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Anya Hogoboom

Kelsey Renoll

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Position and stress as factors in long-distance consonant metathesis

Anya Lunden and Kelsey Renoll

College of William & Mary, University of Virginia

1 Introduction

Metathesis is a relatively rare linguistic phenomenon which may occur sporadically or as a regular phonological process.[1] The result of sporadic metathesis may co-exist in a language alongside the previous form, or may replace it. Linguists have made significant strides in understanding the driving forces of metathesis in adjacent segments. The relevant factors regarding the metathesis of non-adjacent sounds, however, have received much less attention. This work describes an experiment designed to investigate the effects of position and stress on the metathesis of non-adjacent onset consonants.

There have been a few perceptual studies done in regards to the metathesis of adjacent consonants (Makashay 2001, Graff and Scontras 2010). The only study we are aware of that elicited metathesis is Müller (2014) who looks specifically at metathesis involving liquids, and includes displacement of a liquid within the nonce word as well as the switching of sounds. The current study is unique in eliciting metathesis and investigating the roles of position within the word and of stress, adding to our understanding the forces constraining long-distance metathesis.

The majority of metathesis cases involve the switching of adjacent sounds. We find two adjacent consonants metathesizing, as in the regular phonological

[1]We thank the University of Georgia's Statistical Consulting Center, and specifically Kim Love-Myers, for the statistical analyses and helpful consultation. Additional thanks goes to Conner Kasten for writing the script to randomly select consonants for the stimuli. We thank two anonymous reviewers for their comments and suggestions of as well as the audience at Phonetics and Phonology in Europe 2015. Kelsey Renoll's work on the project was supported by the Charles Center of the College of William & Mary.

process in Faroese that switches [s] and [k] when they are followed by a stop (e.g. /bai**sk**-t/ → [bai**ks**t] 'bitter (neut. sg.);' Seo and Hume 2001). We also find metathesis of a consonant and vowel, as occurs in Leti when a consonant is preceded by a vowel and followed by a consonant cluster (/mor**ut**+kdieli/ → [mor**tu**kd^{j}eli] 'hair+ring=very curly hair;' Hume 1998). Such cases of metathesis can typically be understood to result in preferred surface orders: The reordering in Faroese avoids a configuration in which a stop is flanked by consonants (which is unideal for the realization of acoustic cues to place of articulation in stops; see Jun 2004 and references therein) and the consonant/vowel switch in Leti avoids hetrosyllabic consonant clusters ([mor.tuk.d^{j}e.li], *[mo.rut.kd^{j}e.li]).

Long-distance consonant metathesis, on the other hand, seems to exemplify what Hume (2001) calls the "metathesis myth," that metathesis is sporadic and irregular. Not only are such cases not characterizable as a regular phonological process, they are difficult to find motivation for, and seem to be a kind of word-level spoonerism. For these reasons, long-distance metathesis has not been scrutinized to the degree that adjacent metathesis has in the phonology literature. Mielke and Hume (2001) typologically examine known cases of synchronic metathesis and propose that "cases of non-adjacent synchronic metathesis are rare, if they exist at all." They extend this to diachronic cases, arguing that we would expect diachronic metatheses to reflect possible synchronic metathesis. We argue that while long-distance consonant metathesis is rare, there is ample evidence in the literature that it exists.

The most commonly-discussed type of long-distance consonant metathesis in the literature is the diachronic metathesis of liquids, which has well-known examples from the history of Spanish (*pa**l**ab**r**a* < Latin *pa**r**abo**l**a* 'word,' *mi**l**ag**r**o* < *mi**ːr**aku**l**um* 'miracle;' Buckley 2011). Bloomfield (1933) gives further examples of historical metathesis of [l] and [r] from Germanic languages (Old High German *e**l**i**r**a* ∼ *e**r**i**l**a* 'alder [tree]'; Gothic *we**r**io**lː**s* cf. Old English *we**l**e**r**as* 'lips'). Blevins and Garrett (2004) point to the finding that sonorous sounds like liquids, rhotics, and nasals can have acoustic effects several segments, or even syllables, away from their source, resulting in potential perceptional confusion as to the actual linear location of the segment. The fact that these sounds are the ones that do have wider-spread acoustic cues coincides with the observation by Ultan (1978), in his survey of metathesis, that more sonorant sounds are more likely to be involved in a

position switch.[2]

There are further cases of long-distance metathesis that are not liquid-specific, and are, in some cases, synchronic. Harlow (2007) describes Māori as a language where "examples [of metathesis] abound." While many involve [r], not all do, and no mention is made of the process targeting particular segments, although it is stated as being restricted to consonants in adjacent syllables. We find cases such as *kā**he**ru* ∼ *kā**re**hu* 'spade', and *pae**fe**nua* ∼ *pae**ne**hua* (f → h because *fu) 'dock (the weed)' as well as cases of reduplication where the metathesis is evident in both the base and the reduplicant: ***h**o**n**u**h**o**n**u* ∼ ***n**o**h**u**n**o**h**u* 'nauseous,' *pū**r**o**k**u**r**o**k**u* ∼ *pū**k**o**r**u**k**o**r**u* 'gather up, of garments.' Another language with reported long-distance synchronic consonant metathesis is Samoan. Pratt's (1878) grammar gives several examples (e.g. ***n**ā**m**u* ∼ ***m**ā**n**u* 'a scent', ***l**a**v**aʔau* ∼ ***v**a**l**aʔau* 'to call') alongside a note that "many natives are exceedingly careless and incorrect in the pronunciation of consonants, and even exchange or transpose them without confusion," suggesting that there are many examples of a similar nature. Corfu Greek has multiple cases of (historical) long-distance consonant metathesis: e.g. *ku**r**a**m**a* > *ku**m**a**r**a* 'kurama' [type of plant], ***m**oli**v**i* > ***v**oli**m**i* 'lead' (Linda Lanz, p.c.). We also find two language families of the Americas with a large number of metathesized roots diachronically. Noonan (1997) assembles a large number of cognate sets within the Salish languages where we see an onset consonant switched with a coda consonant in roots, as in Shuswap ***q**'i**w*** 'break' cf. Squamish ***wiq'*** 'open' and Squamish *s-**q**a**ƛ'*** cf. Shuswap *s**ƛ'i**q**t* 'cloud, sky.' Langdon (1976) discusses many cases of diachronic consonant metathesis among the Yuman languages, a good number of which occur with the first and second consonants in the word (e.g. Diegueno-Ipai ***m**ə**x**ətun* ∼ ***x**ə**m**ətun* 'knee', Havasupai ***k**a**t**o* cf. Walapai ***t**a**k**o* 'belly/stomach').

A core question is whether long-distance metathesis is fundamentally different from adjacent metathesis. While both long-distance and adjacent metathesis can be sporadic, only adjacent metathesis seems to be able to occur as a regular phonological process. Even within languages for which

[2]Additionally, liquids are common examples of segments that undergo displacement, a process in which one segment moves to a different position in the word, and which is sometimes folded into the term "metathesis" (e.g. Coffman (2013); Mielke and Hume's (2001) discussion of long-distance movement as being best understood as multiple instances of adjacent metathesis (e.g. Bagnéres-de-Luchon French: **káp**r**a* > (**ca**r**po* >) *c**r**abo* 'goat')). This paper looks specifically at long-distance consonant switches, which are not amendable to this type of analysis.

there are many similar cases, like the Salish languages as discussed above, long-distance metathesis is never regular. Thus, it does seem that regular metathesis is probably confined to segments that are, at some level, adjacent.

However, both adjacent and non-adjacent metathesis can be sporadic. We find many cases of consonant/consonant and consonant/vowel metathesis occurring sporadically; for example, [k] and [s] have metathesized historically in English [æ**ks**] > [æ**sk**] (> [æ**ks**] in some dialects), presumably due to the same auditory pressures that cause fricative-stop metathesis in Faroese, and English *th**ir**teen* is the result of consonant/vowel metathesis (cf. *th**ree***), which results in noncomplex syllable margins.

We can judge the similarity or lack thereof between the types of metathesis by investigating the behavior of long-distance consonant metathesis to see how similar it is to adjacent-segment metathesis. Mielke and Hume (2001) look at the typology of cases of metathesis to conclude that (1) metathesis avoids the initial syllable and (2) metathesis occurs strictly between adjacent segments.[3] Obviously, only the first finding would be relevant for a comparison of the two types. Mielke and Hume discuss that it makes sense that the segments in the initial syllable are unlikely to participate in metathesis because of their importance in word-recognition (e.g. Marslen-Wilson and Zwitserlood 1989). Unfortunately, however, there are not enough cases of long-distance metathesis to clearly show whether the initial syllable is less likely to be involved or not. A major impediment is that words tend to be short, and so the metathesis of onset consonants in a two-syllable word necessarily involves the initial consonant.

Although Mielke and Hume do not examine the role of stress typologically in metathesis, if long-distance metathesis is indeed sensitive to phonological pressures, we might expect the avoidance of metathesis involving segments of stressed syllables, given that stressed syllables are also known to be a privileged position (Beckman 1998). Again, however, it is hard to investigate the distribution of consonants involved or not involved in long-distance metathesis. For example, in order to judge whether privileged positions are indeed avoided, in a language with penultimate stress, we would need to be able to look at multiple cases of metathesis in words of at least four syllables, as this is the shortest word that would permit the metathesis of onsets that belong to neither the initial nor the stressed syllable (e.g. CV.**C**V.CV́.**C**V).

[3]Mielke and Hume use the term "local," rather than "adjacent," but "local" is used differently in the present paper (to refer to metathesis between onsets of adjacent syllables).

Therefore, in order to probe for evidence for these (dis)preferences and investigate whether long-distance consonant metathesis is sensitive to phonologically-privileged positions, we undertook a production experiment to elicit metathesis in long nonce words. We constructed five-syllable CV words that each contained a primary stress and a secondary stress so there was always at least one set of consonants in non-initial, unstressed syllables, allowing us to see whether consonant switching, when it happened, was more likely to happen between those consonants than between consonants in stronger positions. None of the consonants used were liquids so as to exclude consonant manner as a factor.

2 Methods

Thirty-five subjects (aged 19-37, average=21) were recruited through flyers posted at the College of William & Mary. Participants received $10.

Forty-five five-syllable nonce words with CV syllables were constructed. Each word had five different onset consonants, based on random sets drawn from the set of labial and alveolar stops, fricatives, and nasals: [p, b, f, v, m, t, d, s, z, n]. The vowels were the six patterns of /i, u, ɑ/ which do not result in any adjacent identical vowels, and the additional nine patterns with two adjacent identical vowels in the first two syllables, the second and third syllables, and the fourth and fifth syllables.

Each of these 15 vowel patterns were given three different stress patterns, each of which had a primary and a secondary stressed syllable that reflect possible English stress patterns.

(1) Stress patterns

pattern	English word
ὸσσσόσ	*àbracadábra*
σὸσσόσ	*apprèciátion*
ὸσσόσσ	*ùnivérsity*

The resulting nonce words were recorded by a single native English speaker as a noun in two sentences which gave information about the nonce word. Vowels in unstressed syllables were reduced, as per natural English pronunciation. The transcription of the target words in the stimuli is given in Appendix A. After hearing each pair of sentences, subjects were prompted to say the nonce word and another piece of information given.

(2) Example task:

Prompt:	My friend had a *bìfuvazípu*. He was pleased to find that his *bìfuvazípu* had won an award. What did my friend have?
Target response:	A *bìfuvazípu* that won an award.

The fact that each nonce word was presented not only in a sentence but as part of a question-answer pair puts it in the context of an actual noun for the speakers. Although speakers' reproductions of nonce words are more likely to have errors than their production of lexical items (Hartley and Houghton 1996, it has been established that phonological information is accessed by speakers in nonce word repetition tasks (e.g. Gathercole et al 1991), making them appropriate forms for phonological study. The higher error rate associated with nonce word tasks allows for more data of the relevant kind to be collected.

The stimuli were presented auditorily via a listening experiment in Praat (Boersma and Weenink 2013). Subjects were told to listen to each prompt and to answer the question in the format modeled. If they got muddled in their response or otherwise felt that their answer was not correct, subjects were instructed to use the "repeat" button in Praat to listen to the prompt a second time and respond a second time. The repeat button worked only once for each prompt. When speakers were done with a prompt they clicked a button to continue to the next prompt. All subjects heard all 45 prompts, in random order. Subjects wore a Shure WH30 head-mounted microphone connected to a continuously-recording Tascam DR-100.

3 Results

The recordings were listened to and the pronunciation of the nonce words transcribed and compared to their target forms. It was often difficult to identify the vowels with certainty, due to reduction, and so the analysis only considers the consonants. The study found 53 cases of two-consonant metathesis[4] which includes at least one case from 22 subjects and 29 of the nonce words. The metathesized data (and, indeed, the repetitions overall) overwhelmingly had the modeled stress pattern, although in some cases subjects carefully

[4]Note that two of these cases come from a single response, which involved two separate two-consonant switches.

pronounced each syllable, wiping out distinctions between stressed and unstressed syllables. While the other consonants in the word were generally faithfully reproduced (e.g. [dùpə**v**isú**n**ə] repeated as [dùpə**n**ɪsú**v**ə]), 39 there were cases where voicing changes had also occurred (e.g. [bì**f**uvə̲ź**p**u] repeated as [bì**p**uvə̲ś**f**u]), and, occasionally, manner changes (e.g. [zənìs̲i**b**ú**p**ə] repeated as [zənìt̲i**p**ú**b**ə]). In a very few cases the consonant undergoing metathesis was changed slightly, for example, a participant repeated [mìfə**z**ə**d**úni] as [mìfə**d**ə**s̲**úni] which was categorized as a metathesis of the consonants of the antepenultimate and penultimate syllables.

The cases of metathesis were analyzed for consonant position, stress-status of the syllable, and syllable adjacency. No analysis involving consonant identity is possible since the consonants used were not constructed in a balanced design because the focus was on potential word-structure factors.

3.1 Stress patterns

Recall that three different stress patterns were equally represented in the data (see (1)). The dataset comprises 16 cases of metathesis from ὸσσσόσ words (30.2%), 20 cases from σὸσσόσ words (37.7%), and 17 cases from ὸσσόσσ words (32.1%). These stress patterns represent the three possible stress patterns for five-syllable words in English, and are therefore not balanced at the syllable level for stress-status. Two of the patterns include adjacent unstressed syllables, which might be expected to be relatively more prone to metatheses, but instead we see more occurring in the forms with alternating stress. A chi-square test for equal proportions fails to find that any stress pattern resulted in significantly more cases of metathesis than any other ($p = 0.782$). The finding that there is no significant difference between the patterns may be because the dataset is too small for differences to register as significant. While an effect of word-level stress pattern cannot be ruled out, we do see that metathesis certainly occurred under all three stress patterns. The small size of the dataset does not allow for metathesis under the different word-level stress patterns to be analyzed separately and so cases of metathesis will be analyzed at the local level of the stress-status of the syllable, although this obscures the stress pattern of the word.

3.2 Onset metathesis by syllable position

Each nonce word had five consonant positions. The distribution of positions involved in a case of metathesis is shown in (3). Notice that the position of both consonants in each case of consonant/consonant metathesis are considered separately here; thus there are 106 total instances of consonants involved in a metathesis.

(3) Onset metatheses by syllable position

		switched with					
position		1	2	3	4	5	total
initial	1	–	2	0	0	0	2
peninital	2	2	–	10	8	7	27
antepenult	3	0	10	–	5	8	23
penult	4	0	8	5	–	13	26
final	5	0	7	8	13	–	28

All onsets were equally likely to be involved in a metathesis with the exception of the initial onset, which metathesized with another consonant in just two cases. A chi-square test for equal proportions finds that the proportions are unequal among the five syllables ($p < 0.001$), but when run for only the four non-initial syllables, finds no significant difference ($p = 0.972$), demonstrating that non-initial onsets were equally likely to be involved in a case of metathesis and that it was the initial onset only that behaved differently. Consonant position was purposefully not crossed with stress-status in the experimental design and thus these factors must be considered separately. While it is possible that they interact, the clear difference in the likelihood of the first position to be involved in a metathesis and the close to complete equivalence of the other four positions, despite different stress-statuses being grouped together, strongly suggests that the effect of position is sufficiently robust that it may be considered independently from a syllable's stress-status.

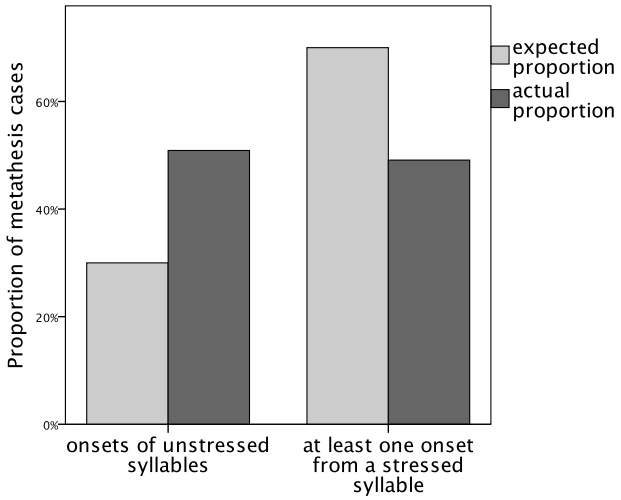
The fact that the onset of the initial syllable was rarely involved in a metathesis is similar to Mielke and Hume's findings for cases of adjacent-segment metathesis, and so we see that adjacent and long-distance metatheses are subject to the same pressure to avoid involving a word-initial segment.

3.3 Onset metathesis and syllable stress

We want to know whether metathesis was equally likely to involve the onsets of stressed syllables as it was the onsets of unstressed syllables. A confounding issue is that there are not an equal number of stressed and unstressed syllables in each word. Since there were unequal chances for each to occur, a straightforward comparison between the number of times the onset of an unstressed syllable switched with the onset of an unstressed or stressed syllable would not be representative of which type of metathesis is actually more likely.

Instead, we need to look at the number of opportunities the stress patterns provided for metatheses to involve the onset of a stressed syllable. Note that metatheses are now being treated in pairs, unlike in the previous consideration of syllable position, where each involved syllable was considered separately. Each word has a possible seven combinations involving one of the stressed syllables and a possible three combinations of unstressed-only syllables. This means that if metathesis occurred at random, regardless of the stress conditions of the syllables of the onsets involved, then we should find 70% of the cases of metathesis involving the onset of a stressed syllable. In fact, only 41.9% of the cases of metathesis involved the onset from a stressed syllable, which is significantly below chance ($p = 0.001$, one-sample binomial test with dependent variable "included at least one stressed syllable" run on paired instances of metathesis against a hypothesized proportion of 70%).

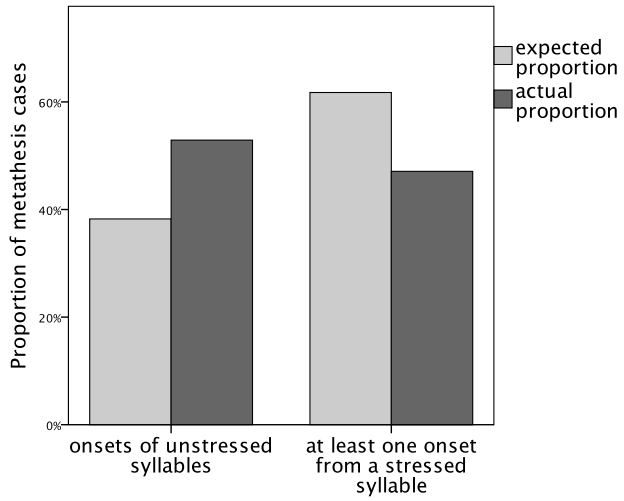
(4) Expected and attested proportions of metathesis cases regarding syllable stress



However, it was previously established that the onset of the initial syllable was very unlikely to be involved in metathesis. Since two of the three stress patterns involve a stress on the initial syllable we want to reexamine the results without this confound. Therefore, we need to compare the expected and attested proportions excluding the initial syllable. The expected proportion of metatheses involving the onset of a stressed syllable is different depending on the stress pattern: 33 cases of metathesis involved a stress pattern that gives a 50% chance of a random case of metathesis involving the onset of a stressed syllable if the initial syllable is excluded, and 18 cases with a stress pattern that gives a 83.33% of a random switch involving a stressed syllable. Thus, if metathesis is equally likely to involve the onset of a stressed or unstressed syllable, then we would expect to see 61.76%[5] involving the onset of a stressed syllable, but we found 47.1%. This falls significantly below the expected proportion of stressed-syllable-involved cases of metathesis ($p = 0.022$, one-sample binomial test).

[5]((33*0.5) + (18*0.8333))/51=61.76%; We have 51 cases of metathesis considered here, rather than 53, since two involved the onset of the initial syllable.

(5) Expected and attested proportions excluding the initial position



We can therefore conclude that unstressed syllables are significantly more likely to participate in onset metathesis. This is consistent with the expectation that weaker positions are more susceptible to change. It is noteworthy, however, that we do find a fair number of cases of metathesis that involve the onset of a stressed syllable, indicating that stressed-syllable onsets are not eschewed to the same degree as initial syllable onsets.

3.4 Locality of metathesis

Metathesis was equally likely to occur between onsets of adjacent syllables (which we will refer to as "local" metathesis) as between non-adjacent syllables ("non-local" metathesis). Since we have seen that the onset of the initial syllable is significantly less likely to participate in metathesis, the first position was excluded from the analysis. Looking only at the remaining four syllables in each word, there are an equal number of local and non-local metatheses possible. Local metathesis accounted for 54.9% of all cases found, which is not significantly different from the expected 50% ($p = 0.575$, binomial test). More data could potentially show a significant tendency for local metathesis. However, it is clear that we do find long-distance metathesis reasonably robustly both between consonants in adjacent syllables and between consonants at greater distances.

3.5 Onset metathesis and syllable stress with regards to locality

Although the onsets of stressed syllables participated in metathesis less than the null hypothesis would predict, we still found a substantial number of instances of metathesis that involved the onset of a stressed syllable. We now turn to examining the role of syllable adjacency in the likelihood of the onset of a stressed syllable being involved in metathesis.

Since we have established that the first syllable is independently unlikely to participate in metathesis, it is excluded from this analysis. Two of the three stress patterns allowed the possibility of three adjacent metatheses, two of which would involve a stressed syllable and one of which would involve only unstressed syllables ((σ̀)σσσ́σ and (σ̀)σσ́σσ). The other stress pattern had no two adjacent unstressed syllables and so is excluded from consideration here.

In the relevant stress patterns, two-thirds of possible local cases of metathesis would involve a stressed syllable and one-third of possible non-local cases would. These are the proportions of metathesis cases that should involve a stressed syllable if metatheses happened at random, regardless of stress.

Narrowing the dataset to only local metatheses in the two relevant stress patterns, we only have 16 cases of metathesis to examine, meaning that the power of any statistical analysis is notably low. Nine of 16 local cases, or 56.3%, occurred with a stressed syllable. A binomial test run on paired instances of metathesis failed to find that local metathesis was significantly more likely to occur with a stressed syllable ($p = 0.263$). While the low power does not rule out some asymmetry in frequency of occurrence, the fact that we see multiple cases of metathesis between the consonants of adjacent stressed and unstressed syllables indicates that such metathesis is not highly unusual, compared to that between consonants of adjacent unstressed syllables.

However, when we instead narrow the dataset to the 17 cases of non-local metathesis, we see that stressed syllables are significantly less likely to be involved with non-local cases of metathesis ($p < 0.001$, binomial test), as only one case involved a stressed syllable, falling significantly short of the expected one-third.

Thus, we must modify our finding in §3.3: The onsets of stressed syllables are less likely to participate in metathesis, but there is only evidence for this dispreference with non-local metathesis. We do not find an aversion to the onsets of stressed syllables being involved in cases where the metathesis

occurs with the onset of an adjacent syllable.

3.6 Narrowing the data set

While the particular consonants involved were not the focus of the study, the similarity between metathesized consonants were examined. Thirty-one of the 53 cases occurred between consonants that differed only in one phonological feature (labial ∼ coronal, [+ voice] ∼ [-voice], [-cont] ∼ [+cont], [+nasal] ∼ [+nasal]). Thirteen differed in two features and 9 differed in three. Of the 31 cases involving only one difference, 18 cases occurred more than twice: p/b (6 cases), b/v (9 cases), s/z (3 cases). These are pairs of sounds that are easy to confuse, and were the type of mistake not uncommonly found among non-metathesis responses in the study. These are therefore potentially independent speech errors (that is, it is possible that [b] was incorrectly said as [v] and that, independently, [v] was incorrectly said as [b]) rather than being true cases of metathesis. Further, many of these switches occurred in the same words: In three cases, particular words stood out as undergoing metathesis relatively frequently. Five subjects pronounced *zanìsi**b**úpa* as *zanìsi**p**úba*, four pronounced *dù**v**utá**b**isa* as *dù**b**utá**v**isa*, and four pronounced *tù**v**ipumá**b**a* as *tù**b**ipumá**v**a*.

If we put these 18 cases aside because of this concern, we are left with 35 cases for which a stronger argument can be made that they are true instances of metathesis rather than two independent speech errors. Looking at this reduced set, however, we see essentially the same distributions as before. It is important to note that the statistical tests in this section may not tell us much in the cases where the null hypothesis is not rejected because of the very low power available in this reduced dataset. The results of statistical tests are reported, however, because there are multiple cases where significance or marginal significance are found, and these are meaningful even when the sample size is small, and also because all but the last test reported find the same results as were found with the full dataset. This suggests that nothing is fundamentally different between the full dataset and the narrowed version.

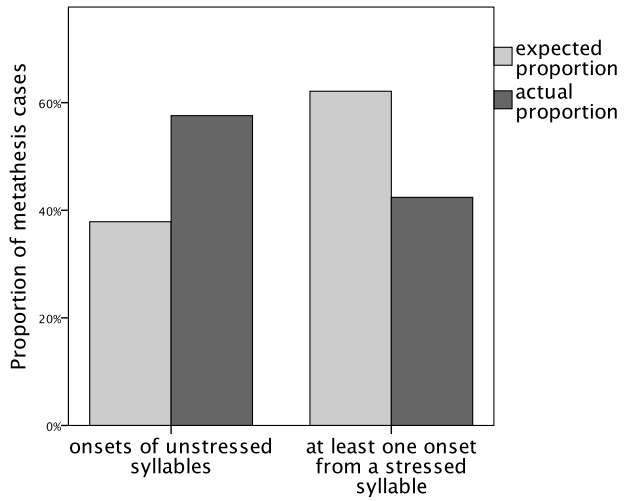
We still see that the first onset resists metathesis compared to all other positions. A chi-square test for equal proportions finds that the proportions are unequal among the five syllables ($p < 0.007$), but when run for only the four non-initial syllables, finds no significant difference ($p = 0.787$).

(6) Cases of onset metathesis by syllable position for reduced set

		switched with					
position		1	2	3	4	5	total
initial	1	–	2	0	0	0	2
peninital	2	2	–	7	4	1	14
antepenult	3	0	7	–	5	8	20
penult	4	0	4	5	–	8	17
final	5	0	1	8	8	–	17

Again, metathesis is no more or less likely with any of the three stress patterns ($p = 0.465$). We still see that metathesis was more likely to affect the onsets of two unstressed syllables. Excluding the first position from the analysis, we would expect 62.12% of all metathesis cases to involve a stressed syllable,[6] but only 42.4% do (14 out of 33). A binomial test finds this to be significantly below chance ($p = 0.016$).

(7) Unstressed/stressed syllables involved in onset metathesis for reduced set



We again do not see that either local or non-local switches occurred more often than expected ($p = 0.486$), once the initial position is excluded. As before, local cases of metathesis are no more or less likely to include a stressed

[6]Twenty-one cases come from stress patterns that give a 50% chance of a stressed syllable being involved in a metathesis, and 13 come from the stress pattern that gives an 83.33% chance, so ((21*0.5) + (12*0.8333))/33=62.12%.

syllable ($p = 0.067$). Before, we found that non-local cases were significantly less likely to include a stressed syllable than the expected 33% of cases. We only see 11.1% involving a stressed syllable, which is statistically significantly different ($p = 0.001$). Thus we see that narrowed dataset yields the same results as the original dataset, allowing us to be more confident that the original findings in fact reflect metathesis (and not independent speech errors).

4 Foot-based observations

Thus far we have simply looked at linear positions within the word. It is pertinent to ask whether foot structure could play a role in whether onset-to-onset metathesis is more or less likely to occur.[7] What would traditionally be assumed as the binary footing for each of the three stress patterns is shown in (8).

(8) $(\grave{\sigma}\sigma)\sigma(\acute{\sigma}\sigma)$
$\sigma(\grave{\sigma}\sigma)(\acute{\sigma}\sigma)$
$(\grave{\sigma}\sigma)(\acute{\sigma}\sigma)\sigma$

The first possible foot-based generalization is that metathesis of onsets is more likely to take place within a foot. If this were a strong tendency then we should find a preference for local metathesis, which could not be established overall, but was found for metatheses involving the onset of stressed syllables. Therefore, the relevant foot-based generalization would be that stressed syllables, specifically, are more likely to be foot-bound in cases of onset metathesis. There are 24 instances of metathesis involving the onset of a stressed syllable, and 23 of them involve the onset of an adjacent syllable. Of those 23, 14 occur within a foot, and 9 occur across a foot boundary, as per the footing shown in (8). If we narrow the dataset as per the discussion in §3.6, we then have 8 cases of foot-bound metathesis and 6 that go across a foot boundary. While the dataset is too small to show if there is any level of preference for same-foot metathesis, the similar numbers of each at least show that there is not a strong preference of foot-bound metathesis. Thus, a preference for foot-bound metathesis does not appear to the be the cause of the locality preference of metathesis involving stressed syllables.

[7] My thanks to an anonymous reviewer for suggesting looking at parallel positions, à la the onsets of different words in spoonerisms. Additional thanks to Amalia Arvaniti and Nick Kalivoda for suggestion of, discussion of, foot-based possibilities.

The second possible foot-based generalization is that switches are more likely to occur in parallel positions: that is, that onsets of strong members of different feet, or of weak members of different feet are more likely to metathesize. We only have one case of the onsets of two stressed syllables metathesizing, which necessarily come from parallel foot positions. The relevant question therefore is whether there is a parallel position preference for cases of metathesis of the onsets of two unstressed syllables. The parallel unstressed positions are shown in (9) along with the found number of cases. The number in parentheses is the number of cases in the narrowed dataset, where different from the full dataset.

(9) Cases of non-local metathesis of onsets of unstressed syllables

parallel positions							
	↓ ↓			↓ ↓		↓ ↓	
	(σ́σ)σ(σ́σ)	6 (2)		σ(σ́σ)(σ́σ)	4	(σ́σ)(σ́σ)σ	7 (3)
not parallel positions							
	↓ ↓			↓& ↓or ↓		↓ ↓	
	(σ́σ)σ(σ́σ)	3		σ(σ́σ)(σ́σ)	0	(σ́σ)(σ́σ)σ	0

There does seem to be a preference for non-local metathesis of the onsets of unstressed syllables to occur in parallel foot positions, given the 17 cases found in parallel positions compared to the 3 cases found in non-parallel positions. However, any long distance metathesis involving only unstressed syllables in the middle stress pattern in (9) would necessarily involve the initial syllable, and so we might want to put that stress pattern aside, as we know independently that the onset of the initial syllable avoids participating in metathesis. The larger numbers of the full dataset do still suggest that parallel positions may well be a factor in the likelihood of non-local metathesis involving the onsets of unstressed syllables.

5 Discussion

The target words were created to allow us to study the tendencies relating to long-distance consonant metathesis. What we found reflects the typological findings of Mielke and Hume as far as they could: long-distance consonant metathesis clearly avoids initial syllables. This commonality between adja-

cent and non-adjacent metathesis suggests that the two types are not dissimilar. Mielke and Hume's other finding, that metathesis occurs between adjacent segments was not relevant for the investigation at hand. While not discussed by Mielke and Hume, we might expect segments in stressed syllables to also avoid metathesis. Of course, all consonants were onsets, and thus not part of the rhyme of the syllable, which is typically considered relevant for, and particularly affected phonetically by, stress. While stress did not play a role in whether or not consonants of adjacent syllables switched, the onsets of stressed syllables resisted participation in metathesis at longer distances. It is not clear why the onsets of stressed syllables should be less likely to participate in longer-distance metathesis specifically. No preference for foot-bound metathesis of the onsets of stressed syllables was found in the data, which, if present, would have explained the avoidance of non-local metathesis.

If long-distance consonant metathesis is indeed of the same ilk as adjacent segment metathesis, we must explain why (1) there are no regular cases of long-distance metathesis and (2) it is so much less common than adjacent-segment metathesis.

For the former, we suggest that there is no principled way for long distance metathesis to regularly occur. If metathesized consonants are constrained to the same syllable position, then there could be no well-formedness motivation for consonants to switch, as an onset would always be an onset, just of a different syllable. There is no "phonological betterment" pressure for long-distance metathesis. It is possible that long-distance consonant metathesis is not actually constrained by syllable position, and segments in different positions can in fact metathesize. This would mean that, in principle, long-distance consonant metathesis could result in an improved surface form. For example, a language could regularly metathesize a word-final onset nasal with the stop coda of an unstressed syllable: e.g. hypothetical /kahə**p**fa**n**i/ → [kàhə**n**fá**p**i], so that the more sonorous segment was in coda position and the less sonorous on onset position; a preferred position for each (Hooper 1976, Murray and Vennemann 1983). However, phonology is not expected to be able to scan such a large domain without reference to some kind of identifiable prosodic edge(s). Therefore we suggest that regular long-distance processes do not exist because the ones that could be phonologically motivated cannot be phonologically referenced.

The fact that there is no clear benefit to long-distance metathesis, coupled with the finding that word-initial consonants are unlikely to metathesize,

explains why long-distance consonant metathesis is particularly rare among cases of metathesis, which, in any form, is already a relatively rare phonological phenomenon. It is important to note that metathesis involving the initial segment was not unattested in our results, it was just unusual. This would seem to correspond reasonably well with the existence, albeit uncommon cross-linguistically, of long-distance consonant metatheses of the variety found in Samoan, e.g. *geno* ∼ *nego* 'to nod, to beckon' (Pratt 1878). Many of the examples of this phenomenon, as shown in the introduction, do involve the initial consonant. However, the commonality of short words makes this unsurprising.

An interesting, and still unexplained, observation is that languages seem to either eschew (non-liquid-specific) long-distance metathesis altogether, or allow it not-uncommonly, like Samoan and Māori do synchronically, and the Salish and Yuman languages appear to have done historically. Perhaps, of course, there are languages where it occurs in only a few forms: Corfu Greek is a possible example. But it is striking that most languages that allow, or have allowed, long-distance metathesis, are either documented as allowing it extensively (among the Salish and Yuman languages) or are described as commonly allowing it (Samoan and Māori).

6 Conclusion

While long-distance consonant switchings are common as examples of historical metatheses, these cases are rarely addressed in the metathesis literature because they do not occur as regular phonological processes. This study demonstrates that we can experimentally duplicate long-distance consonant metathesis of the type found in Samoan, Māori, and other languages. It establishes the positional pressures on this kind of metathesis; something that a typological survey would be unable to do, as naturally-occurring examples are too limited and too short to explore these questions. Specifically, we found the same avoidance of the initial onset as is found with adjacent segment metathesis, and some avoidance of consonants in stressed syllables, showing that long-distance consonant metathesis is not insensitive to phonologically-privileged positions.

Taking into consideration that long-distance consonant metathesis does not result in a better linear order and the ubiquity of short words, we can understand why long-distance consonant metathesis is the rarest type of the

already-uncommon phenomenon of metathesis.

Appendix A

(10) All stimuli, with cases of onset/onset metathesis

a.	ὸσσσόσ	Cs switched	subject
	bìfuvəzípu	2,5	21
	dùpəvisúnə	3,5 x 2	14, 18
	vàsidutápi	–	
	nàzuvisámu	3,5	14
	tùzipəsúbi	3,4	23
	tìzəsudípə	3,4; 4,5	12; 3
	tìmivudánu	2,5	1
	bùdutəfínə	–	
	màbəsipúvi	3,4	25
	tìmudufápi	2,3	7
	dàmisipúbə	–	
	mìfəzədúni	3,4	26
	sànupəvízi	–	
	dìtəpivúnu	2,3	14
	tùvipumábə	2,5 x 4	1, 3, 13, 21

b.	σ̀σσ́σ	Cs switched	subject
	nɪpùdəvífu	–	
	dʊtàvizúpə	4,5; 2,3	12; 27
	zəvìtufámi	1,2	6
	vəfùsipátu	1,2; 2,3	18; 19
	bʊvìnəmúfi	–	
	vɪfàtumíbə	–	
	tɪsìvunádu	3,5 x 2	24, 25
	tʊvùfəpíbə	2,5	16
	vədàfizúni	2,4	18
	tɪbùzufási	–	
	zənìsibúpə	4,5 x 5	5, 9, 12, 17, 31
	fʊmàbəzúdi	–	
	səfùtənívi	2,3; 4,5	26; 29
	pɪvàmizútu	2,3; 3,5	23; 14
	fʊpìtudásə	2,3; 3,5	16; 19

c.	σ̀σσ́σ	Cs switched	subject
	mìvufánitu	–	
	sùpədítumə	4,5	21
	bàvifúnədi	–	
	sàtumíbənu	–	
	sùpimávuni	4,5	31
	pìzədúbifə	4,5	18
	vìzidúsəmu	–	
	dùvutábisə	2,4 x4; 3,5	6, 16, 23, 25; 23
	zànətívumi	–	
	vìsuzúpədi	2,3 x3	12, 18, 26
	fàvinítumə	–	
	tùdəsánuvi	2,4 x2; 4,5	11, 19; 3
	vàbutádifi	–	
	nìdəzívupu	2,4; 4,5	1; 14
	vùzibúpəmə	3,4	12

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