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Effects of orthographic silent ‘l’ on preceding vowel duration

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Section 1: Introduction

Homophones, words which have the same pronunciation but different meanings, are a somewhat common occurrence in everyday language use. Interestingly, upon careful study, many of these homophonous word pairs have been found to exhibit consistent acoustic differences. For instance, several studies have found that the process of word-final consonant devoicing, which is found in many languages, does not actually lead to identical acoustic productions between underlying voiceless and underlying voiced final consonants, despite what IPA transcriptions would indicate. For example, words like "bund" (group) [bunt] and "bunt" (colorful) [bunt] in German have been shown to retain some characteristic differences. These retained characteristics, which resist neutralization, are sub-phonemic, meaning they do not cross the threshold which causes listeners to perceive them as a different phoneme, though they have been found to have some impact on speaker perception (Port and O'Dell, 1985; Warner, Jongman, Sereno, & Kemps, 2004).

In English, researchers have investigated another variable which causes measurable differences between the members of a homophone pair: word frequency. These studies have shown that when speakers intend to convey the less-frequent meaning of the homophone pair, they produce the word with a longer overall duration than they do when they are using it to communicate a more frequently heard meaning (ex: 'thyme' has a longer duration than 'time') (Gahl, 2008). One recent study examined this phenomenon in child-directed speech, the register of speech adults use to talk with children. It found that word category and word frequency both had significant effects on the production of homophones. The authors of the study postulated that this distinction allowed children to distinguish between the homophonous words and acquire and use them accurately at an early age, despite their struggles elsewhere to grasp the concept of one word having multiple meanings (Conwell, 2017). The results of this study challenge the assumption that homophones are represented by the same string of phonemes in a speaker's mental lexicon and argue that in fact we learn homophones as inherently separate lexical items, which are distinguished in production by our adult caretakers.

Linguists have linked these auditory differences between homophonous words to several possible causes. In the above paragraph I have mentioned frequency and word category, another often invoked cause is morphological differences. It has been found that, at least in some cases, monomorphemic and polymorphemic homophones, like the pair freeze (monomorphemic) and frees (polymorphemic, free + s), are produced differently. Seyfarth, Garellek, Gillingham, Ackerman, & Malouf (2017) found that the duration of the final obstruent in pairs like the example given previously is longer for words in which it is representing an additional morpheme. Other linguists are investigating another possible source for these differing pronunciations: orthography.

Thus far, all the word pairs studied to look at the effect of word-frequency, category and morpheme status have varied orthographically as well. To isolate just orthographic difference and see if a resulting production difference was found, Warner et al. (2004) devoted an experiment in their evaluation of Dutch neutralization to the comparison of word pairs that differed orthographically, but which contained identical numbers of morphemes and belonged to identical lexical categories. The pairs each consisted of two conjugated forms of one Dutch verb. The forms were considered homophones and only differed orthographically due to spelling convention (ex: kleden vs kleedden). The researchers found significant durational differences between the orthographically distinct homophones, supporting the idea that orthography may have a direct influence on pronunciation separate from the influence of morphology. In English, this orthography-to-production link has been demonstrated to hold true as well. Elicitation and corpus-based research has found that different spellings of word-final obstruents lead to different durations for those obstruents sounds. The number of letters used to represent the final obstruent appears to correlate directly with its spoken duration, leading, for instance, to the /s/ in “fuss” being longer than the /s/ in “us” (Brewer, 2006).

Thus, there is reason to believe that orthographic patterns may impact speech at a sub-phonemic level, creating measurable differences between words or sounds that we would categorize as phonemically the same (homophones, identical word codas, etc.). Within this realm of orthographic influence, one unit of orthography that invites further examination is the silent letter, which by definition is thought to exert no influence on pronunciation. Silent letters have been the focus of some exciting new linguistic research. Lambert, Sausset, & Rigalleau (2015) examined examples of orthographic ‘e’ in French which are not pronounced in spoken language, with medial and word final examples. Through a series of writing evaluations, they demonstrated that adult speakers process two syllable words with silent ‘e’ at the same rate as three syllable words, pointing to the existence of an “ortho-syllable” which causes them to take time processing silent ‘e’ even though it is null in spoken speech. This result demonstrates that silent graphemes are processed, at least at the stage of writing, as productive units of words, which sets the stage for much exciting future research in languages with deep orthographies, (that is, languages in which the spelling of a word often does not correlate predictably or directly with how that word is pronounced) (Schmalz, Marinus, Coltheart, & Castles, 2015). In these deep orthographies, English being a classic example, we encounter phenomena like silent letters and a-typical grapheme pronunciations often. Lambert et al.’s (2015) work proves that, at least at the stage of writing, these orthographic features are processed in much the same way as typical, non-silent, phonologically-linked graphemes. This opens the door to much future research on these orthographic features, investigating the effect they have on speakers’ mental representation of the words that contain them.

Additional studies on the topic of silent letters have investigated whether these silent grapheme units impact spoken perception, as well as mental representation. One experiment asked subjects to make ‘same’ or ‘different’ judgement between two auditory samples, which were very similar except in the pronunciation of either an orthography supported or unsupported additional letter in one of the samples. It was found that speakers tend to perceive an orthographically supported mispronunciation as correct more often than mispronunciations of identical severity which are unsupported by orthography. For instance, /kæstəl/ for “castle” would be judged more favorably than /hæstəl/ for “hassle” (Ranbom, 2011). Another experiment found that speakers of a non-rhotic variety of English (Australian) were less likely to judge a word pair as homophonous if one member had a final ‘r’ and the other did not, despite the fact that final ‘r’ is silent in their dialect. The researchers in this experiment argue that this mismatch shows that the orthographic ‘r’ is being represented in speakers’ mental phonology and interfering with the homophony judgement, despite it being lacking in production (Taft, 2006). This finding thus supports the idea of an abstract phonology stored in the speaker’s lexicon which is influenced and/or reflected by orthography, and that silent letters may meaningfully feature within this abstract phonological representation.

This paper will examine another silent letter pattern found in English: silent ‘l’ before k in words like ‘walk’ and ‘talk’. To investigate whether the silent ‘l’ grapheme has a measurable effect on speaker production, subjects were recorded producing homophonous word pairs with the ending “-k/ck” and “-lk” (example: “walk” and “wok”). Special attention was paid to the vowel length in each member of these word pairs, as our hypothesis was that the influence of orthographic ‘l’ would be most clear in this area. In section 2, I outline the procedure which was used to record and analyze speaker productions of the “-k/ck” and “-lk” words, as well as additional target and filler words. In section 3, I discuss to what extent the presence or absence of ‘l’ was found to significantly affect vowel duration, as well as other significant trends present in the data though it is important to note that data analysis is still ongoing at this time.

Section 2: Methods

In this experiment the effect of silent letter ‘l’ in words such as “walk” and “talk” was evaluated. In English (as well as many other languages) vowels before voiced consonants have longer durations than vowels before voiceless consonants. Experimentation by Walsh (1985) has indicated that this is a phonological rather than physiological rule. Vowels are produced longer before consonants with the phonological feature [+voicing] independent of the actual presence or absence of vocal fold vibration. The hypothesis motivating the current experiment is therefore that, **if (1)** silent letters have been shown to be present in the mental phonological representations of lexical entries (Taft, 2006), and **(2)** the phonological identity, specifically the voicing feature, of the post-vocalic consonant has been shown to be the primary influence on vowel length (Walsh, 1985), and **(3)** differences between the abstract phonological representations of homophonous words have been shown to lead to measurable sub-phonemic differences between words (Port and O’Dell, 1985; Shrager, 2012; Warner et al., 2004) **then** the presence of the silent orthographic ‘l’ (a voiced consonant) will cause the preceding vowel to lengthen, such that the homophones “wok” and “walk” would be produced with different average vowel durations.

An alternate hypothesis would attribute the lengthening of preceding vowels before silent ‘l’ to the process of compensatory lengthening, where the loss of one segment causes another, usually a vowel, to lengthen. This process is well-documented in historical linguistics. For instance, one known example is the historical evolution of Proto-Germanic *tonθ into English tōθ where /n/ was lost and /o/ lengthened, eventually raising to modern English ‘tooth’ /tuθ/ (Campbell, 2013). One preliminary study has found synchronic examples of compensatory lengthening in the productions of English children between the ages of 1 and 3. An analysis of these children's natural speech showed that when they failed to produce a final consonant in words like 'dog' they lengthened the vowel to compensate. Two of the three children in this study exhibited this behavior consistently across both tense and lax vowels, indicating the lengthening was likely meant to compensate for the lost coda, while the final child seemed to show a preference for the lax vowels which supported an earlier proposed theory that childhood vowel lengthening serves to preserve minimal word structure rules which do not allow a single open syllable with a short lax vowel (Song and Demuth, 2008). The results of this study are clearly inconclusive, but they do demonstrate the possibility of segment-loss triggering compensatory vowel lengthening in some speakers. A final alternate hypothesis worth considering is that the same process at work in Brewer (2006) is present here. This hypothesis would propose that the addition of an extra written letter, the silent 'l', causes words like 'walk' to have longer vowel durations than words spelled without the 'l' and thus with fewer letters. This hypothesis requires that the speakers perceive the written 'l' as part of the nucleus/vowel sound of the syllable. If 'l' is alternatively being read by speakers as an addition to the coda of the word, then we might expect to see the lengthening of this portion of the word instead. Either attribution appears plausible as 'l' is a consonant that is also considered a semivowel, and can on occasion be the nucleus of English syllables, such as in the word "bottle".

In order to test whether any vowel lengthening we observe is best attributed to compensatory vowel lengthening/additional letter duration or to the effect of phonological voicing on the preceding vowel we examined two additional homophone pairs: 'calm'/'com' and 'palm'/'pom'. In these pairs the final consonant is voiced; therefore, the only difference between the two members of each pair is the presence or absence of the additional orthographic segment 'l'. If we see a similar degree of vowel lengthening between 'com' and 'calm as we do between 'wok' and 'walk' then we will know that it is either compensatory lengthening or the addition of orthographic characters that is the cause of such lengthening and not the phonological processes of vowel lengthening discussed above. Alternatively, if we find a greater degree of difference between 'walk'/'wok' than between 'calm'/'com', this will support the theory that the underlying voiced /l/ is triggering a phonological rule which causes the preceding vowel to lengthen, causing a more severe change when the underlying 'l' is of a different voicing quality than the following consonant.

Section 2.1: Participants

The participants in this experiment were 47 undergraduate students at Western Washington University. The majority of these students were enrolled in a 200 level linguistics course called Language and the Brain and participated in the experiment for course credit (though they were free to choose whether or not they wanted their data analyzed or would prefer to walk through the experiment without having their data recorded). Thus far only 20 of those participants' data has been adequately analyzed. Of the remaining 27 participants, several were disqualified from inclusion because they did not follow the experimental procedure. Excluding these cases, the remaining 20 or so have received partial but not total analysis due to time constraints and so their data was not included in our first round of statistical analyses. In looking at the data from the randomly selected 20 participants of focus, 12 productions were discounted due to mispronunciations. In order to compare accurately across the homophone pairs using a paired T-test, the homophone counterparts of these mispronounced words were also removed from the data (i.e. if Participant 1 mispronounced 'wok' on their first production then their first production of its homophone counterpart 'walk' was also removed from the data). This left 536 productions (20 speakers x 14 target words x 2 repetitions per word –24 mispronunciations and their counterparts). Additionally, there were 64 productions in which the 'l' was audibly pronounced. These productions and their homophone counterparts were removed from our analysis as well, in order to only examine the effect of silent 'l'. This left 408 usable points of data.

Section 2.2: Materials

The 14 target words for this experiment are listed in Table 1, this group includes 10 words of primary focus (the –lk and -k/-ck homophone pairs) and the 4 additional words mentioned in the introduction to this section which will be used to examine the effect of silent orthographic 'l' in environments where its voicing is not a relevant factor. In Table 2, 66 additional filler words are listed. These words were included to ensure that the subjects did not become aware of the focus of the experiment and potentially produce unnatural pronunciations, intentionally trying to differentiate the homophone pairs. The filler word "chant" appeared twice during each experimental trial. This was due to a researcher error but was unlikely to have any negative effect on the experiment. The single duplication may even have helped to distract the participants from the true focus of the experiment.

In both tables, the words' approximate frequency in English, according to the Corpus of Contemporary American English (Davies, 2008), are reflected by a number in parenthesis. This number represents how many times the word was found per one million words in the COCA collection, examining both written and spoken examples of English speech. The higher the number, the more frequently used that word is according to COCA. For the words which can have multiple uses (ie. “walk" as a noun or a verb) the highest frequency ranking of the multiple uses is reported here (thus the frequency rankings for “walk” and “talk” are both for the verbal rather than the nominal use of these words). The frequency data for Tok may not accurately represent its true frequency for the participants in this experiment as the popularity of the application TikTok has led to –tok being a frequently used productive suffix among younger speakers of English.

This frequency data is relevant because previous research has found that high frequency words are produced with shorter overall durations than low-frequency words (Gahl, 2008). It was therefore important to acknowledge the relative frequency of our target words and consider in the analysis stage whether trends we attribute to the presence or absence of orthographic ‘l’ could simply be an effect of word frequency or, alternatively, whether effects of word frequency could be masking the effects of orthographic ‘l’. For instance, if our data showed ‘walk’ and ‘wok’ have identical vowel durations, we might question whether this apparent equivalence is actually a result of two opposite processes. It may be that the entirety of ‘walk’ is produced shorter because it is more frequent and that this shortening masks any vowel lengthening caused by orthographic ‘l’. To rule out this possibility, we examine the spectrograms to see if the vowel-duration to word-duration ratio was significantly different between the two words, essentially shifting from an absolute measurement of vowel duration to a relative one, in order to isolate vowel duration from other durational phenomena.

In 6 out of 7 of the homophones pairs the –lk pair member was much more frequent than the –k/ck pair member, in 1 pair the reverse scenario occurred with ‘stock’ being much more common than ‘stalk’. The homophone pair ‘ca(u)lk’/’cock’ was included in the original materials for this experiment but was removed before testing began. After careful consideration we decided that the optional ‘u’ in the –lk pair member introduced too much uncertainty. Without the ‘u’ the word was much less likely to be recognized and pronounced correctly by Pacific Northwest speakers of English, but with the ‘u’ we introduce a vowel sound represented by a digraph (‘au’) and couldn’t be certain whether any vowel lengthening we observe was caused by the silent ‘l’ or the digraph, as a fundamental basis of this experiment is the fact that additional graphemes can alter pronunciation and perception. We therefore thought it was important that all the pair members were matched in terms of the number of letters used to represent their vowel sounds.

-lk words	-k/-ck words
Walk (123.74)	Wok (0.93)
Talk (363.24)	Tok (0.1)
Chalk (4.14)	Chock (0.6)
Balk (0.85)	Bock (0.57)
Stalk (2.48)	Stock (72.05)
*Calm (38.13)	*Com (7.76)
*Palm (22.08)	*Pom (NA)

Table 1: Target –lk and –k/ck words and relative frequencies in the English language.

**These words will be used to evaluate the alternate compensatory lengthening hypothesis.*

Bag (63.24)	Drag (17.69)	Keep (403.81)	Nag (1.05)	Slime (1.99)	Trot (1.84)	Bet* (50.67)
Best (453.71)	Edge (65.98)	King (137.81)	Nerve (14.61)	Sloth (0.89)	Weave (3.56)	About* (2911.37)
Broth (6.73)	Gaff (0.28)	Kit (14.39)	Nest (11.09)	Sniff (3.0)	Wick (1.1)	No* (2470.4)
Camp (60.67)	Gift (50.06)	Knot (5.71)	Nose (41.76)	Stall (5.66)	Bread* (33.46)	So* (2921.42)
Cap (26.35)	Goth (0.71)	Left (423.57)	Peak (24.91)	Stem (19.35)	Lead* (144.11)	Debt* (65.93)
Chant (3.06)	Groove (3.55)	Link (52.48)	Raft (3.95)	Swamp (5.96)	Toe* (9.31)	Doubt* (76.03)
Cone (4.59)	Heft (1.11)	loll (0.18)	Rank (17.3)	Tent (15.38)	Poe* (3.45)	
Craft (19.46)	Jam (9.55)	Lurk (0.99)	Reed (15.14)	Tilt (4.55)	Bred* (3.5)	
Creep (5.49)	Jeep (5.6)	Mean (518.85)	Shift (45.34)	Toll (11.92)	Bed* (115.69)	
Crew (42.59)	Joust (0.23)	Mope (0.3)	Shop (53.22)	Trash (19.44)	Led* (116.11)	

Table 2: Filler words and relative frequencies in the English language

**These words were chosen to test the effects of some other interesting orthographic traits such as silent 'b' and digraphic vowel spellings. They will be more fully analyzed at a later stage.*

Section 2.3: Experimental Procedure

This experiment took place in a sound booth in a small room in Miller Hall on Western Washington University's campus during Winter quarter of 2022. After participants had completed the informed consent process, discussing the goals and risks associated with the experiment and reading a written document detailing the same, they were walked to the sound booth and left to complete the experiment. During the experiment, the 80 words in Tables 1 and 2 were presented to the test subjects one by one on a computer screen. An instructions slide at the beginning of the experiment instructed participants to say each word they saw on the screen, pause for several seconds, and then say the word again. A brief 0.8 second break was then observed before moving on to the next word. These pauses between repetitions and between each of the 81 words (80 unique words with chant appearing twice as discussed in the previous section) were observed in order to prevent the subjects from reading the words as a list, as there is evidence that list intonation can modify vowel duration, thus interfering with the durational data we were hoping to acquire (Grice, Savino, & Roettger, 2019).

The order the words were presented in was semi-random but maintained that two filler words always came between each new focus word. The word order was different for each participant in order to minimize the possibility that fatigue would lead to the words which were always in the latter half of the experiment being said much faster or more erratically than those encountered earlier on (Harrington, 2010). This semi-random order also ensured that the homophone pairs never appeared too near one another, specifically never within 10 words of one another. Because steps were taken to avoid list intonation, we did not feel it was necessary to prevent the target words from coming last in the overall order. However, they were prevented from coming first so that any initial confusion or hesitancy with the procedure could be worked out with the first filler word. The experiment took a total of approximately 15-25 minutes, including the time needed to give initial instructions and walk through the informed consent process.

Section 2.4: Data Analysis Protocols

Both productions of each word were recorded using Audacity recording software and then opened in the Praat analysis software. Working within Praat, the duration of the vowel was measured from the onset to the dissolution of a clear formant pattern. In the case of 'walk'/'wok' F1 and F2 are present during the /w/ glide and so it was the beginning of F3, as well as the onset of a different wave pattern in the waveform, which was taken as the starting point of the vowel segment (always confirmed with a by-ear judgement as well) (Mannell, 2020). We also measured the duration of the final consonant sound in each word. For obstruents, this measurement was taken from the onset of the closure (silence) to the release of that closure, plus 1-2 perturbations in the waveform after that initial release in order to hear the release. Final nasal consonants were measured from where the waveform and spectrogram change significantly from the vowel or /l/ pattern and there is an audible difference of sound quality to the end of the pitch line. If there was a clear release with what sounds like a /b/ or /p/ after the beginning of the nasal sound, that release and any aspiration is not included. Many participants were found to have instances of breathy and creaky voicing in their vowel productions. Both types of voicing were considered legitimate continuations of the vowel sound and were included in the duration measurement, while also being marked separately as breathy or creaky. The total word duration was also recorded, measuring from the designated end point of the final consonant to the beginning of audible noise (excepting instances of pre-voicing or false-starts). All spectrogram analysis used to calculate these durations was completed by the author of this paper. A random sample of the measurements were checked by Dr. Jordan Sandoval to confirm the legitimacy of the measures.

Section 3: Preliminary Findings

After 20 participants' recordings had been fully measured, the resulting durational information was compiled into a master spreadsheet and run through paired T-tests to determine whether the mean duration for vowels and/or final consonants was longer for the words containing silent 'l'. No significant trends were found for absolute duration numbers. This was an expected result due to the significant difference in frequency between the members of each homophone pair. However, by combining the vowel/consonant duration measurements with the total word duration measurements, we were able to calculate percentage-of-whole-word values. Looking at these values, we found that the vowel took up a larger percentage of the total word duration in 'l'-containing words (like 'walk') compared to 'l' less words (like 'wok'). In the 'l'-less words the vowel took up just under 44% of the word duration, in the 'l'-containing words it took up just over 45%. This difference, though small, was found to be statistically significant, with a P-value of 0.017850005. The final consonant duration was found to be impacted in the opposite direction, occupying a smaller portion of the word in the 'l'-containing words than in the 'l'-less words (29.8% vs 31.9%). This difference was also found to be statistically significant, with a P-value of 0.00879691.

	L-less word % vowel	*L word % vowel*
Mean	**0.439353898**	**0.452762783**
Variance	0.012563394	0.013120447
Observations	204	204
Pearson Correlation	0.680730961	
Hypothesized Mean Difference	0	
df	203	
t Stat	-2.114416165	
P(T<=t) one-tail	**0.017850005**	
t Critical one-tail	1.65239446	
P(T<=t) two-tail	**0.03570001**	
t Critical two-tail	1.971718848	

	L-less word % consonant	*L-word % consonant*
Mean	**0.318597653**	**0.2975811**
Variance	0.017944357	0.010939298
Observations	204	204
Pearson Correlation	0.469523102	
Hypothesized Mean Difference	0	
df	203	
t Stat	2.393611633	
P(T<=t) one-tail	**0.00879691**	
t Critical one-tail	1.65239446	
P(T<=t) two-tail	**0.017593821**	
t Critical two-tail	1.971718848	

Table 3: Comparison of the relative duration of the vowel and final consonant in ‘l’ and no ‘l’ words, as represented by percentage of total word duration.

When we separated out just the focus words ending in /m/ and ran the same paired T-test no significant difference was found in either the vowel or consonant duration for those words, while the /k/ ending words in isolation were found to once again confirm the findings from the earlier test, with the differences being even slightly larger now that the /-m/ words were removed.

t-Test: % Vowel Duration for Words ending in k or ck with no pronounced L

	L-less word % vowel	*L word % vowel*
Mean	0.426764768	0.44550979
Variance	0.013707976	0.014411221

Observations	165	165
Pearson Correlation	0.702624071	
Hypothesized Mean Difference	0	
df	164	
t Stat	-2.632165259	
P(T<=t) one-tail	0.004647214	
t Critical one-tail	1.654197929	
P(T<=t) two-tail	0.009294427	
t Critical two-tail	1.974534576	

	L-less word % consonant	*L-word % consonant*
Mean	0.319274354	0.293829584
Variance	0.020966642	0.011812443
Observations	165	165
Pearson Correlation	0.484839145	
Hypothesized Mean Difference	0	
df	164	
t Stat	2.46938056	
P(T<=t) one-tail	0.007279605	
t Critical one-tail	1.654197929	
P(T<=t) two-tail	0.014559211	
t Critical two-tail	1.974534576	

Table 4: Comparison of the relative duration of the vowel and final consonant in ‘l’ and no ‘l’ words which end in /k/, as represented by percentage of total word duration.

	L-less word % vowel	*L word % vowel*
Mean	0.492615602	0.483448521
Variance	0.004354612	0.006700198
Observations	39	39
Pearson Correlation	0.369263203	
Hypothesized Mean Difference	0	
df	38	
t Stat	0.681064437	
P(T<=t) one-tail	0.249980117	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.499960233	
t Critical two-tail	2.024394164	

	L-less word % consonant	*L-word % consonant*

Mean	0.315734688	0.313452899
Variance	0.00536263	0.007139209
Observations	39	39
Pearson Correlation	0.366829499	
Hypothesized Mean Difference	0	
df	38	
t Stat	0.159693613	
P(T<=t) one-tail	0.436984128	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.873968257	
t Critical two-tail	2.024394164	

Table 5: Comparison of the relative duration of the vowel and final consonant in ‘l’ and no ‘l’ words ending in /m/, as represented by percentage of total word duration.

This would appear to support the idea that the switch of phonological voicing identity is what is causing the difference between the ‘l’ and ‘l’-less homophones in terms of their vowel/final consonant durations. However, due to many participants pronouncing the ‘l’ in “calm” and “palm”, the sample size for our T-test on the /-m/ words was much smaller (only 38 data points, compared to 165 data points for the /-k/ words), therefore the lack of significance could be simply due to an inadequate amount of data.

At this stage we therefore do not have enough evidence to support one of the explanatory hypotheses (lengthening caused by activation of phonological voicing rule, lengthening caused by compensatory lengthening, lengthening caused by increase in number of characters used to represent the same sound) over the others. However, excitingly, this data does appear to show that the presence of the silent ‘l’ in these words is impacting the preceding vowel in the manner we had predicted: making it longer before the written silent ‘l’. Analysis of this data set will continue over the Summer of 2022 and beyond as we work to gather more supporting measurements and investigate the cause of this effect.

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