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Phonetic complexity of words immediately following utterance-initial productions in children who stutter

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ABSTRACT

Purpose: The purpose of the present study was to analyze phonetic complexity in the speech of children who stutter in a manner distinct from previous research with specific emphasis on three methodological considerations: (1) analysis of the word immediately following the initial word in the utterance; (2) accounting for other additional linguistic and lexical factors; and (3) discrimination of disfluency types produced.
Methods: Parent–child conversations were transcribed for 14 children who stutter (mean age = 3 years, 7 months; SD = 11.20 months) and coded for phonetic complexity using the Word Complexity Measure (WCM). Phonetic complexity of words immediately following the initial fluent or stuttered words of an utterance were included within binomial regression analyses, along with additional linguistic and lexical factors.
Results: Analyses indicate that the phonetic complexity of the second word of an utterance was not a significant contributor to the likelihood of whole- or part-word repetitions on the preceding initial word of the utterance.
Conclusion: Findings support previous data that suggest the phonetic complexity of speech, at least as measured by the WCM, does not distinctly influence stuttered speech in preschool-age children.

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1. Introduction

Phonetic complexity is defined by the number of late-developing sounds, sound sequences, and prosodic features required to accurately produce a target word (e.g., Howell, 2004, 2011; Howell & Dworzynski, 2005). The contribution of phonetic complexity to stuttered speech is central to Howell and colleagues' EXPLAN model of stuttering (EX: execution, PLAN: planning). Researchers have explored the phonetic complexity of stuttered words in children and adults using a variety of assessment tools (e.g., Al-Timimi, Khamaiseh, & Howell, 2013; Coalson, Byrd, & Davis, 2012; Dworzynski & Howell, 2004; Howell & Au-Yeung, 1995, 2007; Howell, Au-Yeung, Yaruss, & Eldridge, 2006; Throneburg, Yairi, & Paden, 1994). Across these studies, a relationship between phonetic complexity and stuttering has been observed in older children and adults, but not in children younger than 6 years of age.

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Howell and colleagues (e.g., Howell, 2011; Howell & Au-Yeung, 2002) describe the frequency and type of disfluencies within the context of a phonological word. A phonological word is defined as a speech planning unit comprised of a content word preceded by a function word (Howell & Dworzynski, 2005, pp. 347–350). The EXPLAN model predicts that the phonetic complexity of the content word within a phonological word determines whether stuttering will occur, as well as the type of disfluency produced. According to Howell (2011, pp. 268–269), the presence of a phonetically complex content word requires additional time to prepare. Increased phonetic complexity of the second word may result in two distinct types of stuttered speech: (1) "stalling disfluencies," such as whole-word repetition of the initial, monosyllabic function word, or (2) "advancing disfluencies," such as sound-syllable repetitions, if the speaker prematurely attempts to produce the second, more complex content word. Studies by Howell and colleagues support that the phonetic complexity of the stuttered content words is higher than the phonetic complexity of the fluent content words produced by adults and older children (e.g., Dworzynski & Howell, 2004; Howell & Au-Yeung, 2007; Howell et al., 2006). If increased phonetic complexity provokes stuttered speech, as suggested by the EXPLAN model, one would expect younger children to be particularly vulnerable, as their speech production systems are less mature. Upon review of the theoretical tenets of the EXPLAN model, the reports of non-significant findings in younger children may be related to three methodological limitations.

First, previous studies investigating the predictions of the EXPLAN model in younger children examined the fluency of a word relative to its *own* phonetic complexity (Coalson et al., 2012; Dworzynski & Howell, 2004). However, the EXPLAN model predicts that the presence or absence of stuttering is contingent on the complexity of the upcoming (content) word. Second, when the upcoming word was considered during analysis (e.g., Howell & Au-Yeung, 1995; Throneburg et al., 1994), relevant factors known or suspected to influence speech fluency were not taken into consideration (e.g., word frequency, phonotactic properties, neighborhood density or frequency, utterance length and syntactic complexity). Finally, none of the previous studies considered which types of disfluencies are predicted to occur relative to the phonetically complex word. If stalling and advancing disfluencies occur as predicted by the EXPLAN model, increased phonetic complexity of the word immediately following the stuttered word should predict only the whole-word repetition of the previous word (Howell & Au-Yeung, 1995; Throneburg et al., 1994), while increased phonetic complexity of the word currently in production should predict only the frequency of part-word disfluencies (Coalson et al., 2012; Dworzynski & Howell, 2004). However, across all studies completed to date, no distinction has been made among disfluency types produced. Thus, the purpose of the present study is to analyze phonetic complexity in the speech output of children who stutter in a manner distinct from previous research with specific emphasis on the following methodological considerations: (1) analysis of the word that immediately follows the initial word in the utterance; (2) accounting for other linguistic variables; and (3) distinction of disfluency types produced. In addition, to isolate the most common loci of stuttering during production (e.g., Buhr & Zebrowski, 2009; Richels, Buhr, Conture, & Ntourou, 2010), words in the initial position and immediately following the initial position of utterances were selected.

1.1. Phonetic complexity of the stuttered word

Dworzynski and Howell (2004) explored the phonetic complexity of the stuttered word using the Index of Phonetic Complexity (IPC), a tool developed by Jakielski (2000) to describe the nature of early acquisition patterns in young children's sound inventories. The IPC is an additive index of phonological complexity based on analysis of spontaneous speech. A numerical value is assigned to types of sounds and structures produced by young children in the following areas: (1) consonant place, (2) consonant manner, (3) vowel types, (4) word shapes, (5) word length, (6) consonant reduplication versus variegation, (7) singletons versus clusters, and (8) cluster types (see Table 1 for IPC scoring rubric). IPC points reflect relatively later age of acquisition of associated phonetic constructs. As such, higher IPC scores per word would be expected with age given the similarity of the IPC to typical developmental phonetic milestones (e.g., late-emerging sounds; multisyllabic words, consonant clusters). There are data that suggest children produce increasingly higher mean IPC scores per word across the period of 1–3 years of age (Jakielski, 2002; Jakielski, Matyasse, & Doyle, 2006). These findings support phonetic inventory diversification for sounds and sequences as a reflection of the broadening capacities of the production system.

As previously noted, results from the studies that have employed the IPC indicate that phonetic complexity is associated with stuttered words in older children and adults but similar findings of significance have not been reported in children (Al-Tamimi et al., 2013: 6–11 years of age; Dworzynski & Howell, 2004: beyond 6 years of age; Howell et al., 2006: 11–18 years of age; Howell & Au-Yeung, 2007: beyond 6 years of age). Given that the IPC is based on infant–toddler speech development patterns, these findings are surprising as the fluent speech of younger speakers should presumably be more vulnerable to phonetic difficulty than older speakers. Coalson et al. (2012) argued that these unexpected findings might be attributed to limitations with respect to the use of the IPC and/or other linguistic factors that may have contributed to the observed effects of phonetic complexity with development.

Specifically, Coalson et al. (2012) examined the role of phonetic complexity during stuttered speech in two critical ways that differed from past research. First, they employed Stoel-Gammon's Word Complexity Measure (WCM, 2010). The WCM is a measure of phonetic complexity with constructs similar, but not identical, to the IPC (see Table 1 for comparative scoring rubric). For example, the WCM does not award points for (a) place variegation of consonants within words or clusters, or (b) inter-syllabic clusters. Another key difference from the IPC is that the WCM awards points for (a) voiced fricatives and affricates, and (b) non-initial word stress pattern. Stoel-Gammon also developed the WCM using speech samples of seven children whose age range (17–48 months) was closer to the age of onset of stuttering than the age range of the children