education system; prescriptive, grammatical rules for consonant mutation are strongly impressed on Welsh speakers. In spoken Welsh, speakers use mutated forms considerably less often, although still more often than the radical form. These results are consistent with a hypothesis where prescriptive pressures are attenuated in less formal, spoken language use, and largely inconsistent with a functional hypothesis for use of mutation.

Results of our frequency analysis were inconsistent with previous findings for other phonology-syntax interface phenomena; less frequent forms were found to have a higher proportion of mutation use in the written corpus, while both high and low frequency nouns were mutated the same amount in the spoken corpus. One possible account for our findings is that more frequent nouns are more likely to occur in non-mutated contexts, since non-mutating contexts are more frequent in general than mutating ones, but low frequency nouns could show less of an asymmetry. This difference could have unexpected influence on incidence of mutation for high vs. low frequency nouns, and in written vs. spoken contexts. However, this under-developed explanation is purely speculative, and this question merits further investigation.

These results provide preliminary evidence for language change in progress, where Welsh initial consonant mutation may be come a more variable phenomenon, as in other Celtic languages. While soft mutation persist in both corpora, we found convincing data suggesting both the aspirate and nasal mutations will fall out of disuse in spoken Welsh. With the loss of these two mutation classes, Welsh would resemble its Celtic relatives. Furthermore it also constitutes a kind of anti-frequency effect, though, as has been argued, one which is not commensurate with the current understanding of the role of frequency on lexical representations.

The current analysis utilized a constrained subset of both triggering environments, partly due to the limited amount of triggers, and mutable nouns, to control for phonetic-level effects (e.g., manner of articulation). To obtain a more comprehensive understanding of the mutation process, future research should consider a wider range of mutation triggers and mutable consonants. It is possible that segment-level effects themselves could be contributing to some of the differences in the initial estimates (i.e., perhaps mutations on /k/-initial words are less frequent than those on /p/-initial words). Therefore, including more nouns could improve our understand of the current state of consonant mutations in Welsh both in written and spoken forms of the language.

The current findings contribute to a body of work supporting the context-dependence of processes like initial consonant mutation. Our results suggest that this process is at least partially preserved by prescriptive pressures, although mutation classes with low type frequency (aspirate and nasal) may soon fall out of use, leaving only soft mutation. The relatively high proportion of soft mutations in both language contexts (spoken and written) suggests an additional force driving this phenomenon beyond prescriptivism. Continued study will hopefully reveal more about the psycholinguistic aspects of this phenomenon towards a better understanding of what kind of syntactic and lexical representations contribute to such an exotic process.

References

Bybee, J. (2001). Frequency effects on French liaison. *Typological Studies in Language, 45,* 337-360.

Durand, J., & Lyche, C. (2008). French liaison in the light of corpus data. *Journal of French Language Studies*, *18*(01), 33-66.

King, R. D. (1967). Functional load and sound change. *Language, 43*(4), 831-852.

As was already mentioned, tight control must also be exerted here, since there may be segment-level effects which would affect the final proportion of mutations and so be a confound for ultimately concluding whether an explanation according to prescriptive tendencies or functional utility is to be considered more consistent with the facts.

Perhaps the most striking example of an interface phenomenon which is both robust in the languages which possess it and which has completely eluded understanding are the systems of initial consonant mutations in the insular Celtic languages, the most extensive system of which belongs to Welsh.

The table above demonstrates a certain level of diversity in the initial consonant mutations that is not found in other Celtic languages. In those languages (Breton, Irish, Scots Gaelic), the system of initial consonant mutations has more or less collapsed into a single morphophonological alternation, affecting a single class of consonants and not distinguishing environments into different types of sound change.

The first reason is that the aspirate and nasal mutations serve some particular function which is useful to speakers of Welsh, and so the preservation is due to functional pressure. One reason to think this is that certain structures are in fact disambiguated by the presence of a mutation (3).

The mutation trigger *ei* is in fact homophonous between a feminine and masculine reading, but the feminine form triggers an aspirate mutation and the masculine form triggers a soft mutation. The only way to disambiguate the reference set is by the mutation itself, if there is no syntactic binding

These findings are difficult to reconcile both with previous work on related phenomena, and with our understanding of how word frequency is encoded in the lexicon.

Under the assumption that both radical and mutated forms have lexical representations, an assumption supported by studies investigating similar phonological processes (e.g., French schwa deletion; Bürki, Alario, & Frauenfelder, 2011), we could propose that radical variants of high frequency nouns have higher resting activation than mutated variants. As a result, The reason for the effects of frequency of the particular noun on whether or not it is mutated in the spoken corpus remain unclear. One possible account for our findings is that more frequent nouns are more likely to occur in non-mutated contexts, since non-mutating contexts are more frequent in general than mutating ones. Under the assumption that both radical and mutated forms have lexical representations, an assumption supported by studies investigating similar phonological processes (e.g., French schwa deletion; Bürki, Alario, & Frauenfelder, 2011), we could propose that radical variants of high frequency nouns have higher resting activation than mutated variants. As a result,

high frequency nouns: more radical than mutated exemplars

low frequency nouns: perhaps equal numbers radical and mutated exemplars

lexical representations for forms As a result, I This could cause speakers to have the lexical representation of the non-mutating form be more common, and so come more readily to mind in speech production regardless of awareness of the relevant context. Conversely, low frequency words are retrieved from the lexicon slower, and so that extra time makes the context more readily available to the speaker and so the mutated form is more likely to result. This explanation is purely speculative, and deserves further inquiry.

Things to talk about in paper:
-what is Welsh consonant mutation?
    *three types
    *nouns mutate
-why are we comparing corpora?
-how did we select…
    1) triggering environments for three types of mutation
        -tried to balance POS/function/whatever for trigger across types
        -numerals, prepositions, etc.

2) the target nouns
-p, t, c, only (common across mutations)
-two frequency bins (hi vs. low)

-models
*bigram models to determine how many times triggering environments for each type of mutation resulted in either a mutation or preservation of radical form
*did not go so far as to compute TPs

-questions we'd like to answer with the modeling

1) Difference across corpus
-Hypothesis: task demand? prescriptive pressure (although Klinton didn't like this idea?)
-Prediction: more mutation in written vs. spoken corpus
-Result:
*Written: ~93% mutation
*Spoken:

2) Difference across type
-Hypothesis:
-Prediction: more mutation for soft vs. aspirate/nasal (is that right?)
-Result:
*Written: soft/aspirate near 100%, nasal at 60%
*Spoken:

3) Difference by word frequency
-Hypothesis 1:
-Prediction 1: More frequent words more likely to mutate (in spoken corpus specifically)
-Hypothesis 2: Differences across type attributable to word-level factors, such as frequency (right? I still have trouble wrapping my brain around this idea for some reason)
-Prediction 2: