Disentangling Stress and Pitch Accent in Munster Irish

Joseph W. Windsor, Stephanie Coward, and Darin Flynn

1. Introduction

In her analysis of Connemara Irish (CI) prosody, Elfner (2015: 1173) states that because phrasal pitch accents and word stress are realized on the same syllable (each word in Irish typically only ever having a single stress), stress in that dialect can be realized by pitch when a word is accented. Due to the distribution of pitch accents that Elfner provides evidence for, it is rarely the case that any prosodic word will go unaccented. But, in those rare circumstances where a prosodic word does have a stress but no accent, what are the phonetic characteristics of stress devoid of accent? Another unanswered question from Elfner's analysis of pitch accent distribution is, can the distribution analyzed in CI be extended to other dialects, and if so, are the phonetic realizations of stress and accent in those other dialects the same as those in CI?

In this article, we independently confirm Elfner's (2012, 2015) results for pitch accent distribution in CI. We then utilize Elfner's findings to isolate target nouns in a syntactic/prosodic environment such that they are realized without phrasal accents. This allows us to study the phonetic correlates of word stress when not compounded by accent (*cf.* Hyman 1977). We find that in CI, in accordance with Elfner's previous findings, one phonetic correlate can be used to recognize both word-level stress and phrasal accents. We then extend the analysis of CI to two varieties of Munster Irish (MI) as provided by a speaker of Cill na Martra Irish, Co. Cork and a speaker of an tSeanphobail Irish, Co. Waterford. We find that phrasal accents in MI are distributed by the same phonological structures as CI but that the phonetic instantiations of stress and accent in these varieties are completely separate. Additionally, we find that accents and word stress are not as rigidly aligned in MI varieties as they are in CI.

Finally, the differences between the previously observed CI patterns and those reported here from MI are used to inform a hypothesis regarding the origins of a phenomenon of stress shift in MI that is not present in most other varieties. We conclude that the accent distribution and phonetic realization provide evidence that CI is what Gordon (2014) calls a bottom-up language in his typology of prominence assignment. By contrast, MI is a top-down language – a typological variant that typically presents with edge repulsion effects (*cf.* Blakenhorn 1981; Dalton & Ní Chasaide 2003), which may account for the stress shift present in that dialect. We use this conclusion to suggest a hypothesis into the origins of stress shift in MI varieties.

* Joseph W. Windsor, Stephanie Coward, and Darin Flynn, University of Calgary. Corresponding Author: Joseph W. Windsor: jwwindso@ucalgary.ca We wish to thank our Irish consultants, Darina, Muireann, Siobhán, and Caitríona as well as research assistants, Maggie Bonsey, Katherine Gerke, and Stéphanie Chicoine. We would also like to thank professors Máire Ní Chiosáin and Gearóid Ó Domagáin for their valuable feedback on the stimuli used for this study, as well as the professors and graduate students at University of Calgary and the Ulster University. A special thank you to Frances Kane for theoretical discussions on many of the stimuli used in this research. Finally, thank you to the audiences of CLA 2016, CLC 9, ACOL 2016, and WCCFL 35 for your valuable feedback. This research was supported by the Social Sciences and Humanities Research Council of Canada.

 Proceedings of the 35th West Coast Conference on Formal Linguistics, ed. Wm. G. Bennett et al., 430-437. Somerville, MA: Cascadilla Proceedings Project.

1.1. Accent distribution

Using a Match Theoretic approach to the syntax-phonology interface (Selkirk 2009, 2011), Elfner (2012, 2015) discovered that the distribution of two types of pitch accents could be predicted by the syntactic structure of an utterance. Using the constraint ranking BINARITYMINIMUM (BINMIN) ≫ MATCHPHRASE ≫ MATCHWORD (defined below), Elfner showed how the prosodic hierarchy of an utterance was nearly isomorphic to the structure at syntactic spell-out.

(1) BINARITYMINIMUM (BINMIN) (Elfner 2015: 1180)
A φ constituent in the prosodic representation must dominate a minimum of two ωs.

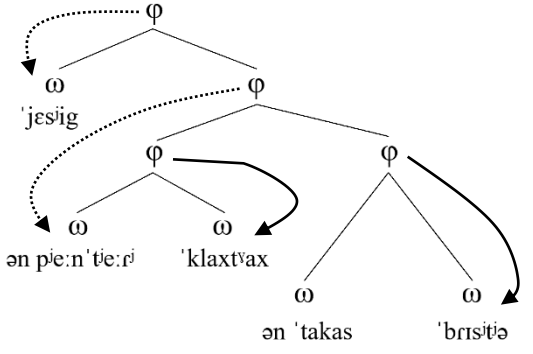
(2) MATCHWORD (Selkirk 2011: 439)
A word in syntactic constituent structure must be matched by a corresponding prosodic constituent, call it ω, in phonological representation.

(3) MATCHPHRASE (Selkirk 2011: 439)
A phrase in syntactic constituent structure must be matched by a corresponding prosodic constituent, call it φ, in phonological representation.

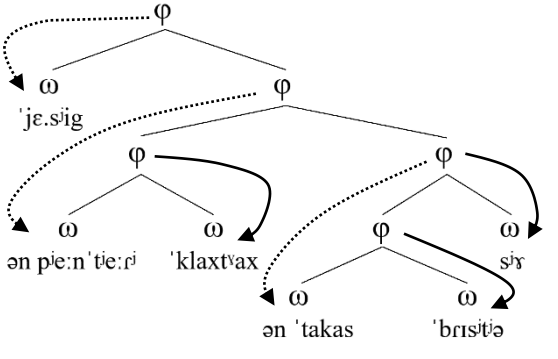
Elfner used the constraints in (1-3) to show how XPs in the syntactic structure were matched as phonological phrases (φ) in prosodic structure with one important exception for the present analysis: non-branching adjective phrases (APs) violate BINMIN if matched as a φ, and were therefore realized only as ωs.

By using the structure created by the above constraints, Elfner examined the distribution of phrasal accents in various CI utterances and concluded that each φ provides an HL accent to its rightmost daughter (solid-line arrows) and that each $\varphi^{\text{non-min}}$ provides an LH accent to its leftmost daughter (dotted-line arrows), as depicted in (4a). Utilizing the same constraints to form prosodic structure, Windsor (2016) concluded that demonstratives (*seo* 'this', *sin* 'that', and *siúd* 'yon') dominate DPs and provide the structure necessary to force a pitch accent onto otherwise accentless object nouns, as depicted in (4b):

(4a)



(4b)



a. LH LH HL HL
ˈjɛsʲig ən pʲeːnˈtʲeɾʲ ˈklaxtˠax ən ˈtakas ˈbɾɪsʲtʲə
fixed the painter experienced the easel broken
'the experienced painter fixed the broken easel'

b. LH LH HL LH HL HL
ˈjɛsʲig ən pʲeːnˈtʲeɾʲ ˈklaxtˠax ən ˈtakas ˈbɾɪsʲtʲə sʲɤ
fixed the painter experienced the easel broken this
'the experienced painter fixed this broken easel'

The differences between the structures in (4a) and (4b) above allow a lexical item to be elicited both with and without a pitch accent in the same position within the breath group, thus allowing the direct comparison between the two forms. Further, it provides a frame for eliciting an accentless lexeme for the study of stress which is not compounded by accent.

1.2. Extending the analysis to Munster Irish

The distribution of phrasal accents was established for CI in Elfner (2012, 2015) and in Windsor (2016). Bennett *et al.,* (forthcoming) suggest that the same distribution of accents was found in Ulster Irish, examining the variety spoken in Donegal. They suggest that the primary difference in the realization of pitch accents across Irish dialects "resides in the shape of the tunes used rather than their distributions" (personal correspondence 2017) (see also Quiggin 1906 or Dalton & Ní Chasaide 2005, 2007). Before investigating the phonetics of stress and accent in MI, it was first necessary to confirm that the distribution of accents followed the same pattern in that dialect. That confirmation was done by testing the difference between dialects based on accent realization on nouns in subject position (Subject Condition), in object position (Object Condition), and in object position modified by a demonstrative (Demonstrative Condition) using a chi-squared test in R (R core team 2013). The results of the chi-squared test are presented in Table 1:

	Subject Condition		Object Condition		Demonstrative Condition	
	CI	MI	CI	MI	CI	MI
Pitch accent present	57	45	21	15	55	40
Pitch accent absent	19	14	55	41	21	19
χ^2	0.029061		0.011631		0.33296	
p	0.865		0.914		0.564	

Table 1: Confusion matrix of accent distribution in CI and MI with chi-squared tests

As can be determined by the results presented in Table 1, there are no significant differences between the two dialects in terms of accent distribution. Using further chi-squared tests to account for the presence or absence of pitch accents using the combined numbers above, we can conclude that pitch accents can differentiate between nouns in subject vs. object conditions ([$\chi^2 = 63.32$; $p < 0.001$]) and between nouns in object vs. demonstrative conditions ([$\chi^2 = 50.6192$; $p < 0.001$]), but not between nouns in subject vs. demonstrative conditions ([$\chi^2 = 0.92$; $p = 0.337$]). These results show that there is no significant difference between the two dialects in terms of accent realization, but that there is a significant contrast between accent realization in object versus demonstrative conditions: Accents are not realized in the object condition but are realized in the demonstrative condition.

1.3. On stress shift in Munster Irish

While stress is realized on the left edge of the word in CI with very few exceptions, a pattern of stress shift to the second or third syllable is one of the major distinguishing characteristics of the MI dialect. There is little consensus about the prosodic representations of lexemes with shifted stress in MI – whether they are best accounted for by a particular prosodic structure such as the colon, recursive metrical feet, or recursive syllable structure (Green 1996, 1997; Gussmann 1997; Thrift 1999; Ó Sé 2008; Iosad 2013) – but it is generally agreed upon that stress is shifted to a heavy syllable, maximally the third syllable from the left edge of the word. As shown in (5) below, alignment of stress to the left edge of the word remains the default pattern in MI, and an initial syllable is stressed if heavy unless it is immediately followed by another heavy syllable.

Iosad (2013 and references therein) analyzes a heavy syllable as one containing a long vowel and argues that coda consonants (at least in MI) are non-moraic, or at least do not add to syllable weight.[1] He provides the following list compiled from Ó hÓgain (1984) and Ó Sé (2000) as examples of the possible syllable templates and of how stress is allocated in MI.[2]

(5) Word types and stress in MI (Ó hÓgain 1984 and Ó Sé 2000 qtd. in Iosad 2013: 68)

a.	ĹL	*Carraig*	[ˈkarɪgʲ]	‘rock, boulder’
b.	ĹLL	*Clagarnach*	[ˈklagərnex]	‘clattering’
c.	ĹLLL	*Armacach*	[ˈarəməkəx]	‘tender’
d.	ĹLLH	*Imleacán*	[ˈimʲɪlʲəkɑːn]	‘navel’
e.	ḾL	*Álainn*	[ˈɑːlɪnʲ]	‘nice, beautiful’
f.	ḾLL	*Cúramach*	[ˈkuːrəməx]	‘careful’
g.	ḾLH	*Údarás*	[ˈuːdərɑːs]	‘authority’
h.	ḾLHL	*Údaráiseach*	[ˈuːdərɑːʃəx]	‘authoritative’
i.	ḾLHH	*Amparánaíocht*	[ˈoumpərɑːniːxt]	‘ungainliness’
j.	LḾ	*Cailín*	[kaˈlʲiːn]	‘girl’
k.	LḾL	*Coiméadann*	[kʲɪˈmʲɑːdən]	‘(s/he) observes’
l.	LḾH	*Bithiúntaíocht*	[bʲɪˈhuːntiːxt]	‘villany’
m.	LLḾ	*Ceannaitheoir*	[kʲanəˈhoːrʲ]	‘buyer’
n.	LLḾH	*Amadántaíocht*	[əməˈdɑːntiːxt]	‘foolishness’
o.	HḾ	*Díomhaoin*	[dʲiːˈviːnʲ]	‘idle’
p.	HḾL	*Ógánach*	[oːˈgɑːnəx]	‘young man’
q.	HḾH	*Amhránaí*	[uːˈrɑːniː]	‘songs’

All the forms provided in (5) are realized with initial stress in CI, unlike in MI. This dialectal difference raises another interesting question: is accent aligned to the left edge of a ω, to the stressed syllable, or do alignment strategies differ according to dialect?[3]

2. Methodology

Using the type of sentences provided in (4a, b) above, 40 target nouns were embedded into sentences in each of the three conditions and randomized with 40 filler tokens for a total of 160 sentences. Four participants were recruited to provide production data. To independently confirm the results of Elfner (2012, 2015), two female native speakers (18-25 years old) were recruited from the same dialect region used in the Elfner’s study, from the town of an Ceathrú Rua, Co. Galway. One female native speaker in the same age range as the Galway speakers was from Cill na Martra, Co. Cork, and the other MI speaker was a female native speaker aged between 30-40 years old from an tSeanphobail, Co. Waterford. All participants use Irish on a daily basis outside of academic settings.

Participants were presented the 160 sentences using Powerpoint, asked to read the sentences to themselves, and then say them as naturally as possible – as if speaking to a friend. Elicitations were conducted entirely through the medium of Irish. Sessions were recorded on a Zoom H4n digital stereo recorder with internal microphones set to 90º and recording level set to 90. A windsock was used over the device to eliminate any background noise that existed in the rooms.

The elicited data were loaded into Praat (Boersma & Weenink 2016) for analysis. The target nouns in each of the sentences were isolated and syllables were analyzed for maximal, minimal, mean, and

[1] Ní Chiosáin (1991) explains epenthetic vowels in words like *gorm* ‘blue’ (/gorm/ → [gorəm]) as the result of a condition on maximally bimoraic syllables with epenthesis used to prevent the two sonorant coda consonants from creating one superheavy syllable.

[2] Words containing four or more syllables are exceedingly rare in Irish.

[3] The target noun *siompóisiam* ‘symposium’ was eliminated from the studies reported here because it presented as a loanword, maintaining English-like stress. However, the pitch accent elicited on this target from CI speakers did align with the stress, which was realized on the second syllable. This fact alone suggests that, at least in CI, accent is aligned to the stressed syllable, not the word edge.

range of both pitch (Hz) and amplitude (dB). Vowel length (ms) was also recorded. The same syllables were measured in both accented (demonstrative condition) and accentless (object condition) nouns for direct comparison. Immediately adjacent syllables were also measured for the same variables to allow for subsequent analyses of stress. If a noun had final stress (*i.e.*, did not have a syllable directly following the stressed syllable), the token was eliminated from the study.

All of the phonetic data was analyzed in R (R core team 2013) using a Generalized Linear Model with binomial distribution to discover the predictors of accent and stress. Differences between dialects and token types (*i.e.*, stress-initial vs. shifted-stress tokens) were also evaluated in R using chi-squared tests.

3. The phonetics of stress and accent

3.1. Measures of stress and accent

The phonetic correlates of stress and accent are represented below in Table 2:

	CI	MI
φ-Prominence (accent)	Range Hz : Mean Hz [G^2 (1, 435) = 10.016; p = 0.001]	Min Hz : Mean Hz [G^2 (1,352) = 30.714; p = 0.003]
ω-Prominence (stress)	Range Hz : Range dB [G^2 (1,139) = 8.4895; p = 0.007] Max Hz : Range dB [G^2 (1,140) = 11.8231; p < 0.001]	Max Hz : Range dB : Max dB [G^2 (1,107) = 11.1146; p = 0.012]

Table 2: Phonetic correlates of stress and accent by dialect

The general phonological conclusions we can reach, based on the statistical testing, are that accent can be predicted by an interaction with the mean pitch (Mean Hz), and that stress can be predicted by an interaction with the range of amplitude change across the syllable (Range dB). The difference between the two dialects lays in which variables interact with Mean Hz/Range dB to produce the significant result. Vowel length was not found to be a significant predictor of prominence in any of the models tested.[4]

Considering the CI dialect, we can see from Table 2 that there is a common correlate used to predict both accent and stress in this dialect: both accent and stress can be predicted based on interactions with the range of pitch across the syllable (Range Hz). Accent is predicted based on an interaction between the range of pitch across the syllable (Range Hz) and the mean pitch in the syllable (Mean Hz). Stress is predicted based on two interactions with the range of amplitude change across the syllable (Range dB), one with the range of pitch across the syllable (Range Hz), and one with the maximal pitch (Max Hz).

The MI dialect differs from CI in that the interactions used to predict accent and stress are somewhat different, and, more importantly for the present study, do not show that a common correlate is used to predict both accent and stress. Once again, we can see from Table 2 that accent can be significantly predicted by an interaction between the minimum level of pitch (Min Hz) and the mean level of pitch (Mean Hz). Stress, on the other hand, was significantly predicted by a three-way interaction between the maximal pitch (Max Hz), the range that amplitude changed across the syllable (Range dB), and the maximum amplitude (Max dB). We draw your attention specifically to the fact that there is no common phonetic correlate that is used both in the prediction of accent and stress in MI.

We will return to the importance of the fact that there is a common correlate for predicting stress and accent in CI, but not in MI in §4, but first, we review findings on the temporal alignment of stress and accent which will bear on that discussion.

[4] A Linear Discriminate Analysis failed to accurately classify /i/ vowels, for example, as belonging to stressed or unstressed syllables 50% of the time, performing exactly at chance.

3.2. Temporal alignment of stress and accent

In the CI dialect, as stated when referencing Elfner (2015) in §1, accents are invariably realized on the stressed syllable of a given lexeme. No CI tokens elicited for the present study displayed any misalignment of stress and accent (*cf.* fn. 3 above). The same cannot be said of the MI dialects. Temporal misalignment of stress and accent was observed in 34% of MI tokens analyzed in the present study. Lexemes with shifted stress displayed misalignment in a little over 50% of tokens, accounting for 70% of the misalignment found overall. Table 3 below gives the number of tokens in each category and the significant differences between columns.

	All Speakers/Tokens		MI Speakers Only	
	CI	MI	Stress-initial	Shifted stress
Aligned	132	90	56	32
Misaligned	0	47	14	33
χ^2	54.872		14.06	
p	< 0.001		< 0.001	

Table 3: Analysis of stress-accent alignment by dialect and stress type

As can be seen in Table 3, the amount of misalignment evidenced in all tokens is significantly different between MI and CI (the latter of the two displayed no misalignment). Looking only at the MI speakers, misalignment was evidenced more often in tokens with shifted stress than those with initial stress, a significant difference between the two groups. Like the fact that CI stress and accent have a common phonetic correlate for both stress and accent but MI does not, the fact that MI displays significantly more stress-accent misalignment than CI, especially in shifted stress tokens, is also important for the discussion of how these phonetic facts support a hypothesis on the diachronic origins of stress shift in MI due to tonal crowding and edge repulsion effects (Gordon 2014).

4. Discussion: Temporal misalignment, edge repulsion, and stress shift

The principal phonetic findings of this study are that there is a common variable used in the realization of both stress and accent in CI, but no common variable that can be used to predict both levels of prominence in MI dialects. Additionally, in the CI dialect where there is a common phonetic predictor for stress and accent, the two levels of prominence are realized on the same syllable – almost always at the left edge of the word (*cf.* fn. 3 above). The MI dialect, on the other hand, displays a higher rate of temporal misalignment between stress and accent, and a higher rate again when stress-initial tokens are compared to shifted stress tokens (as summarized in Table 3 above showing that the differences are significant). We now discuss these findings with respect to Gordon's (2014) typology of prominence and we suggest that the tonal crowding and edge repulsion effects described therein provide a plausible diachronic explanation for stress shift in MI varieties.

In his description of prominence assignment, Gordon (2014) describes two typological variants: languages that assign ω and φ prominence top-down, and languages that assign those prominences bottom-up. Based on the results of this study, we find that CI is consistent with a bottom-up approach to prominence assignment: the fixed alignment of stress and accent suggests that stress is assigned to a particular syllable and then accent from the phrase is aligned with that syllable. This fixed alignment is a hallmark of bottom-up languages where prominence from several levels of the prosodic hierarchy are all realized on the same syllable. The variable alignment strategies of MI speakers are consistent with a top-down approach to prominence assignment: the accent is assigned by the phrase independently of where word stress is assigned. Variable alignment is a hallmark of top-down languages according to Gordon's typological study, where accent is frequently found to not associate with the primary stressed syllable of the word.

Another aspect of top-down languages, and perhaps what provides the diachronic pressure for accent and stress to be realized on separate syllables, is tonal crowding. Tonal crowding occurs when

multiple tones are realized on a single syllable. The realization of multiple tones on a single syllable in turn leads to edge repulsion effects where one of the tones is forced away from the edge of the word that it typically aligns with in order to prevent tonal crowding. Gordon considers edge repulsion effects at the left edge of a φ relatively week. He hypothesizes that such examples of tonal crowding would stem from an interaction with the left edge of an utterance. However, in the case of MI, we observe that the interacting tones are at the levels of the ω and φ. These prosodic constituents provide a stronger motivation for edge repulsion effects than the utterance would (being more robust in the input). Therefore, we extend Gordon's analysis to MI to suggest that these effects may explain the phonetic conclusions of the present study. Our hypothesis is that since CI uses a common phonetic cue to realize both stress and accent, this minimizes the effect of tonal crowding: one tone serves two purposes, rather than having two separate tones realized on a single syllable. However, since MI varieties have no common phonetic correlate to realize stress and accent, realizing both tones on a single syllable would lead to tonal crowding. The tonal crowding that would have been present in MI could in turn lead to edge repulsion effects, providing diachronic pressure to realize the two tones on separate syllables, which could in turn be phonologized as a stress-shift rule.

This hypothesis is consistent with the phonetic data examined in the present study, which provides evidence in support of the intuitions of Dalton & Ní Chasaide (2003) who suggest, in passing, that the patterns of MI stress shift may have developed from a temporal misalignment with pitch accents (*cf.* Blakenhorn 1981). This hypothesis also explains why misalignment is significantly more common in tokens displaying shifted stress (stress shift being the phonologized process to resolve tonal crowding), but is still attested in tokens with initial stress – the accent being realized outside of the default position on the left edge of the word, on a later syllable.

5. Conclusion

The data presented here support the hypothesis that a primary difference between CI varieties and MI varieties distills down to typological differences in stress assignment: CI is a bottom-up prominence assigning variety and MI is a top-down stress assigning variety (in Gordon's 2014 terminology). We can draw no firm conclusions as to the direction of change which ultimately resulted in a stress shift phenomenon in MI varieties. However, the phonetic data provided here are consistent with the hypothesis that the phonetic implementation of stress and accent in MI varieties lead to tonal crowding which provided diachronic pressure to move either stress or accent away from the left edge of the word. That diachronic process, under the present hypothesis, would have eventually been phonologized as a stress shift phenomenon.

The opposite direction of change, that stress shift facilitated the realization of stress and accent by separate phonetic cues, is a plausible alternative hypothesis, though perhaps not quite as probable given that misalignment only occurred in 34% of analyzed tokens. If stress shift was the catalyst that caused the different levels of prominence to be implemented using different phonetic strategies rather than vice versa, one might expect the temporal misalignment of the two tones to be far more regular across all tokens. On the other hand, if tonal crowding was the catalyst for the change leading to the eventual phonologization of the stress shift patterns, one might expect to find significantly more temporal misalignment in those tokens; this is exactly what was found, with 70% of the misalignment being observed in tokens with shifted stress.

While we find the evidence presented here compelling, we simply cannot make a firm conclusion as to what the diachronic catalyst of change was. Further study of other varieties of Irish is needed to support or reject the hypothesis advanced here. In particular, this study should be replicated on varieties spoken in East Mayo which, although being a regional variety within the Connemara dialect area, show similar stress shift patterns to varieties spoken in Munster (Lavin 1957; Dillon 1973; Green 1997). If the hypothesis advanced here is correct, one would expect the same phonetic patterns found in MI to hold true of the varieties spoken in East Mayo. Similarly, although the precise measurements of tonal alignment were different from the present study, Dalton & Ní Chasaide (2007) suggest that there is alignment variation between micro-dialects of CI and suggest that a variety spoken on Inis Oirr, Co.

Galway has a more variable alignment strategy for pitch targets than the nearby variety spoken in Cois Fharraige (very near to the Ceathrú Rua variety examined in the present study). It would be enormously beneficial to examine the alignment of pitch and accent, as well as the phonetic correlates of each, in that regional variety as well. Finally, cross-linguistically, one might expect that other languages described in Gordon's (2014) typology as top-down languages would show similar phonetic patterns to those found here in the Cill na Martra and an tSeanphobail varieties.

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Proceedings of the 35th West Coast Conference on Formal Linguistics

edited by Wm. G. Bennett, Lindsay Hracs, and Dennis Ryan Storoshenko

Cascadilla Proceedings Project Somerville, MA 2018

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Windsor, Joseph W., Stephanie Coward, and Darin Flynn. 2018. Disentangling Stress and Pitch Accent in Munster Irish. In *Proceedings of the 35th West Coast Conference on Formal Linguistics*, ed. Wm. G. Bennett et al., 430-437. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #3416.