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Stuttering Frequency in Relation to Lexical Diversity, Syntactic Complexity, and Utterance Length

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Abstract

Children's frequency of stuttering can be affected by utterance length, syntactic complexity, and lexical content of language. Using a unique small-scale within-subjects design, this study explored whether language samples that contain more stuttering have (a) longer, (b) syntactically more complex, and (c) lexically more diverse utterances than samples that contain less stuttering. Children who stutter, ages 2 years 1 month to 4 years 11 months, produced 10 monthly language samples. For each child, samples were divided into the first five (early) and the last five (later). Utterance length, syntactic complexity, and lexical diversity analyses were performed on samples that contained the most and least stuttering for early and later samples. For the later samples but not the early ones, samples with the most stuttering contained longer mean lengths of utterance, more diverse vocabulary overall, and greater syntactic complexity than samples with the least stuttering. Contributions of language growth, time, and specific linguistic factors are discussed.

Keywords

stuttering, 3 to 5 years, syntax, language/linguistics, semantics

Introduction

Understanding the relationship between fluency and language skills in young children who stutter (CWS) has been an area of focus for some time (see, for example, Hall, Wagovich, & Bernstein Ratner, 2007, for a discussion). The interest in this area generally stems from the fact that children are in the midst of language learning when they experience stuttering onset and, therefore, by recognizing patterns of language use during this time period, we are able to understand more fully the potential linguistic contributors to stuttering in early childhood. Indeed, current models of stuttering (e.g., the *Diathesis-Stressor Model*, Conture & Walden, 2012; Walden et al., 2012) as well as earlier models (e.g., the *Dynamic Multifactorial Model*, Smith & Kelly, 1997; the *Demands and Capacities Model*, Starkweather, 1987; the *Covert Repair Hypothesis*, Kolk & Postma, 1997) have included language in explanations of the occurrence of stuttering.

Linguistic complexity exists in many forms, including phonological, syntactic, lexical, and pragmatic. Studies of overall language skills and linguistic complexity in young CWS have generally yielded results suggesting poorer performance compared with typically fluent peers. Between-group differences have been observed in children's morphosyntactic skills (Ntourou, Conture, & Lipsey, 2011), their lexical skills (Anderson & Conture, 2000; Bernstein Ratner & Silverman, 2000; Coulter, Anderson, & Conture, 2009; Ntourou et al., 2011; Pellowski & Conture, 2005; Silverman & Bernstein Ratner, 2002), as well as other language areas. Differences, however, tend to be subclinical (i.e., the language of CWS is still within normal limits).

Frequency of Stuttering in Relation to Length and Linguistic Complexity

CWS are more likely to be disfluent on utterances that are longer (e.g., Brundage & Bernstein Ratner, 1989; Buhr & Zebrowski, 2009; Logan & Conture, 1995; Richels, Buhr, Conture, & Ntourou, 2010; Yaruss, 1999; Zackheim & Conture, 2003). Length effects have been demonstrated whether utterances are measured in syllables, words, or morphemes. For example, Zackheim and Conture examined the fluency of utterances that exceeded children's individual mean length of utterance (MLU) compared with utterances that were shorter than their MLU. For both CWS and children who do not stutter (CWNS), they found that

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disfluency was more likely in utterances that exceeded a child's MLU.

One difficulty in analyzing spontaneous language sample data is in disentangling utterance length from linguistic complexity, given that longer utterances are generally more linguistically complex than shorter ones. For example, although MLU measures length (in morphemes), it is also considered a measure of grammatical development (Rice, Redmond, & Hoffman, 2006). Moreover, just as length appears to affect the frequency of stuttering, so too do aspects of linguistic complexity (i.e., phonological, lexical, syntactic). Of these, syntactic complexity has received the most attention. CWS are more disfluent on sentences of greater syntactic complexity (e.g., Bernstein Ratner & Sih, 1987, Buhr & Zebrowski, 2009; Gaines, Runyan, & Meyers, 1991; Kadi-Hanifi & Howell, 1992; Weiss & Zebrowski, 1992), a finding that extends across studies of elicited (Bernstein Ratner & Sih, 1987) and spontaneous language (Buhr & Zebrowski, 2009; Gaines et al., 1991; Kadi-Hanifi & Howell, 1992; Weiss & Zebrowski, 1992).

Most prior research has focused on stuttering and linguistic complexity in CWS at one point in time. An exception is Buhr and Zebrowski (2009), who conducted a longitudinal study of young CWS. They found that sentences containing stutter-like disfluencies (SLDs) and other disfluencies were longer and syntactically more complex than fluent utterances, a finding which remained stable over the 2-year time period in which children were enrolled in the study. The present study is similar to Buhr and Zebrowski in that it examines linguistic complexity in relation to stuttering *over time*. However, our study differs in that the analyses are of whole language samples, rather than individual sentences within the samples. As such, our data provide a more global look at children's language and fluency within a conversational language sample context.

Syntactic Complexity in the Conversational Language of CWS

In examining the interaction between syntactic complexity and stuttering in the spontaneous language of CWS, a variety of procedures have been used. Developmental Sentence Scoring (DSS; Lee & Canter, 1971) and the Index of Productive Syntax (IPSyn; Scarborough, 1990) are global analyses that assign points for a range of morphological and syntactic structures. Of these, DSS has been more widely used in studies with CWS. Overall, findings have suggested that CWS do not differ from CWNS on DSS (Ryan, 2000; Westby, 1979), but that utterances that contain more stuttering or more disfluency overall had higher DSS scores than those that were produced fluently (Buhr & Zebrowski, 2009; Gaines et al., 1991; Ryan, 2000; Weiss & Zebrowski, 1992). IPSyn assigns points for the presence of 56 syntactic and morphological structures within the following categories: noun and verb phrases, questions and negation, and sentence structures. Structures range in complexity; more complex structures include relative clauses, complex infinitives, and gerunds. For each of the 56 structures, a sample can be awarded 2 points for two or more occurrences of the structure, 1 point for one occurrence, or 0 points for no occurrences. One advantage of IPSyn over DSS is that it awards more points to samples with a greater range of *different* morphological and syntactic structures, and once a sample is awarded 2 points for a particular structure occurring twice, no more points are awarded for any additional occurrences of that structure. There is some evidence that IPSyn may be more sensitive than DSS, detecting subtle differences in syntax between populations (Holdgrafer, 1995). In fact, in relation to CWS, findings of a recent study of syntactic complexity using both DSS and IPSyn (Bauman, Hall, Wagovich, Weber-Fox, & Bernstein Ratner, 2015)[5] indicated that IPSyn scores were significantly lower for the CWS group, whereas DSS scores did not differ between the groups of CWS and CWNS.

Lexical Diversity in the Conversational Language of CWS

Studies of overall lexical skills in the conversational language of CWS have not been plentiful, but of the work in this area, there is evidence that CWS show less diversity of vocabulary (Silverman & Bernstein Ratner, 2002) and use fewer lexically rare items (Bernstein Ratner & Silverman, 2000). For example, Silverman and Bernstein Ratner (2002) examined overall vocabulary diversity in conversational language samples with young CWS and typically fluent peers. The children's vocabulary diversity was assessed using the program *VOCD* (Malvern & Richards, 1997; MacWhinney, 2000). Compared with other lexical diversity measures, such as the number of different words, *VOCD* is relatively more stable across language samples that vary in length. Findings suggested that CWS show less overall lexical diversity than children of the same age who do not stutter.

Given these overall lexical differences between groups, it seems reasonable to question whether a particular aspect of lexical complexity is driving the differences observed (Wagovich & Bernstein Ratner, 2007). In particular, *verbs* may represent a linguistic challenge for young children relative to nouns (e.g., Camarata & Leonard, 1986; Gentner, 1978; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). Whereas verbs express relationships between entities or ideas, nouns are referential. In addition, verb use requires understanding and use of the appropriate argument structure (e.g., Gleitman et al., 2005; Lidz & Gleitman, 2004), which places limits on their correct use; nouns are more flexible in the ways in which they can be used acceptably.

Relatively few studies have focused on verb use in CWS. Findings, however, suggest that stuttering is more likely to occur at the beginnings of verb phrases than noun phrases (Bernstein, 1981). In addition, although there is some evidence to suggest that CWS produce fewer total verbs and fewer different verbs in language samples relative to peers (Wagovich & Bernstein Ratner, 2007), Pawlowska, Brown, Redden, and Weber-Fox (2008) found young CWS to be similar to peers in the verb diversity of their language samples. Based on these two studies, however, it appears that CWS produced fewer copulas within their conversational language samples relative to peers. Finally, Bauman and colleagues (Bauman, Hall, Wagovich, Weber-Fox, & Bernstein Ratner, 2012) observed a trend suggesting that preschool-age CWS may double-mark verbs (e.g., *ated* for *ate*) more often than CWNS. Taken as a whole, then, results are inconsistent in the verb use differences observed between CWS and typically fluent peers.

Time as a Confound to Examining Changes in Language and Stuttering

Language skills develop with time; therefore, analyses of language in relation to stuttering need to take into account the natural language growth expected as a child develops. To date, most studies have used cross-sectional designs to explore development of language and stuttering. As noted, one exception is the work of Buhr and Zebrowski (2009), who sampled the speech of CWS and CWNS at 6-month intervals over a 2-year period. Their study focused on a similar age range, examining disfluencies in relation to language characteristics at the word and sentence level. For example, they found that children stuttered more at the beginnings of sentences, and that, when they stuttered on function words, this generally occurred at the beginnings of sentences. These findings were found to be stable over time. Our study complements the Buhr and Zebrowski study, in that it also focused on the relationship between language and fluency over time, but we examined stuttering fluctuation over time as the starting point, focusing on the samples that contained the most and the least stuttering and comparing children's conversational language within samples that contained the most stuttering and samples that contained the least for each child. Although the approach was different, the intent was to observe conversational language skills by focusing on the whole language samples and by comparing the complexity of the language produced when CWS are demonstrating periods of more stuttering versus less stuttering. We addressed the confound of time, at least in part, through the separate analysis of "early" language samples and "later" language samples. By examining stuttering frequency and linguistic complexity within smaller windows of time, the impact of time on the measurement of language skills was lessened. Moreover, this type of analysis enabled examination of *differences* in language performance relative to stuttering frequency across the two time periods.

Purpose of the Study

In this study, we explored the extent to which linguistic variables correspond with changes in SLD (Yairi & Ambrose, 1999; Yairi & Seery, 2011), using 10 monthly language samples obtained from each of nine preschool-age CWS. Specifically, for each child, the set containing the first five monthly samples and the set containing the last five monthly samples were analyzed to select the one sample in each set that contained the most SLD and the one sample that contained the least SLD. (Hereafter, we use "SLD" and "stuttering" interchangeably.) Samples with the most stuttering and samples with the least stuttering were compared in terms of utterance length, lexical and verb diversity, and syntactic complexity. In addition, we examined the extent to which age and the passage of time might explain the correspondence between children's stuttering frequency and their language. We hypothesized the following:

> **Hypothesis:** Although the findings would not differ across the two time periods, utterance length, syntactic complexity, overall lexical diversity, and verb diversity would be greater in samples that contained more stuttering than in those that contained less.

Method

Participants

Nine CWS (six males, three females), described in Wagovich, Hall, and Clifford (2009) and Wagovich and Hall (2007), participated in the study (see Note 1). The children ranged in age from 2 years 1 month 4 years 11 months at the beginning of the study. Stuttering severity, measured using the *Stuttering Severity Instrument–3rd Edition* (Riley, 1994), ranged from *very mild* to *moderate* (1 = *very mild*, 3 = *mild*, and 5 = *moderate*). Time post onset of stuttering, as reported by the children's parents, varied from 2 months to 19 months. Although some parents reported informally that their children were receiving stuttering treatment, data on the nature or length of treatment were not collected.

The *Preschool Language Scale–4th Edition* (PLS-4; Zimmerman, Steiner, & Pond, 2002) was administered to assess global receptive and expressive language. The PLS-4 Auditory Comprehension scores (standard score M = 105.8, SD = 11.1, range = 92–126) and Expressive Communication scores (standard score M = 108.4, SD = 17.1, range = 87–141) of all nine children were within normal limits, with all children receiving standard scores of 85 or higher on both scales. Receptive vocabulary testing was performed using the *Receptive One-Word Picture Vocabulary Test* (Brownell, 2000a) for all but one child; this child received the *Peabody Picture Vocabulary Test* (Dunn & Dunn, 1997). Expressive vocabulary was assessed using *Expressive One-Word Vocabulary Test* (EOWPVT; Brownell, 2000b) for all children. Standard scores for receptive (M = 102.8, SD = 9.2, range = 86–117) and expressive vocabulary (M = 97.9, SD = 11.4, range = 87–121) were all within normal limits (i.e., standard scores of 85 or higher).

Procedure

As described by Wagovich and colleagues (Wagovich & Hall, 2007; Wagovich et al., 2009), participants attended a testing session at the beginning of the study to assess their language skills and fluency. During this session, several parent questionnaires were administered, and a language sample was collected. After the first session, children attended nine more monthly sessions, during which an additional language sample was obtained. Each of the language samples was truncated to 100 child utterances (using the middle 100 utterances for analysis), so that all samples would be equivalent in length.

All samples were obtained by a graduate student clinician trained in speech-language sample elicitation. Samples were recorded using digital video and a cordless lapel microphone. A standard set of toys/books was used for all children in obtaining the play-based sample. At the beginning of each session, the children chose the books and toys, from the preestablished set, to be used in that session. By giving the children a choice about the target of play, we increased the likelihood that children would be engaged, interested, and interactive during the sample.

All samples were analyzed for the presence of SLD, defined as part-word repetitions, single-syllable whole-word repetitions, blocks, and prolongations (Yairi & Ambrose, 1999; Yairi & Seery, 2011). Coding was performed by trained graduate research assistants. Following completion of the disfluency coding, a certified speech-language pathologist (lab assistant) recoded 18 of the samples to establish reliability. Across samples, utterance-by-utterance agreement of the presence or absence of SLD was 92.8% (range = 81%–99%).

Following SLD coding, the 10 language samples for each child were divided into the first five samples (referred to as "early samples") and last five samples ("later samples"). Within these subsets, we identified the sample that contained the most stuttering and the sample that contained the least stuttering. This procedure enabled us to compare language performance of samples with relatively more stuttering with those with less stuttering. By analyzing early and later samples separately, we placed some modest controls over the potential effects of time and development.

Table 1 details which samples were selected for each participant and the percent stuttered syllables within each of the samples. As can be seen from the table, the sessions that contained the most and least stuttering varied across participants. It is not the case, for example, that most children showed the greatest or least stuttering at either the beginning or the end of the 10-sample study. In addition, individual children's stuttering frequency also varied; for example, among the first five sessions (early samples), samples that contained the most stuttering across children varied from 3.0% SLD to 14.1% SLD, whereas samples with the least stuttering varied from 0.9% SLD to 7.4% SLD.

Table 1. Stuttering Frequency Across Sessions.

	Early sessions (S1–S5)		Later sessions (S6–S10)	
Participant	Least stuttering	Most stuttering	Least stuttering	Most stuttering
1	S4 (4.5%)[a]	S5 (10.6%)	S10 (2.3%)	S6 (9.7%)
2	S4 (3.1%)	S1 (14.1%)	S6 (4.6%)	S7 (8.7%)
3	S3 (7.4%)	S2 (11.7%)	S10 (2.5%)	S7 (6.3%)
4	S1 (1.4%)	S5 (3.0%)	S7 (1.6%)	S10 (3.7%)
5	S1 (2.5%)[b]	S4 (8.1%)	S6 (1.8%)	S8 (6.5%)
6	S5 (0.9%)	S3 (3.9%)	S6 (0.5%)	S9 (2.8%)
7	S4 (2.9%)	S2 (9.4%)	S7 (1.5%)	S10 (10.5%)
8	S3 (3.3%)	S5 (7.0%)	S8 (1.7%)	S10 (23.0%)
9	S5 (1.9%)	S1 (8.9%)	S10 (1.0%)	S6 (1.4%)
M	3.1	8.5	1.9	8.1
SD	1.9	3.6	1.2	6.4

[a]% stutter-like disfluency. [b]Sample contained too few verbs and was, therefore, excluded from verb diversity analysis.

Language analysis. Language samples were transcribed in SALT (*Systematic Analysis of Language Transcripts*; Miller, 2008) format. Transcription procedures were similar to those used by Logan, Byrd, Mazzocchi, and Gillam (2011) and others. Specifically, the initial basic transcription (i.e., gloss) was performed by one trained undergraduate research assistant, and then a second trained undergraduate research assistant viewed the videotape and made any corrections to the transcription. Finally, the first author checked the transcription for accuracy and made any final edits. Utterance boundaries were defined in the same manner as Yaruss and Conture (1996), Meyers and Freeman (1985), and others. Namely, they were determined by considering content (i.e., the communication of an idea), pausing, and the intonational contour of the utterance. Samples were converted to CHILDES Transcription and Coding Format (CHAT) format (Child Language Data Exchange System [*CHILDES*]; MacWhinney, 2000), so that the CLAN suite of programs could be used to perform all language analyses. Following sample conversion from SALT to CHAT format, samples were checked (using the CHECK command in CLAN to identify errors, so that the files could be edited manually until all issues were satisfactorily resolved). Samples were then morphemized (using the MOR and POST commands), with manual coding in between these two steps as needed. Through this process,

Table 2. Language Performance on Samples With the Most Stuttering Versus Least Stuttering.

	Samples with most stuttering			Samples with least stuttering					
Language analysis	*M*	*SD*	Range	*M*	*SD*	Range	*t*	*p*	Cohen's *d*
Early sessions									
MLU	3.9	0.9	2.9–5.6	4.0	1.2	1.9–5.8	−0.3	.76	−0.1
DSS	7.0	1.3	5.4–9.2	7.1	1.5	4.0–9.2	−0.1	.92	−0.1
IPSyn	74.0	6.6	65–85	74.6	12.3	45–88	−0.2	.86	−0.1
VOCD	54.1	16.5	30.8–78.0	47.5	15.3	26.3–69.0	1.4	.21	0.5
Verb *VOCD*	17.2	13.5	5.2–44.0	14.6	6.0	4.8–21.7	0.5	.63	0.2
Later sessions									
MLU	5.1	1.0	3.5–6.7	3.9	0.8	3.1–5.2	5.4*	.001	1.7
DSS	7.8	1.6	5.6–10.5	6.9	0.8	6.0–8.3	1.9	.10	0.6
IPSyn	80.6	6.4	73–90	74.9	6.7	65–83	4.0*	.004	1.4
VOCD	58.3	14.5	34.3–85.0	45.9	6.2	37.4–56.1	2.6*	.03	0.9
Verb *VOCD*	21.4	9.2	11.1–38.9	16.9	10.5	6.6–37.8	1.0	.34	0.3

Note. Contrasts were conducted using paired-samples *t* tests, and effect sizes were estimated using Cohen's *d* (Cohen, 1988): large effect ≥.8, medium effect ≥.5, small effect ≥.2. MLU = mean length of utterance; DSS = Developmental Sentence Score (Lee & Canter, 1971); IPSyn = Index of Productive Syntax (Scarborough, 1990); *VOCD* = vocabulary diversity (Malvern & Richards, 1997) of 400-token samples; verb *VOCD* = diversity of verbs in the samples.
*$p < .05$.

CLAN segmented utterances into morphemes, parsing each utterance syntactically. After these initial data processing steps, the following CLAN analyses were performed: MLU (length analysis), *VOCD* (lexical diversity; Malvern & Richards, 1997; see Note 2), verb *VOCD* (verb diversity; see Note 3), and IPSyn (syntactic analysis; Scarborough, 1990).

Statistical analysis. Statistical analyses consisted of paired-samples *t* tests to compare utterance length, lexical diversity, verb diversity, and syntactic complexity (see Note 4). Samples containing the most stuttering and those containing the least were compared for the early sessions (1–5) and the later sessions (6–10). Effect sizes were estimated using Cohen's *d* (Cohen, 1988), in which values of .8 represent large effects, .5 medium effects, and .2 small effects.

Results

To determine whether the pattern of correspondence between language and stuttering frequency differed across the two time periods, early and later samples with the most and least stuttering were analyzed separately. Next, to place these findings in context, children's performance was examined relative to age, to examine individual differences. Finally, the passage of time was considered as a factor related to stuttering and language.

Language and Stuttering Frequency: Early Versus Later Sessions

Table 2 displays descriptive statistics, *t* test results, and effect sizes for contrasts between sessions with the most stuttering versus those with the least stuttering. As can be seen from the table, language analyses from the first five sessions of the project revealed a different pattern of correspondence between language and stuttering, compared with the samples from the last five sessions. Comparing the samples with the most and least stuttering in the early sessions revealed no significant differences in language performance. In fact, for length and syntax, the group means favored the samples with the least stuttering. In contrast, among the later samples with the most and least stuttering, the pattern was markedly different. Utterance length, lexical diversity, and syntactic complexity were significantly greater for samples with the most stuttering, compared with samples with the least stuttering; however, verb diversity did not differ across sample types.

Individual Patterns of Performance

To examine individual patterns of performance based on age, children's scores on MLU, *VOCD*, and IPSyn were plotted for the early and later sessions with the most and least stuttering (see Figure 1, Supplemental Material). The overall pattern of MLU differed considerably from the early sessions to the later sessions. In the early sessions, from the sample with the least to the most stuttering, children increased, decreased, or remained about the same on MLU, and performance did not vary by age. In contrast, for the later sessions, all the children with one exception had a higher MLU for the sample with the most stuttering. The exception was a 4-year-old child, who had the same MLU for both samples. Lexical diversity, as measured by *VOCD*, also showed a mixed pattern of performance in the early sessions (see Figure 2, Supplemental Material). Both the 2-year-olds showed an increase in lexical diversity from sessions with the least to the most stuttering; however, the 3- and 4-year-olds showed a more mixed pattern. Among the later sessions, the 3- and 4-year-old children all showed an increase in lexical diversity, comparing samples with the least stuttering with samples with the most stuttering. The 2-year-olds performed differently, with one showing a decrease and one performing the same across the samples.

Children's syntactic complexity, as measured by IPSyn, is depicted in Figure 3 (Supplemental Material). IPSyn scores in the early sessions mostly showed a declining pattern from least to most stuttering, with the exception of one 2-year-old and one 3-year-old. However, in the later sessions, all children except one showed an increase in score from the sample with the least stuttering to the sample with the most. The exception was a 4-year-old, who had the same score across both sessions.

In sum, for these three language sample analyses, considerable variability was noted for the early samples. For the later samples, however, most children produced longer utterances with greater lexical diversity and syntactic complexity on the samples with the most stuttering. There is some indication of an age-related difference for lexical diversity among the later samples. For those samples, the 3- and 4-year-olds each showed an increase in *VOCD* from sessions with the least to those with the most stuttering, yet the 2-year-olds did not show this pattern.

Descriptive Analysis of the Impact of Time on Performance

To evaluate the possibility that time affected the findings of the study, we asked what proportion of samples containing the most and least stuttering were a full 4 months apart (i.e., spanned the full length of the 5-month time window for the early sessions and for the later sessions). Table 1 reveals that only two children in the early sessions and two children in the later sessions produced their "most" and "least stuttering" samples 4 months apart. Thus, the majority of intervals between most and least stuttering samples were 3 months or fewer.

Second, we examined whether the samples with the most and least stuttering occurred in the same order over time. If stuttering and language development are linked, such that more stuttering is associated with increased language development, we would expect a trend showing the sample with the least amount of stuttering occurring before the sample with most stuttering. Furthermore, we could expect this both for the early and the later sessions. Instead, we found that, for the early sessions, about half (five of the nine children) produced the most stuttering in a session prior to the one with the least. For the later sessions, a third (three of the nine) had the session with the most stuttering prior to the session with the least.

Discussion

The focus of this study was to examine whether the conversational language of CWS is more or less complex in samples that contain more stuttering, compared with samples that contain less stuttering. Some previous work has focused on correspondence between frequency of disfluencies and linguistic complexity (e.g., Buhr & Zebrowski, 2009; Richels et al., 2010; Zackheim & Conture, 2003). In contrast to studies that have examined the occurrence of stuttering in subsets of utterances that display particular linguistic characteristics (e.g., stuttering on function words vs. content words, stuttering on syntactically complex utterances), our study examined stuttering frequency more globally—at the *sample* level rather than the utterance or word level. We chose this approach in an attempt to account for fluency fluctuations occurring over time, rather than over the course of one interaction.

In brief, results revealed that, for the early samples, no differences in language performance emerged. This finding is likely explained by the impact of time on children's language performance and/or greater variability of language development across samples with most and least stuttering. However, among the later samples, those with the most stuttering contained longer MLUs, more diverse vocabulary overall, and greater syntactic complexity than samples with the least stuttering. Thus, although developmental and/or maturational factors may have corresponded to the complexity of children's language production early on, stuttering frequency and language complexity showed greater correspondence later, over the last 5 months of the study. As is discussed in the section that follows, the study offers two findings supporting this shift.

Impact of Time in Relation to Language and Fluency Performance

Based on two descriptive analyses, it appears that age and language development over time contributed to the differences in the patterns of performance observed between early and later sessions. First, examining individual performance by age group, in general, it was the older children in the study who displayed more complex language in samples with more stuttering. It should be noted, however, that even the older children did not generally show this pattern in the early sessions, suggesting that perhaps comfort with the examiner and situation may have contributed somewhat to language and fluency performance observed early on.

Second, in the early sessions, language performance in relation to stuttering frequency appeared to vary depending on whether the session with the most stuttering occurred before or after the session with the least stuttering. This suggests that, for the early sessions, time played a role in the results with respect to the language complexity observed across sessions. For the later sessions, however, it did not appear to make a difference whether the session with the most stuttering occurred before or after the session with the least stuttering in terms of the child's language complexity. In general, for these sessions, language complexity more directly corresponded with stuttering frequency than with time.

Syntactic Complexity and Length

Although stuttering and other disfluencies are more likely to occur on more syntactically complex utterances (e.g., Bernstein Ratner & Sih, 1987; Buhr & Zebrowski, 2009; Logan & Conture, 1997; Zackheim & Conture, 2003), in conversational speech, syntactically complex utterances also tend to be longer. It is difficult to disentangle the impact of length from that of syntactic complexity. Formal measures of syntax such as IPSyn are valuable in this regard because they are less length dependent, focusing on the presence of a specific set of grammatical structures. Clearly, length of utterance was also an important factor in our findings. In the later sessions, samples with more stuttering had significantly longer utterances, as measured in morphemes, than samples with less stuttering. This finding represented a large effect.

Overall Lexical Diversity and Verb Diversity

In the later samples of this study, the diversity of lexical content of the children's language was greater in samples that contained the most stuttering than in samples that contained the least stuttering. These results are intriguing. On one hand, the children had the same set of toys from which to select for the entire 10-month participation in the study, so the content the children conveyed was based on the same or similar experiences with the set of toys. On the other hand, clearly, as children develop, they are able to talk about their play with more sophisticated words and concepts, linking play to their experiences and world knowledge. In this sense, it is not surprising that, just as syntactic complexity and length correspond to greater stuttering, lexical diversity does, as well. By using *VOCD* as the lexical diversity analysis, the impact of sample length is reasonably controlled; therefore, this finding of greater lexical diversity on samples with the most stuttering cannot be attributed either to sample length or syntactic complexity.

Studies of word frequency effects in children and adults who stutter suggest that content words are more likely to be stuttered when they occur with low frequency (i.e., not as frequently used) within the language (e.g., Anderson, 2007; Newman & Bernstein Ratner, 2007; Soderberg, 1966). Word frequency and lexical diversity are different constructs and are measured differently; word frequency compares one's lexical choices with a data set containing the overall frequency with which words are produced within a language, whereas lexical diversity is a within-sample analysis (i.e., without reference to an external database). It estimates the range of vocabulary used in a language sample. Nonetheless, the findings of the present study complement those of word frequency studies, in that together, these findings suggest that when children stretch themselves in their word choices, either by selecting words less frequent in the language or by using a greater range of lexical items in conveying thoughts and ideas, more stuttering results. Prior work documents this phenomenon at the word or sentence level (i.e., content words that are of low frequency or sentences with low-frequency words are more often stuttered), whereas the present study provides evidence of the correspondence between lexical choices and stuttering at the sample level.

An unexpected finding was that verb diversity did not differ for samples that contained the most and least stuttering. As discussed, in early language development, verbs represent a significant challenge for children, especially relative to nouns. It was anticipated that, if samples with the most stuttering had greater overall lexical diversity, these samples would display greater verb diversity, as well. This was not the case. Thus, it is likely that verb use at the *sample* level does not represent a lexical challenge to the same extent as overall lexical diversity. This finding is in contrast to utterance-level findings that stuttering is more likely to occur on verbs than other word types. For example, Bernstein (1981) found that young CWS were more likely to stutter on verb phrases than noun phrases. Within the adult literature, a bilingual case study by Ardila, Ramos, and Barrocas (2011) comes closest to examining this issue. Through a series of language sample tasks in English and Spanish, they found that their adult participant produced more stuttering on verbs than on nouns in both languages.

Individual Differences

A strength of this study is that it was designed to examine individual differences, using within-subject comparisons. When children range in age, it is critical to take into account their developmental levels in establishing what represents "complex language" for a particular child (Richels et al., 2010; Zackheim & Conture, 2003). Within the present study, it appears that the children as a whole showed variability in performance on the early samples. For the later samples, lexical diversity for 3- and 4-year-olds was greater in samples that contained the most stuttering than samples that contained the least, whereas the 2-year-olds did not show this pattern. Thus, for lexical diversity, at least, there is some suggestion of age-related differences in the correspondence between stuttering and language.

Another source of individual difference was the stuttering frequency of a child's "most stuttered" versus "least stuttered" session. We do not view it as problematic that the CWS varied in their percent stuttered syllables across samples. Selecting the sessions that contained the most and least stuttering for each child enabled us to establish *for individual children* the appropriate comparison sessions to test the hypothesis that sessions that contained relatively more stuttering would also contain relatively more complex language.

Conclusion, Limitations, and Future Directions

This project involved a relatively large corpus of language sample data for each of nine CWS. Because we obtained 10 100-utterance samples from each child, it was possible to analyze fluency and language complexity more globally and interpret findings within the context of whole samples, rather than specific fluent or disfluent utterances. If it is the case that, in a particular language sample, a child stutters more because the child is using more lexically ambitious vocabulary, for example, we might expect that the stuttering within the sample would occur more globally than locally. That is, if the content is more lexically and conceptually complex, the location of fluency breakdown would not necessarily need to be *on* the lexically ambitious word; it could be on a prior word or even in a prior utterance, in anticipation of the word and concept. For this reason, more global analyses such as the ones in this study are important because they can uncover overall correspondences between stuttering and language that might go undetected in utterance-by-utterance analyses.

Findings support the suggestion that utterance length, syntactic complexity, and overall lexical diversity correspond to frequency of stuttering for CWS who are still in the process of acquiring language. However, as noted by Buhr and Zebrowski (2009), a causal relationship between linguistic complexity and stuttering frequency should not necessarily be inferred. Rather, as these authors point out, increased linguistic demand (such as having much to say about a particular toy or event) may account for *both* a child's increased stuttering and the child's increased linguistic complexity.

Two primary limitations of this study should be noted. First, as with most studies using language sample data, situational factors, such as the choice of toys and the nature of the interaction, may have affected both language complexity and stuttering. Attempts were made to limit the influence of toy/setting variables by (a) using a standard set of toys from which the children could choose and (b) conducting sessions in the same setting (the university clinic/lab) and with the same examiner. Theoretically, using the same toys across sessions (as opposed to letting children choose from a set of toys) would have been possible but undesirable, because the quality of the interaction suffers when children are less interested in the toys selected for them.

Related to this issue is the importance of pragmatic factors. Not only is it possible that pragmatic variables influenced lexical and syntactic use but also they may have varied across samples. On one hand, all language samples were elicited by the same clinician who had been trained in sample elicitation beforehand; therefore, her conversational manner (e.g., her overall response latency, speech rate, assertiveness) was a consistent feature of all samples. On the other hand, our analyses did not include evaluation of the pragmatic features of the clinician's language across samples. Therefore, we cannot rule out the possibility that pragmatic factors related to the clinician's interaction style affected findings. In addition, it is perhaps expected that, as the study progressed, the children became more comfortable with the clinician, and this may have impacted their conversational language production. Arguably, the variability of some language measures observed in the early sessions compared with the later sessions may have been due to factors related to the children's "comfort" with the clinician. If this is the case, analysis of the later samples might be viewed as more representative of the children's true language and fluency capabilities. Future studies should explore the role of situational and pragmatic factors on the quality of the samples obtained, in terms of the representativeness of the language and fluency observed.

A second limitation is related to the impact of time on development of the variables in this study. Although a strength of the study is the inclusion of multiple language samples per child, in the future, observations of fluctuations in children's fluency and language need not be made 1 month apart. Rather, a series of weekly speech/language samples could document these fluctuations without children's natural language development potentially affecting results.

This study focused on the linguistic complexity of samples that contained more stuttering, compared with samples that contained less stuttering. Although findings of the later samples suggest a link between stuttering frequency and linguistic complexity, earlier samples point to the importance of acknowledging and taking into account the language development that occurs in children over time. This study included children of a relatively wide age range and children at different points in their language development. We acknowledge that our youngest children were at very different points in their language development than the oldest children in the study. Thus, although these findings provide some insight into the relationship between stuttering frequency and language skills, the findings also point to the need for a more fine-grained, developmentally sensitive examination of language growth over time in relation to stuttering frequency. Future work might include a narrower developmental range, analysis of other disfluencies, as well as SLDs, and inclusion of a matched sample of typically fluent children to examine the extent to which *both* groups evidence more disfluencies in samples that contain more lexically and syntactically complex language. To date, studies by Zackheim and Conture (2003) and Buhr and Zebrowski (2009) come closest to addressing these issues, suggesting greater overall disfluency (both SLDs and other disfluencies) on utterances of greater syntactic complexity and length. Our study extends previous work in this area by providing some evidence that, at the sample level, increased length, syntactic complexity, and lexical diversity correspond to increased stuttering frequency in early childhood.

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Notes

1. Although the participants and the speech/language samples were the same as these two prior studies, the specific samples and analyses in each study were not identical.
2. *VOCD* was used to obtain lexical diversity values. Word and phrase repetitions, revised portions of utterances, and filler words (e.g., *um, uh*) were excluded from analyses. Although values obtained with *VOCD* are less sensitive to variations in sample size length than most other lexical diversity measures, there is evidence that they are the most stable when samples range from 100 to 400 tokens (McCarthy & Jarvis, 2007). Therefore, samples that exceeded 400 tokens were truncated to 400 to conduct this analysis.
3. To obtain verb diversity values, *VOCD* was run only on the verbs in the child's sample. The program generated a list of all tokens included in the analysis. Lists were examined for any errors in coding words as verbs. The analysis was then rerun on the corrected transcripts to obtain final values for verb diversity. *VOCD* requires a minimum of 50 tokens; of the 36 samples, one did not contain enough verbs to perform the analysis (Child 5's early sample with the least stuttering), necessitating exclusion of that sample.
4. Wilcoxon tests were also performed because of the small sample size; results, in terms of significance, were the same as those obtained using paired-samples *t* tests.
5. The study by Bauman, Hall, Wagovich, Weber-Fox, and Bernstein Ratner (2015) was a series of language sample analyses across data sets from four different laboratories. Of the 31 samples of children who stutter (CWS) in Bauman et al., three of the samples are analyzed in the present study, as well. Thus, there is a small degree of overlap of the data between the two studies.

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