



Phonological complexity in school-aged children who stutter and exhibit a language disorder



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ABSTRACT

Purpose: The Index of Phonological Complexity and the Word Complexity Measure are two measures of the phonological complexity of a word. Other phonological measures such as phonological neighborhood density have been used to compare stuttered versus fluent words. It appears that in preschoolers who stutter, the length and complexity of the utterance is more influential than the phonetic features of the stuttered word. The present hypothesis was that in school-age children who stutter, stuttered words would be more phonologically complex than fluent words, when the length and complexity of the utterance containing them is comparable. School-age speakers who stutter were hypothesized to differ from those with a concomitant language disorder.

Methods: Sixteen speakers, six females and ten males (M age = 12;3; Range = 7;7 to 19;5) available from an online database, were divided into eight who had a concomitant language disorder (S + LD) and eight age- and sex-matched speakers who did not (S-Only).

Results: When all stuttered content words were identified, S + LD speakers produced more repetitions, and S-Only speakers produced more inaudible sound prolongations. When stuttered content words were matched to fluent content words and when talker groups were combined, stuttered words were significantly ($p \leq 0.01$) higher in both the Index of Phonological Complexity and the Word Complexity Measure and lower in density ("sparser") than fluent words.

Conclusions: Results corroborate those of previous researchers. Future research directions are suggested, such as cross-sectional designs to evaluate developmental patterns of phonological complexity and stuttering plus language disordered connections.

Educational objectives: The reader will be able to: (a) Define and describe phonological complexity; (b) Define phonological neighborhood density and summarize the literature on the topic; (c) Describe the Index of Phonological Complexity (IPC) for a given word; (d) Describe the Word Complexity Measure (WCM) for a given word; (e) Summarize two findings from the current study and describe how each relates to studies of phonological complexity and fluency disorders.

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1. Introduction

Recent investigations into the stuttering-phonology-language connection have centered on the co-existence of these disorders as well as the phonological and/or language factors associated with stuttering. Historically, there has always been an interest in investigating how language factors may play a role in the stuttered word. Specifically, the idea that stuttering may be linked to phonological factors and speech sound production has been a prominent one for a long time. One of the early important studies in this area was by [Johnson and Brown \(1935\)](#) who analyzed more than 300,000 words in the speech of 32 adults who stuttered. Their findings showed that the most frequently stuttered speech sounds were the stops /t/, /g/, the fricative /z/, and the sonorants /l/ and /j/. Another early study ([Hahn, 1942](#)) showed the specific sounds most likely to be stuttered were the voiced stops /g/, /d/, but also the interdental fricatives, and the affricate /tʃ/.

Findings from both studies showed that stuttering occurs significantly more often on consonants than on vowels. This is important from the fundamental perspective that consonants require more precise articulatory adjustments than do vowels. Within the category of consonants, it is an empirical question as to whether certain consonants and consonant sequences are more susceptible to stuttering and whether they may be considered more complex or difficult to produce in terms of articulatory and linguistic variables. In addition to the nature of the speech sounds that might be considered more likely to be stuttered, factors such as the co-occurrence of phonological and language disorders, and the nature and frequency of their co-existence is crucial to the quest for further understanding a possible link. Researchers have explored the linguistic factors that may affect or in some way be related to dysfluency. These include, but are not limited to the length of utterance, utterance position, within-word position and function versus content words ([Au-Yeung, Howell, & Pilgrim 1998](#); [Buhr & Zebrowski, 2009](#); [Coalson, Byrd, & Davis, 2012](#); [Gaines, Runyan, & Meyers, 1991](#); [MacPherson & Smith, 2013](#); [Natke, Sandrieser, van Ark, Pietrowsky, & Kalveram, 2004](#); [Richels, Buhr, Conture, & Ntourou, 2010](#); [Soderberg, 1967](#); [Yaruss, 1999](#)). [Nippold \(2002\)](#) has questioned if there is an interaction between stuttering and phonology or simply a co-occurrence with confounding factors. However, research into specific stuttering-phonology connections have included the following areas: (a) the nature of the stuttering behavior in children with normal and disordered phonology (e.g., [Wolk, Edwards, & Conture, 1993](#)); (b) correlation between the frequency of disfluencies and number of phonological errors (e.g., [Louko, Conture, & Edwards, 1990](#); [Ryan, 2001](#); [Yaruss & Conture, 1996](#)); (c) phonological behaviors of children who stutter and are normally fluent (e.g., [Wolk et al., 1993](#)); and (d) the relationship between phonological abilities and the course of stuttering as a developmental disorder ([Paden & Yairi, 1996](#); [Paden, Yairi, & Ambrose, 1999](#); [Ryan, 2001](#); [Yairi, Ambrose, Paden, & Throneburg, 1996](#)). An additional focus of interest has been on the relationship between stuttering and the difficulty/phonological complexity of the phoneme and phoneme sequences, such as the phoneme itself, syllable shape, syllable length, and utterance position ([Howell & Au-Yeung, 1995](#); [Throneburg, Yairi, & Paden, 1994](#); [Wolk, Blomgren, & Smith, 2000](#)).

Many studies support the finding that about one third of children who stutter also exhibit a concomitant phonological disorder ([Byrd, Wolk, & Davis, 2007](#); [Wolk, Edwards, & Conture, 1993](#)), and approximately 10% exhibit a concomitant language disorder ([Arndt & Healey, 2001](#); [Blood & Seider, 1981](#)). In particular, it should be noted that [Arndt and Healey \(2001\)](#) studied older dysfluent children who had a concomitant language disorder, and this lends support to the rationale for the present study exploring phonological complexity in older children who stutter. To the extent that these children may have different underlying issues and may respond differently to varied treatment approaches, continued research explores this notion of sub-grouping. It is likely that with future research, we will have a more stable basis upon which to assess disfluent children in terms of sub-groups. In particular, sub-grouping disfluent children with regards to co-occurring phonological and/or language and associated problems seems to be gaining greater support and has important clinical implications ([Conture, Walden, Graham, Arnold, Hartfield, & Karrass, 2006](#); [Ntourou, Conture, & Lipsey, 2011](#); [Tetnowski, Richels, Shenker, Sisskin, & Wolk, 2012](#)).

There have been considerable efforts in recent years to understand how phonological components of stuttered words and/or how language formulation may be a part of the disfluent output (e.g., [Au-Yeung et al., 1998](#); [Throneburg et al., 1994](#); [Weiss & Jakielski, 2001](#); [Wolk et al., 2000](#)). Recent studies have attempted to expand the notions from early work on stuttering, and many authors have discussed a broad connection between phonological factors and stuttering and between language demand and fluency behavior (e.g., [Bloodstein & Bernstein Ratner, 2008](#); [Guitar, 2014](#)). By contrast, others have questioned the stuttering-phonology link. [Gregg and Yairi \(2007\)](#) studied 28 two- to three-year-old children (20 boys; 8 girls) near the onset of stuttering (25–38 months of age). They compared the phonological skills of two groups with different stuttering ratings and compared the stuttering severities of two groups with different levels of phonological skills. Their findings showed no statistically significant differences for either of the two factors. [Gregg and Yairi \(2012\)](#) studied 29 preschool children near the onset of stuttering (29–49 months of age) divided into two groups based on their minimal versus moderate level of phonological deviations, in order to assess whether there is a relationship between phonological skills and stuttering. Results revealed no statistically significant differences in the stuttering characteristics of the two groups near onset, corroborating their earlier findings. Given these findings, if future studies will confirm such data, we may tentatively conclude that phonology plays more of a role in stuttering as children age and continue to cope with stuttering. In sum, we now have substantial information about the relationships between phonological and/or language behavior and stuttering, but the specific aspects of these relationships are not yet fully understood.

One notion related to the stuttered word that has received much interest is that of phonological complexity ([Anderson, 2007](#); [Anderson & Byrd, 2008](#); [Bernstein Ratner, Newman, & Streckas, 2009](#); [Dworzynski & Howell, 2004](#); [Gregg & Yairi, 2007](#); [Gregg & Yairi, 2012](#); [Howell, 2004](#); [Howell, Au-Yeung, Yaruss, & Eldridge, 2006](#); [Howell & Au-Yeung, 2007](#); [LaSalle & Wolk,](#)

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