Phonetic Complexity and Grammatical Classification of Stuttered Words in Children

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Introduction

- A series of studies suggest the influence of phonetic complexity on stuttering is more apparent in older children and adults (Howell et al., 2006; Howell & Au-Yeung, 2007) than preschool children (Throneburg et al., 1994; Howell & Au-Yeung, 1995; Logan & Conture, 1997; Dworzynski & Howell, 2004).
- These findings are unexpected as younger speakers should presumably be more vulnerable to phonetic difficulty than older speakers.
- Three considerations are noted:

  1) Null effects of phonetic complexity were found when content and function words were analyzed in distinct groups. Phonetic complexity may be more predictive when all words within the utterance are considered equally rather than separately relative to grammatical classification.

  2) When analyzing speech fluency at the level of word and/or utterance multiple additional variables of speech-language planning and production known or suspected to influence stuttering (e.g., length and complexity of the utterance) should also be considered in tandem with the target variable of interest (Ratner, 2005) .

  3) The measurement tool used in the majority of the studies (i.e., the IPC: Index of Phonetic Complexity; Jakielski, 1998) is an unpublished tool based on infant babbling. The IPC does not include the phonetic constructs that develop post-babbling.

- Stoel-Gammon (2010) recently published the Word Complexity Measure (WCM), an index of phonetic complexity based on the speech of children who are closer in age to the typical age of stuttering onset (17 to 48 months). See Table 1.
- In contrast to the IPC, the WCM ***excludes*** phonetic factors relevant to phonetic constructs that are characteristic of infant speech production (e.g., place variegation of singletons and clusters) and ***includes*** phonetic factors suggested to influence moments of stuttering (e.g., non-initial stress; Hakim & Ratner, 2004).

Table 1. *Comparative scoring rubrics for the Index of Phonetic Complexity and the Word Complexity Measure.*

IPC Points	IPC	WCM Points	WCM
1	Dorsals	1	Velars/dorsals
1	Fricatives	1	Fricatives
	x	1	Voiced fricatives
1	Affricates	1	Affricates
	x	1	Voiced affricates
1	Liquids	1	Liquids/Syllabic liquids
1	Place variegations of consonants within word		x
1	Rhotics	1	Rhotics
1	Word-final consonant	1	Word-final consonant
1	>2 syllables	1	>2 syllables
1	Consonant clusters (intra-syllabic)	1	Consonant clusters (intra-syllabic)
1	Consonant clusters (inter-syllabic)		x
1	Place variegations within clusters		x
	x	1	Non-initial stress

Note: IPC - Index of Phonetic Complexity (Jakielski, 1998); WCM - Word Complexity Measure (Stoel-Gammon, 2010).

Purpose

The *purpose* of this study was to examine whether phonetic complexity, as measured by the WCM, uniquely predicts stuttered words during spontaneous speech.

Method

Participants
- 14 children who stutter (CWS).
- 8 males, 6 females (M = 44 months; SD = 11 months).
- No other speech and/or language disorder.

Data Collection
- CWS conversed with parents for ~20 min.
- Play-based setting with age-appropriate toys.
- Video recordings were made for all samples.

Data Analysis

Transcript Preparation
- Authors and trained research assistants transcribed conversations word-by-word. Words not included prior to coding:
  - Nonspeech words (Miller & Iglesias, 2006).
  - Interrupted, abandoned or imitated utterances (Sawyer et al., 2008).
  - One-word utterances (Logan & Conture, 1997).

Initial data corpus: N = 5,109

Reliability
- Phonetic transcription, utterance boundary and disfluency type for all words achieved as follows:
  - Initial review of discrepancies by either author and research assistants for 100% agreement by consensus.
  - Second review of remaining discrepancies by either author and different research assistants for 100% agreement by consensus.

Exclusionary Criteria
- Words that did not reach 100% consensus (N = 874)
- Words not found in data base (N = 139)

Final data corpus: N = 4,096

Coded Variables

Fluency
- Stuttered or nonstuttered words (Yairi & Ambrose, 2005).

Phonetic Complexity
- Word Complexity Measure (Stoel-Gammon, 2010; see Table 1).

Grammatical Classification
- Content and function words (Dworzynski & Howell, 2004)
  - *Content:* noun, main verb, adjective, adverb
  - *Function:* pronoun, article, preposition, conjunction, copula , aux verb

Length of Utterance
- Number of syllables per utterance (Logan & LaSalle, 1999).

Syntactic Complexity
- Number of clauses (predicate + noun) per utterance (Logan, 2001).

Utterance Position
- Initial or non-initial (Richels, Buhr, Conture, & Ntourou, 2010).

Phonotactic Probability
- Segmental and biphone values (Anderson & Byrd, 2008).
- Z-scores used to account for length of word (CML: Child Mental Lexicon, Storkel & Hoover, 2010).

Word Frequency, Neighborhood Frequency and Density
- Raw values coded for all three factors (Anderson, 2007).
- Values determined per CML (Storkel & Hoover, 2010).

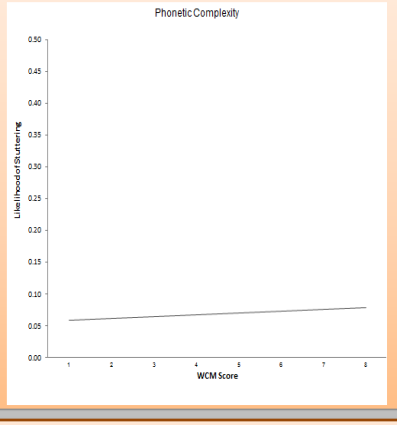
Results

Question: Does **phonetic complexity** uniquely predict stuttered words during spontaneous speech?

Analysis: Binomial logistic regression, (χ^2 (23) = 280.272, p < 0.000)
- 10 predictors
- Total words, N = 4,096 (Stuttered: 214, Nonstuttered: 3,882)

Outcome Measure: Fluency of word
Predictor Variable of Interest: Phonetic complexity
Additional Predictor Variables Included:
- Grammatical classification
- Length of utterance
- Syntactic complexity of utterance
- Utterance position
- Word frequency
- Segmental phonotactic probability
- Biphone phonotactic probabiltiy
- Neighborhood frequency and density
- Neighborhood density
  - *VIF = 1.087 to 2.154, tolerance = 0.464 to 0.920*

Results: **Phonetic complexity was not a significant predictor of greater odds of stuttering (odds ratio = 1.046, p = 0.494).**



Discussion and Conclusions

Question: Does **phonetic complexity** uniquely predict stuttered words during spontaneous speech?

Findings: **Phonetic difficulty, as measured by the WCM, did not influence the likelihood of stuttering.**

- Use of a measurement tool that included phonetic constructs of preschool speech rather than infant babbling did not lead to contrastive findings from past studies. That is, whether using the IPC (as in past studies) or the WCM (in the present study) it appears that phonetic complexity does not uniquely contribute to stuttered speech.
- Collapsing the words across the grammatical class rather than analyzing the words within each class as has been previously done also resulted in findings comparable to past research.
- **In summary,** findings indicate that when analyzing all words equally rather than within two distinct grammatical classes, when using a more age-appropriate measurement tool and when also considering the contribution of factors known to influence stuttering, phonetic complexity does not significantly predict stuttering.
- These results suggest that the motoric complexity of the speech production as measured by the IPC and/or WCM does not appear to be inextricably tied to the fluency of speech production.

Future research should examine the role of phonetic complexity on stuttering in older speakers while again including the additional potential contributors as in the present study as these additional factors in particular may be more influential to the stuttered speech of older children and adults.

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Acknowledgments: *The authors would like to thank our research assistants: Erin Castaneda, Melissa Chalef, Shannon Clark, Brittany Dyer, Angela Espinosa, Selina Gutierrez, Kelly Long, Kristen Mueller, Cara Patierno, Sarah Pequino, Olivia Reed, Elizabeth Rives, and Leslie Wang. Authors would like to extend a special thanks to Elizabeth Hampton, MA, CCC-SLP for data collection and Michael Mahometa, PhD for statistical consulting.* *For questions, please contact first author via email: geoff.coalson@mail.utexas.com.*