CONSONANTAL DURATION SCALING IN ACCENTED WORDS

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1. INTRODUCTION

There are many names for accented speech. These include *functional stress*, *focus*, *emphatic*, *stressed word*, *sentential stress*, *prosodic prominence*, etc. No matter the name, they will all be defined here as the act of accenting part of a sentence (be it a word or a phrase) to change the pragmatics of a sentence. That is, the context in which an otherwise identical sentence is spoken reflects a change in meaning of an utterance. For a clear example,

1a) I thought the idea was brilliant.
1b) I *THOUGHT* the idea was brilliant. (but I changed my mind later)

By accenting part of the sentence, we are using this to assign another semantic element to the sentence via prosody. The above example is assigning a contrastive element to the sentence. Similarly, we can stress a part of a sentence to indicate focus, emphasis, and many other syntactic/semantic elements to change the pragmatics of an utterance. This study sheds more light on the acoustic structure of accented speech.

2. METHOD

This experiment consisted of a simple speaking task which was recorded and analyzed acoustically via Praat. The participants (3 female native speakers of Canadian English) were given identical paired sentences, where one was an unaccented question, and the second was an accented version of the same sentence, where the accented element was the verb. For example:

2a) "Mary [verbed]$_1$ the ball?"
2b) "Mary *[VERBED]*$_1$ the ball?"

This sentence pair was repeated twice per speaker, with 19 different verbs in frame. The verbs are common monosyllabic words. The goal was to capture the durational differences of the different onset consonants of accented words, as the hypothesis is that they will scale differently according to the type of consonant. That is, the onset consonant of an accented word will occupy a larger percentage of the total word duration than it would otherwise occupy in an unaccented position. This hypothesis is brought forth by the idea of domain-initial strengthening [1]. The accenting of a word will create a new prosodic boundary, which will be observable by different prosodic factors, including differences in duration.

3. RESULTS

Table 1 shows the given statistical significances of accented vs. unaccented durations. All statistical analyses were done in statistical analysis software, R, using Welch's Two Sample T-Test.

Variable	P-Value
Word Duration	**< 2.2e-16**
Vowel Duration	0.7335
Vowel Duration after obstruents	0.4851
Vowel Duration after Stops	**0.0007329**
Vowel Duration after Nasals	0.3859
Stop Duration (Closure + Aspiration)	**0.00023**
Stop & Affricate Closure Duration	**0.0002611**
Stop Closure Duration	**0.0007261**
Stop Release Duration	0.8091
Affricate Duration (Closure + Frication)	0.06522
Affricate Closure Duration	**0.02363**
Affricate Frication Duration	0.3212
Fricative Duration	0.109
Nasal Duration	**0.003771**
Liquid Duration	0.4751
Voiced Stop Duration (Closure + Aspiration)	**0.0442**
Voiceless Stop Duration (Closure + Aspiration)	**4.375e-05**
Voiced Affricate Duration (Closure + Frication)	0.1355
Voiceless Affricate Duration (Closure + Frication)	**0.01432**
Voiced Fricative Duration	0.09445
Voiceless Fricative Duration	0.08191

Table 1. Accented vs. Unaccented significance level (T-Test)

Figures 1-6 show the visualizations of the average segment's duration, as proportionate to word duration. All findings show an increased proportional duration of the onset consonant in accented words compared to their

unaccented counterparts, as hypothesized. The strongest statistical findings however, were in favour of consonants with a full oral stricture, namely stops, affricates, and nasals, all with $p < 0.05$. If these onset consonants are segmented even further where possible, the period of full closure is more important than the release, as seen in the smaller p value of stop and affricate closures vs. their released aspiration and frication, respectively. The other consonants without full stricture (fricatives and liquids) still show an increased overall duration within accented words, but without significant p values. P values are further significant again in favour of voiceless consonant onsets as compared to their voiced counterparts.

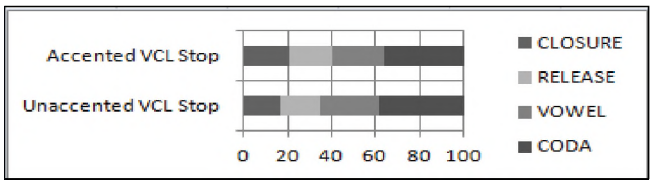

Fig. 1. Avg voiceless stop onset proportions. Accented words are on avg 36% longer than the unaccented.

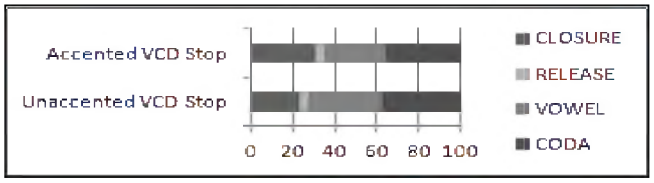

Fig. 2. Avg voiced stop onset proportions. Accented words are on avg 30% longer than the unaccented.

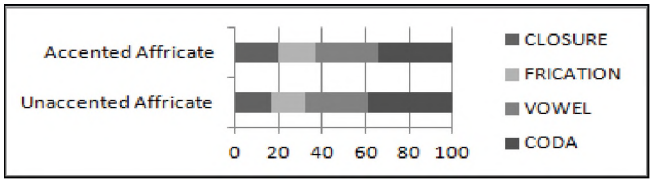

Fig. 3. Avg affricate onset proportions. Accented words are on avg 19% longer than the unaccented.

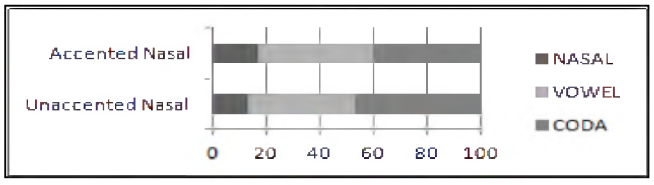

Fig. 4. Avg nasal onset proportions. Accented words are on avg 14% longer than the unaccented.

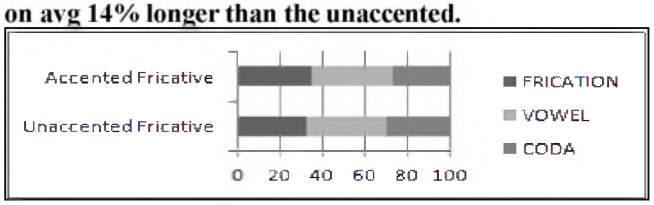

Fig. 5. Avg fricative onset proportions. Accented words are on avg 28% longer than the unaccented.

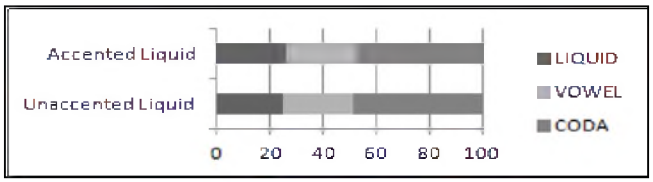

Fig. 6. Avg liquid onset proportions. Accented words are on avg 28% longer than the unaccented.

5. DISCUSSION

There are several ideas as to why consonants with full oral constrictions seemed to result in the most significant findings. Since this type of accenting performs a pragmatic function, functional theories of prosodic prominence and boundaries [2] seem to be a logical point to follow. One hypothesis is that it is the closure period which acts as the silent pause, which cues a different meaning from the norm in the syntax. Fuller constrictions would then likely be more susceptible to holding this pause longer since the closure gestures aren't being made in the fricative and liquid consonants. As such, for these other consonants, a different prosodic cue to accented words are likely more relevant-most likely intonation, intensity, or something else in the surrounding environment. On a similar note, van Santen and Shih [3] indicate that suprasegmental timing (duration) is highly dependent on the suprasegmental unit, and not the prosodic context. If we are to accept this, the analyzed accented words should be analyzed as their own suprasegmental unit, and as such, be in support of a prosodic boundary hypothesis, as boundaries are found outside suprasegmental units.

A second idea is that sonority and degree of stricture somehow plays a role with size of effect, since it was the consonants with high degrees of stricture that proportionally 'grew', while the vowel's duration 'shrank' in comparison to this. If further studies prove this to be true, it could very well weaken any prosodic boundary, or domain initial strengthening hypothesis. Both hypotheses will require further testing, but causation aside, this proves to be another potential cue for fine prosodic identification and voice synthesis.

REFERENCES

[1] Cho, T. & Keating, P. (2009). Effects of initial position versus prominence in English. Journal of Phonetics 37(4), 466-485.

[2] Wagner, Michael & Watson, Duane (2010). Experimental and theoretical advances in prosody: A review. Introduction to special issue of Language and Cognitive Processes 25(7). 905-945.

[3] van Santen, J.P.H & Shih, C. (2000). Suprasegmental timing models in Mandarin Chinese and American English. Journal of the Acoustical Society of America. 107(2), 1012-1026.