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Speech disruptions in relation to language growth in children who stutter: An exploratory study

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Abstract

Young children with typical fluency demonstrate a range of disfluencies, or speech disruptions. One type of disruption, revision, appears to increase in frequency as syntactic skills develop. To date, this phenomenon has not been studied in children who stutter (CWS). Rispoli, Hadley, and Holt (2008) suggest a schema for categorizing speech disruptions in terms of revisions and stalls. The purpose of this exploratory study was to use this schema to evaluate whether CWS show a pattern over time in their production of stuttering, revisions, and stalls. Nine CWS, ages 2;1 to 4;11, participated in the study, producing language samples each month for 10 months. MLU and *vocd* analyses were performed for samples across three time periods. Active declarative sentences within these samples were examined for the presence of disruptions. Results indicated that the proportion of sentences containing revisions increased over time, but proportions for stalls and stuttering did not. Visual inspection revealed that more stuttering and stalls occurred on longer utterances than on shorter utterances. Upon examination of individual children's language, it appears two-thirds of the children showed a pattern in which, as MLU increased, revisions increased as well. Findings are similar to studies of children with typical fluency, suggesting that, despite the fact that CWS display more (and different) disfluencies relative to typically fluent peers, revisions appear to increase over time and correspond to increases in MLU, just as is the case with peers.

Educational objectives: The reader will be able to: (1) describe the three types of speech disruptions assessed in this article; (2) compare present findings of disruptions in children who stutter to findings of previous research with children who are typically fluent; and (3) discuss future directions in this area of research, given the findings and implications of this study.

Keywords: Disruptions; Stuttering; Language; Children; Longitudinal

1. Introduction

Young children who stutter (CWS) experience onset of stuttering during a time when language development is occurring at a rapid rate. Children generally begin stuttering between the ages of 2;0 and 5;0 years. During that time, based on developmental expectations, children's morphosyntactic skills and vocabulary should develop dramatically (e.g., see Miller, 1981; Templin, 1957). Indeed, although in some cases, subtle language weaknesses or differences

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have been observed in lexical tasks and analyses (e.g., Anderson, 2008; Pellowski & Conture, 2005; Silverman & Bernstein Ratner, 2002; Wagovich & Bernstein Ratner, 2007) and measures of syntax (e.g., Anderson & Conture, 2004; Bajaj, Hodson, & Schommer-Aikins, 2004; Logan & LaSalle, 1999; see Bloodstein & Bernstein Ratner, 2008, for a discussion), the language development of CWS progresses much like that of typically fluent children.

A related issue is, when language poses a challenge for a CWS, whether that challenge results in increased normal disfluency and/or stuttering. There is a rather large body of evidence that CWS as well as their typically fluent peers produce more disfluencies on longer/syntactically complex utterances than on shorter/simpler utterances (e.g., see Bernstein Ratner & Sih, 1987; Gaines, Runyan, & Meyers, 1991; Logan & Conture, 1997; Logan & LaSalle, 1999; Weiss & Zebrowski, 1992, for work on CWS; Gordon & Luper, 1989; Haynes & Hood, 1978; McLaughlin & Cullinan, 1989; Yaruss, Newman, & Flora, 1999, for work on typically fluent children).

The relationship between linguistic challenge and disfluency has been explained within the literature in terms of speech and language "trade-offs" (termed the "bucket theory," Crystal, 1987; see Anderson, Pellowski, & Conture, 2005, for discussion of its application to childhood fluency disorders; see Bernstein Ratner, 1997; Hall, Wagovich, et al., 2007; Zackheim & Conture, 2003, for discussion of fluency/language tradeoffs in CWS). That is, it has been suggested that, as children attempt more ambitious or complex language forms, fluency (including normal disfluency in typically developing children) may temporarily suffer. As CWS begin to master a range of linguistic skills, speech, in turn, should become more fluent or, if stuttering persists, its occurrence should not be closely tied to the production of the mastered forms.

Another perspective on the relationship between language and fluency comes from developmental psycholinguistics in which speech disruptions have been explored as a means of shedding light on the development of sentence planning (e.g., MacWhinney & Osser, 1977; McDaniel et al., 2008; Rispoli, 2003; Wijnen, 1990). It has been shown that typically developing children exhibit increases in disruptions and the emergence of specific types of disruptions (i.e., revisions; Rispoli, Hadley, & Holt, 2008) as they move toward grammatical encoding. It is argued that, until children reach a certain aptitude with comprehension and morphosyntax, and amass a large enough lexicon, processes of language formulation lack sophistication, and therefore, are not subject to correction in the form of speech disruptions (namely revisions). We elaborate on this notion later in the section on types of speech disruptions and their potential relationship to language development.

It is relevant to consider speech monitoring processes in this context. At the same time that children are learning to plan for and execute sentences, they are also gaining skill in monitoring the formulation process. The development of monitoring skills may factor into the emergence of speech disruptions as related to sentence planning (Bernstein Ratner & Silverman, 1999; Rispoli et al., 2008). For CWS, Bernstein Ratner and Silverman (1999) theorized, the combination of reduced capacity for speech and language and, perhaps, heightened auditory self-monitoring, may serve to promote stuttering behavior. In addition to work involving typically developing children and CWS, sentence planning and fluency have been explored in children with language impairments (e.g., Boscolo, Bernstein Ratner, & Rescorla, 2002; Guo, Tomblin, & Samelson, 2008; Hall, Yamashita, & Aram, 1993; Hall, 1996, 1999). Recently, Guo et al. (2008) argued that "weaker linguistic representations," as demonstrated by children with specific language impairment, serve to create vulnerability in language formulation, which is manifested as speech disruptions. Explorations of this nature, examining types of speech disruptions as indicators of sentence planning, are critical, not only for illuminating the processes children use in becoming adult sentence producers, but also for understanding the factors related to the onset and development of stuttering.

1.1. Longitudinal studies of the language of children who stutter

To the extent that the language and fluency of CWS can be observed over time, it should be possible to characterize how language and fluency interact as children develop increasing sophistication in language. Several longitudinal studies of CWS have investigated language skills (Rommel, Häge, Kalehne, & Johannsen, 2000; Ryan, 2001; Watkins & Yairi, 1997; Watkins, Yairi, & Ambrose, 1999; Yairi, Ambrose, Paden, & Throneburg, 1996). These have focused primarily on predicting stuttering persistence versus remission and on characterizing the language skills of each subgroup. For example, Watkins et al. (1999) examined the language performance of 84 children who stuttered. Sixty-two of the children had recovered from stuttering over the four-year investigation, and the remaining 22 persisted in stuttering for that period. The authors collected language samples at the beginning of the study, close to the onset of the children's stuttering, and performed a series of lexical and morphosyntactic analyses over the course of the study. They compared the children's performance across three age groups: 2–3 years, 3–4 years, and 4–5 years. Their main finding was

that, compared to developmental expectations, using data from Miller (1981) and Leadholm and Miller (1992), on average, the children performed at or above expectations whether they were in the persistent or the recovered group. In addition, the group of older children who persisted in stuttering showed lower language performance than those who had recovered, but their language skills, as a group, were still within developmental expectations.

A later study by Johnson, DeThorne, Watkins, Ambrose, and Yairi (2003; see Watkins & Johnson, 2004, for a summary) examined preschool-age children's expressive language profiles over time in relation to whether stuttering increased, decreased, or remained stable. They found that, although there was variability within their sample, children who recovered from stuttering tended to move from above-age level performance on spontaneous language measures to performance that was more age-appropriate as they recovered. That is, over time, the rate of language growth slowed for children who recovered from stuttering.

Similar to these findings were those of Rommel et al. (2000), who conducted a large-scale study in which they examined a wide range of developmental variables. Participants were CWS with an average age of 5 at the beginning of the study. They were followed, for this report, for four and a half years, and were grouped, then, according to whether the children persisted in stuttering throughout the time period, or they recovered during that period. The investigators administered, among other measures, a general language battery of receptive and expressive skills, as well as an expressive vocabulary measure. They found that children who continued to stutter at the end of the study showed significantly higher overall language scores than those who recovered. There was no significant difference on the vocabulary measure.

Finally, Wagovich and Hall (2007), using the same sample as in this report, found that three of four preschool-age CWS who showed the most decrease in stuttering over time also showed a decrease in lexical diversity over time. Of the five children whose stuttering remained more stable or increased, the lexical diversity of their samples each increased over time. In sum, there appears to be some converging evidence of the pattern of decreased language growth for children recovering from stuttering. Importantly, however, none of these studies reports subaverage language performance for the children recovering from stuttering.

Typically, variability is noted within the groups for studies of this type. In fact, Seery, Watkins, Mangelsdorf, and Shigeto (2007) recently reviewed this literature, suggesting that (a) longitudinal research is critical to further our understanding of the relationship between language and stuttering, and (b) evaluating the performance of relevant subgroups is also critical, to disambiguate some of the variability observed in prior research. The present longitudinal study was undertaken, in part, as a first step in examining individual language characteristics that might contribute to patterns of speech disruptions in young CWS.

1.2. Types of speech disruptions and their hypothesized relationship to language development

There has been considerable interest in the speech disruptions (or normal disfluencies) of children with typically fluent speech (Colburn & Mysak, 1982; Hall & Burgess, 2000; Hall, Higgins, et al., 2007; Rispoli, 2003; Rispoli & Hadley, 2001; Rispoli et al., 2008; Wijnen, 1990). The overarching hypothesis of studies of this type is that increased speech disruptions or changes in the disruptions signal a maturing linguistic system. Rispoli et al. (Rispoli, 2003; Rispoli et al., 2008) draw a distinction between two main categories of disruptions: stalls and revisions. Stalls were defined as "interruptions that add or change nothing to the linguistic structure being produced. . .includ[ing] long silent pauses, pauses filled with *um* or *uh*, and repetitions of linguistic material already produced" (Rispoli et al., 2008, pp. 953–954). In contrast, revisions were defined as "overt alterations of at least one morpheme previously spoken" (Rispoli et al., 2008, p. 954). While stalls are described as "prospective" or "internal" phenomena, in which there is potentially a "glitch" in the planning of an utterance, revisions are "retrospective" or "external" phenomena. Revisions involve monitoring the agreement between the intended message and the actual message and making the needed changes when there are discrepancies (see Levelt, 1983).

Using this schema, Rispoli and colleagues (Rispoli, 2003; Rispoli et al., 2008) have examined the nature of typically fluent children's speech production in early development. In Rispoli's (2003) cross-sectional study of children, ages 1;10 to 4;0, he found that the revision rate in children's production of active declarative sentences (ADSs) was greater in children whose grammatical development was more advanced; however, this relationship was not apparent for stalls. Similarly, in a longitudinal study (Rispoli et al., 2008) of typically fluent children followed from ages 21 to 33 months, he and his colleagues found that revision rate in ADSs increased over the course of development (and with age), but stall rate did not. In addition, stalls were produced in greater frequency in longer sentences than shorter ones; revisions

did not show this pattern. Finally, significant individual differences were noted for stall rate; some children evidenced a decrease in stalls over time and others showed an increase. Of importance, from a theoretical standpoint, these findings suggest that stalls and revisions, in fact, represent two discrete forms of disruption.

Somewhat similar findings have been obtained by Hall, Higgins, et al. (2007) and Hall and Burgess (2000). Hall et al., in their cross-sectional study of 30 typically developing children from 28 to 56 months of age, found a strong correlation between revisions and MLU, as well as a weaker but significant correlation between stalls and MLU. Hall and Burgess used a different system for categorizing disruptions, a modification of Dollaghan and Campbell (1992). They analyzed the language and disfluency characteristics of a typically developing child (female, age 2;9 at the beginning of the study) at four points over the period of a year. Findings of the language sample analyses relevant to the present investigation were that, as language developed over the course of the year, the proportions of disruption types shifted from a majority of repetitions at Time 1 and Time 2, to an equal proportion of repetitions and revisions at Time 3, to a majority of revisions at Time 4. Taken together, these studies suggest that the production of revisions may be a particularly sensitive indicator of language growth over time.

Of interest, early on, Colburn and Mysak (1982) examined large language sample datasets from four children, classifying individual language samples as Brown's MLU Stages I through IV. They analyzed disruptions across the four stages. Although the authors emphasized the variation across children, their raw data suggest that the "revision – incomplete phrase" category (defined slightly differently from Rispoli, 2003) showed an increase over the stages for all four children. The other categories, similar to the larger category of "stalls" (Rispoli, 2003), showed greater variability over the four stages and across children.

Finally, Wijnen's (1990) longitudinal case study of a typically fluent boy, age 2;4 to 2;11, suggests that qualitative differences in revisions (or "self-corrections") occurred during this time period. Wijnen reported that, over the four time periods totaling six months, the boy, who spoke Dutch, produced more self-corrections that retraced back to the beginning of a sentence at Times 3 and 4 than at Times 1 and 2. Wijnen noted that in Dutch, a right-branching language, this type of retracing is expected in adult language; thus, the child's shift signals his increasing sophistication in language use.

Taken together, these studies suggest that, in young children with typically developing speech and language, the increased use of revisions, relative to stalls, is expected and signals increased grammatical sophistication, as well as an increase in the child's ability to monitor output and make changes as needed. What is not well understood is whether young children with fluency disorders who are in the midst of language development show a similar pattern of increased revision use over time, relative to stalls and stuttering.

Thus, the purpose of the present exploratory study is to apply Rispoli's classification of disruptions to the speech of CWS (adding to this schema the category of stuttered speech disruptions) and examine disruptions and their relation to language in CWS. In particular, the following research questions were posed:

1. Over a period of approximately 10 months, do the CWS as a group show discernible growth in grammatical and lexical development, as would be expected?
2. During this period, how do the three types of speech disruptions (revisions, stalls, and stuttering) change?
3. Do more disruptions occur in longer ADSs than in shorter ones?
4. Descriptively, do the children's individual patterns of disruptions correspond meaningfully to changes in grammatical and lexical development?

Based on previous findings, we hypothesized that the children would show growth in language over time, and that revision rate would also increase over time. In contrast, if stalls and stuttering are considered "individual difference" phenomena, there should not be a group increase in these disruptions over time. Finally, based on previous research, we predicted that stalls and stuttering would be more prevalent in long versus short sentences, but that the rate of revisions would not differ as a function of sentence length.

2. Method

2.1. Participants

Eleven monolingual English-speaking children, ages 2;1 to 4;11 years, were recruited for the study through various advertisements and announcements on the campus of the University of Missouri and in the city of Columbia, Missouri.

Table 1
Description of participants, stuttering severity, and standardized language test performance.

Participant	Age at Session 1 (yr;mo)	Gender	Stuttering severity at Session 1	Estimated time post onset at Session 1 (mo)	PLS-4 AC[a]	PLS-4 EC[b]
P1	4;11	M	Moderate	19	99	89
P2	2;4	M	Moderate	2	111	112
P3	4;8	M	Moderate	Unknown	109	111
P4	4;8	M	Mild	10–12	92	93
P5	2;1	F	Moderate	3–4	118	141
P6	3;2	M	Very Mild	6–7	102	112
P7	4;6	M	Moderate	Unknown	96	87
P8	3;7	F	Mild	6	126	121
P9	3;1	F	Mild	8	99	110

[a] *Preschool Language Scale, 4th edition*, Auditory Comprehension subtest ($M = 100$, $SD = 15$).
[b] *Preschool Language Scale, 4th edition*, Expressive Communication subtest ($M = 100$, $SD = 15$).

Parents of each child indicated concern about observed stuttering in their children's speech. Following enrollment in the study, each child was determined by a certified speech-language pathologist to demonstrate speech characteristics consistent with a diagnosis of stuttering. Each child contributed 10 speech/language samples as part of the study. To be included in the present study, participants had to reach a threshold of at least 3.0% stuttered syllables in at least one of the 10 language samples elicited. Nine of the 11 children met this criterion. Stuttering severity at the initial sessions was estimated using the *Stuttering Severity Instrument, 3rd edition* (SSI-3; Riley, 1994). Table 1 lists each participant's age, gender, stuttering severity, and the length of time since stuttering onset (as reported by parents).

Parents of all participants indicated no concerns about hearing or visual acuity and reported unremarkable developmental histories of their children. All participants demonstrated global receptive and expressive language skills within the average to above average range. Auditory Comprehension and Expressive Communication subtest scores from the *Preschool Language Scale, 4th edition* (PLS-4; Zimmerman, Steiner, & Pond, 2002) are presented in Table 1.

2.2. Procedure

Participants attended a testing session, which included a series of language tests and other tasks, not related to the present study. As part of this session, the children produced a 100-utterance language sample, and a parent completed a questionnaire, responding to questions about the child's overall development, onset of stuttering, family history of stuttering, and stuttering characteristics. When all testing could not be completed within a single session, a second session, within a week of the first, was scheduled to complete it.

Following the testing session(s), the children and their parents were asked to return to the clinic each month for nine months, during which an additional 100-utterance speech/language sample was obtained. The intervals between samples were approximately one month (ranging from four to six weeks). All samples were video recorded using a Sony Mini-DV Digital Handyman camera with digital Mini-DV tapes and a cordless lapel microphone. The language samples were play-based, with a standard set of toys from which the children could choose. All samples were obtained with the same examiner (with one exception: Session 1 for the first participant), a graduate research assistant trained in language sample elicitation. All sessions were conducted in a sound-treated room within the Speech and Hearing Clinic of the University of Missouri.

After each session, language samples were transcribed by graduate and undergraduate research assistants, using the conventions of the *Systematic Analysis of Language Transcripts* (SALT; Miller, 2008). Each sample and its coding were then reviewed and corrected by the first author. As a final step, a different research assistant checked the transcription against the videotaped sample. Any disagreements throughout this process were resolved by consensus.

2.3. Language analyses

Mean length of utterance in morphemes was obtained through the SALT Standard Measures. Samples were then converted to CLAN format (MacWhinney, 2000), using the conversion program in CLAN. This was necessary to run

Table 2
Classification of revisions, stalls, and stuttering.

Revisions	Stalls	Stuttering
"Overt alterations of at least one morpheme previously spoken" (Rispoli et al., 2008, p. 954)	"Interruptions that add or change nothing to the linguistic structure being produced. . .includ[ing] long silent pauses, pauses filled with *um* or *uh*, and repetitions of linguistic material already produced" (Rispoli et al., 2008, pp. 953–954). Sound-syllable repetitions and monosyllabic word repetitions were not considered stalls; they were classified as stuttering.	Consisted of blocks (including tense pauses and broken words), prolongations (including disrhythmic phonations), sound/syllable repetitions, and monosyllabic whole word repetitions

the lexical diversity analysis, *vocd* (Malvern & Richards, 1997). *Vocd* is a program that analyzes samples of any length (50 word minimum) for their lexical diversity, while taking into account sample size. For a description of the use of this program with CWS, see Silverman and Bernstein Ratner (2002).

2.4. Coding of active declarative sentences and disruptions

Upon completion of language sample transcription, the third author reviewed each transcript and coded all active declarative sentences (ADSs) according to Rispoli et al. (2008). Specifically, ADSs were those that contained a lexical verb, excluding imitations and "I don't know" utterances. When an utterance contained a pause of greater than 3.0 s, it was divided into two utterances, with the first considered abandoned. This had the effect of excluding any ADSs with excessive pauses. The 3.0 s cutoff was selected to be consistent with the procedure of Rispoli et al. (2008). Finally, to exert some degree of control over the motoric complexity of ADSs, Rispoli's procedure of limiting ADSs to seven phonological words or fewer was adopted. For analyses that focused on length, utterances with two to four phonological words were considered "short," and those with five to seven phonological words were considered "long."

All ADSs were coded for the presence of revisions, stalls, and stuttering. The classification schema for identifying each of these is described in Table 2. As can be seen from the table, we used a fairly standard description of stuttering for coding. The description included sound-syllable repetitions and monosyllabic whole-word repetitions, among other stuttering types. Because these behaviors were coded as stuttering, they were not coded as stalls. This departure from Rispoli et al. (2008) procedure was necessary because of the difference in populations across studies; in the present study, it seemed critical to consider all "stuttering" behaviors as separate from the other disruption types.

In order to examine performance over time with sufficient separation between time intervals, only language samples from the beginning (Samples 1 and 2), middle (Samples 5 and 6), and end (Samples 9 and 10) of the study were analyzed. Data from each sample pair were merged; MLU and *vocd* values were averaged across each pair. Similarly, the number of ADSs and the number of revisions, stalls, and stuttering were summed across session pairs. To obtain the proportion of ADSs that contained each disruption type, disruption type was divided by the number of ADSs for each sample pair. Thus, the data set consisted of samples from three time periods for each of the nine children.

2.5. Reliability

To estimate the reliability of the coding of disruptions, an undergraduate research assistant listened to 11 of the 54 samples included in the analysis set (20.3%), and coded each ADS as containing stalls, revisions, and/or stuttering. Inter-rater agreement on the presence or absence of each disruption type was assessed using Cohen's kappa. Agreement was .91 for revisions, .88 for stalls, and .90 for stuttering.

2.6. Statistical analysis

Because of the small sample size, the Page-L trend test (Page, 1963; Hicks, 2004) was used to test our hypotheses pertaining to language change and change in disruptions over time. This nonparametric statistic is appropriate for

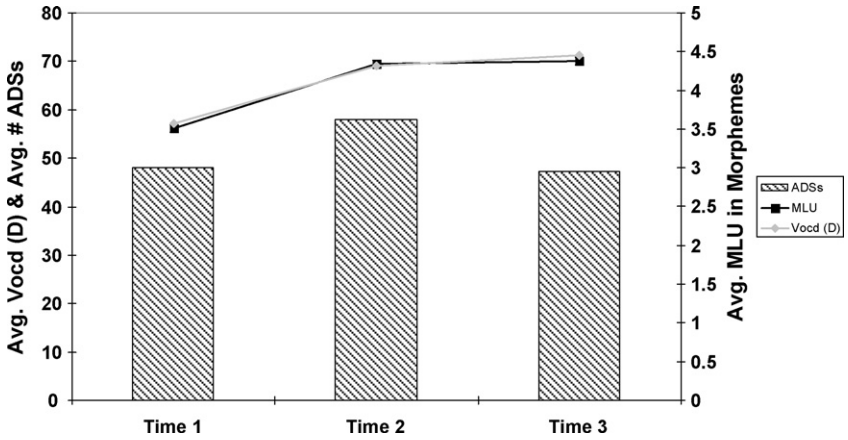

Fig. 1. Mean MLU and *vocd* values and mean number of active declarative sentences (ADSs) over time.

studies of small sample sizes when there are three or more conditions, and when a trend is predictable (such as an increase in language skills or disruptions over time).

3. Results

3.1. Language growth over time

Over the 10 months of the study, the children showed significant growth in their conversational language over time. The difference is particularly apparent from Time 1 to Time 2, as can be seen in Fig. 1. The increase observed was significant for MLU, $L = 121$, $p < .001$, and *vocd*, $L = 117$, $p < .05$. Using Cohen's *d*, effect sizes of the difference in performance between Time 1 and Time 3 were large for MLU ($d = .90$) and medium to large for *vocd* ($d = .71$).[1]

On average, the number of ADSs did not systematically increase over time. Rather, the middle sessions (T2) tended to contain more ADSs than T1 or T3. There was considerable variability across participants in the number of ADSs produced (T1: $M = 48.0$, $SD = 21.7$; T2: $M = 58.0$, $SD = 11.6$; T3: $M = 47.2$, $SD = 7.2$). The number of short ADSs (T1: $M = 20.1$, $SD = 8.1$; T2: $M = 23.6$, $SD = 5.1$; T3: $M = 17.2$, $SD = 4.0$) and long ADSs (T1: $M = 27.9$, $SD = 16.3$; T2: $M = 34.4$, $SD = 11.1$; T3: $M = 30.0$, $SD = 7.3$) also varied. Fig. 1 displays bars representing the average number of ADSs produced at each time period.

3.2. Changes in disruptions over time

Based on the trend analysis, over time, the difference in the use of revisions increased, $L = 116$, $p < .05$, but the use of stalls showed a slight, nonsignificant decrease, $L = 104.5$, $p > .05$. The increase in revisions from Time 1 to Time 3 represented a medium effect ($d = .50$), whereas the decrease in stalls was a small effect ($d = .20$). The change in stuttering, as expected, was variable across children. The difference over time was not significant, $L = 106$, $p > .05$, $d = .09$, with no effect. Fig. 2 displays the changes observed in revisions, stalls, and stuttering over time. Recall that disruption proportions were calculated only on ADSs, in order to exert some degree of control over the range of utterance types (see Rispoli et al., 2008). Therefore, the proportion of ADSs containing stuttering did not necessarily correspond to stuttering severity, but only to the occurrence of stuttering on this one sentence type.

Table 3 shows the proportion of ADSs containing revisions, stalls, and stuttering for each participant over time. Descriptively, most participants, six of the nine, showed an increase in the proportion of ADSs that were revisions, over time. Of the three remaining participants, two showed a variable pattern (P3 and P9), and one showed a clear

[1] As a side analysis, the samples used in the present study were compared to the age-appropriate samples in the SALT Conversational Database (Miller, 2008), to determine whether the children's MLU was comparable to same-age peers. One child, P1, fell below the −1.0 *SD* cutoff for each of the six language samples. In contrast, two of the children (P2 and P5) had MLUs within the average range or above on all six samples. The remaining six children had a mix of MLU values that extended above and below the −1.0 *SD* cutoff. This range of performance was observed despite average to above-average performance for all participants on standardized language testing.

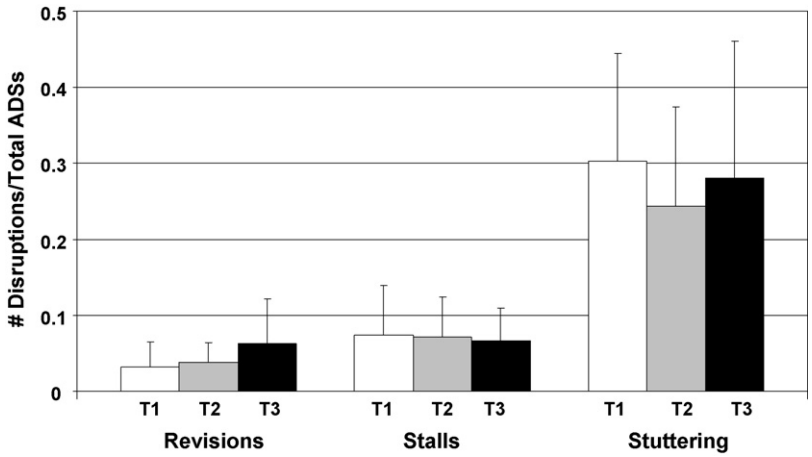

Fig. 2. Changes in revisions, stalls, and stuttering over time: Group results.

decrease over time (P7). In contrast to revisions, production of stalls across participants was quite variable, with only one participant (P5) showing a clear increase over time. Finally, as expected, the children differed from one another in their patterns of stuttering over time. Four of the children showed an increase in stuttering on ADSs over time, three showed a decrease, and two showed a variable pattern.

Table 3
Proportion of ADSs that contained revisions, stalls, and stuttering, for each participant over time.

Participant	Time 1	Time 2	Time 3	Trend
Revisions				
P1	0	0.024	0.100	Increasing
P2	0.085	0.061	0.200	Increasing
P3	0.048	0.063	0.043	Variable
P4	0.016	0	0.039	Increasing
P5	0	0.018	0.045	Increasing
P6	0.024	0.041	0.077	Increasing
P7	0.079	0.037	0.000	Decreasing
P8	0	0.020	0.021	Increasing
P9	0.033	0.081	0.042	Variable
Stalls				
P1	0	0.049	0	Variable
P2	0.153	0.171	0.073	Variable
P3	0.060	0.016	0.106	Variable
P4	0.048	0.111	0.078	Variable
P5	0	0.035	0.045	Increasing
P6	0.190	0.082	0.115	Variable
P7	0.105	0.111	0.100	Variable
P8	0.057	0.059	0	Variable
P9	0.050	0.016	0.083	Variable
Stuttering				
P1	0.511	0.512	0.200	Decreasing
P2	0.458	0.256	0.364	Variable
P3	0.417	0.317	0.149	Decreasing
P4	0.081	0.079	0.118	Increasing
P5	0.143	0.123	0.227	Increasing
P6	0.333	0.224	0.269	Variable
P7	0.237	0.278	0.580	Increasing
P8	0.286	0.275	0.542	Increasing
P9	0.267	0.129	0.083	Decreasing

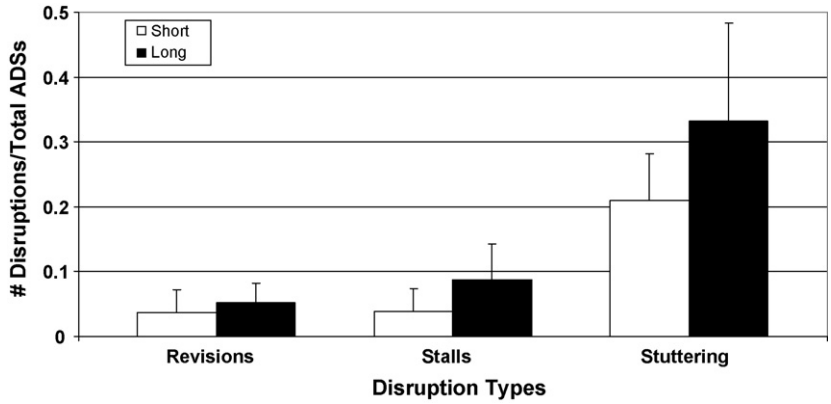

Fig. 3. Production of revisions, stalls, and stuttering in short vs. long ADSs.

3.3. Effect of utterance length on patterns of disruptions

To examine whether longer utterances contained more disruptions of each type than shorter utterances, the proportions of shorter and longer disruption types for each time period were calculated. Fig. 3 shows these mean proportions for revisions, stalls, and stuttering. The standard deviation bars indicate the amount of variability across individual children. Descriptively, revisions did not occur disproportionally on long utterances; they were fairly equally distributed between long and short utterances. In contrast, it appears that stalls and (to a greater extent) stuttering occurred more frequently on long utterances than on short ones.

3.4. Individual patterns of correspondence between language performance and revisions

Given that group data indicated a significant trend of increasing revision use over time (but no significant trend for stalls or stuttering), and a significant trend of increasing *vocd* and MLU over time, the final descriptive analysis is an examination of whether growth in language corresponds to changes in the proportion of revisions for *individual* children. Fig. 4 displays a graph for each participant, depicting performance over time on revisions in relation to *vocd* and MLUx10. (In order to capture revisions and both language analyses on a single graph per participant, MLU scores were converted to "MLUx10" values.) Graphs are arranged in ascending order of the children's ages.

Visual inspection of each graph reveals that most of the children (P5, P9, P6, P3, and possibly P4 and P1) showed a pattern of correspondence between MLU and the use of revisions, such that, when MLU increased, so did the proportion of revisions, and when MLU decreased, revisions did, as well. Of the children who showed that correspondence, two of them (P5 and P6) seem to show some positive correspondence, although weaker, between *vocd* and revision use. Moreover, P8, who did not show correspondence between MLU and revisions, did show positive correspondence between *vocd* and revisions. Two of the children, P2 and P7, showed no clear pattern of correspondence between revisions and either language measure.

4. Discussion

This study was intended as a preliminary look at the speech disruptions of young children who stutter. Revisions, stalls, and stuttering were examined in the active declarative sentences of children who stutter. Disruptions were examined over time and also with respect to language skills.

4.1. Changes in language growth over time

As a group, the CWS showed language growth, in both morphosyntactic and lexical skills, suggesting that despite fluctuations of various disruption types, the language skills of CWS progress over time. This, of course, is an expected finding; it confirms the expected upward trend in expressive language skills as children develop. It should be noted that, although Fig. 1 shows an overall increase in performance on the language measures, Fig. 4 displays some variability across participants. For example, only six of the nine children produced their lowest MLU at T1 and their highest at

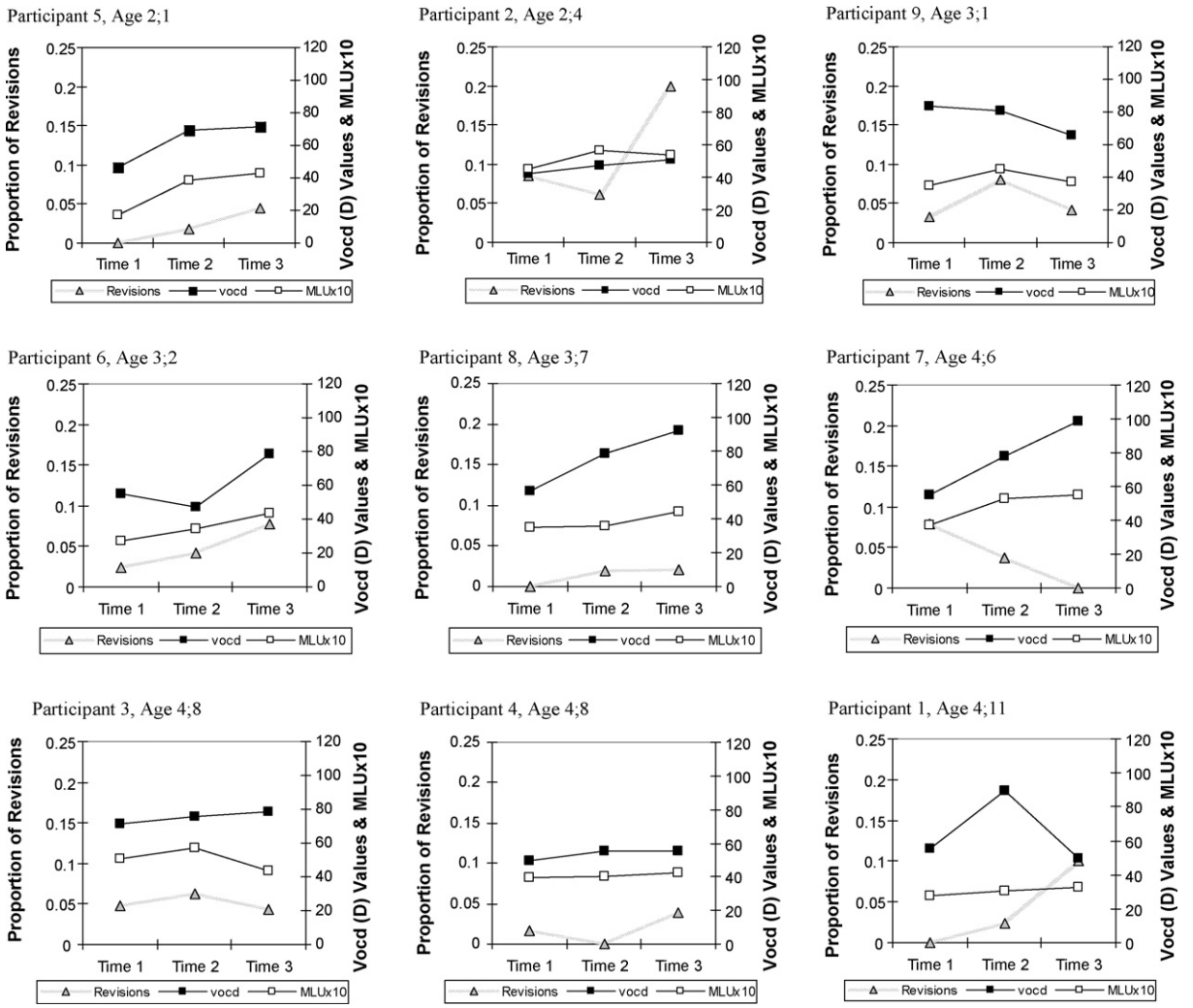

Fig. 4. Individual patterns of correspondence between revisions versus *vocd* and versus MLU.

T3. Thus, our study is similar to other longitudinal work with CWS, which also shows variability in performance (e.g., Johnson et al., 2003; Watkins et al., 1999).

4.2. Changes in disruptions over time

A central aim of this study was to explore whether CWS display a similar pattern of disruption use over time, compared to typically fluent children. Indeed, the findings of this study suggest that our small group of nine CWS show a pattern of increased revision use over time, but variable use of stalls and, as expected, a variable stuttering pattern over time. These findings are consistent with the Rispoli (2003) and Rispoli et al. (2008) studies of typically fluent children. The former study, a cross-sectional design, demonstrated that revision rate of ADSs was greater with the older children in the group than the younger, but that stall production did not show this pattern. Similarly, the latter study, a longitudinal study, showed that revision rate increased over time, but stall rate remained variable, with children showing individual patterns of change in either direction. Findings of Colburn and Mysak (1982) and Hall and Burgess (2000) of increased rate of revisions in typically fluent children over time are also consistent with our findings.

The present findings are somewhat in contrast to those of Hall, Higgins, et al. (2007), with typically fluent children. In their cross-sectional sample, they found MLU significantly related to both revisions and stalls (with *vocd* not significantly related to either disruption type). Their study was different from the present study in several important

ways. It was cross-sectional, as opposed to longitudinal, and had a larger sample size. Importantly, the Hall, Higgins, et al. study used all utterances regardless of length or sentence type. As noted, previous research in this area and the results of the present study suggest that stalls are more common in longer utterances, which could account for the significant relationship between stalls and MLU in Hall, Higgins, et al. Thus, if the present study had not limited the analysis set to ADSs of seven or fewer phonological words, our findings likely would have been similar.

Of course, an alternative explanation is that findings of the present study differed because the populations differed (i.e., typically fluent children vs. CWS). Our intent in the present study was to replicate the methodological details of the studies by Rispoli (2003) and in particular, Rispoli et al. (2008), to the extent possible, given our small sample. The fact that, despite studying different populations, the present study is quite similar in outcomes to Rispoli et al., suggests that CWS perform similarly to fluent peers in their use of revisions and stalls, and that the differences observed between Hall, Higgins, et al. (2007) and the present study are due to methodological factors.

It should be noted that the children in the present study varied in their rates of revision use, but the extent to which they varied, on average, was similar to Rispoli et al. (2008). They reported revision rates of approximately .05 for short ($SD = .02$) and long ($SD = .04$) ADSs. In comparison, average revisions rates for the present study were .04 ($SD = .04$) for short ADSs and .05 ($SD = .03$) for long ADSs. The children's revision use ranged from rates of 0 to .19 for short and from 0 to .21 for long ADSs, indicating some variability.

4.3. *Effect of utterance length on patterns of disruptions*

One of the motivations for carefully controlling length of utterance in the analyses of disruptions was to enable evaluation of the interaction of length and rate of disruption. There is evidence that CWS are more likely to be disfluent on longer utterances (e.g., Logan & Conture, 1995; Melnick & Conture, 2000). Of course, logically, it makes sense that disruptions of all types should occur in greater numbers within longer utterances, because longer utterances are more motorically complex and contain more opportunities (i.e., more syllables) on which to be disfluent. Thus, it is not surprising that our descriptive analyses revealed what appears to be more stuttering and more stalls on the longer utterances. Initially, what is somewhat surprising, at least using the above logic, is that there is not an apparent difference in the number of revisions in long versus short utterances. However, these findings are consistent with Rispoli et al. (2008), who found that children with normal fluency produced more stalls in longer than shorter utterances, but that the occurrence of revisions did not differ by length of utterance. Rispoli et al. suggest that stalls signal a slow down in the planning of an utterance; this idea is consistent with our findings that stalls (and stuttering) occur more frequently on longer utterances that potentially tax planning capabilities more. In contrast, revisions occur following production of some language, and involve comprehension processes and detection of the language to be revised. Considered in this light, the choice to revise language would not be expected to occur disproportionately in long utterances. Hence, Rispoli and colleagues' findings are consistent with their predictions, and our findings with children who stutter seem to support their predictions, as well.

4.4. *Individual patterns between language performance and revisions*

An emphasis of our study was on assessing the individual patterns of language growth in relation to the use of disruptions. In particular, given that the proportion of ADSs containing revisions increased over time, we evaluated whether this change in revision use corresponded to the increases we observed in MLU and *vocd* over time. Through visual inspection, it appears that two-thirds of the children showed a positive correspondence between revision use and MLU. The degree of correspondence is striking and consistent with findings of typically fluent children (Rispoli, 2003; Hall, Higgins, et al., 2007). Thus, the present findings suggest similarity between CWS and children who do not stutter in that, overall, both groups show positive correspondence between revision use and MLU.

Findings of the present study suggest that only three of the children showed a positive correspondence between revisions and *vocd*; in fact, two of those showed stronger correspondence between MLU and revisions than *vocd* and revisions. These findings are interesting, particularly in light of the observation of Wagovich and Hall (2007), with the same children, that increases in lexical diversity scores seem to correspond somewhat to increases in *stuttering* during this developmental time period.

4.5. Summary, limitations, and future directions

The central findings of the present study were that (a) the CWS showed an increase in revisions, but not stalls or stuttering over time; (b) descriptively, stuttering and stalls, but not revisions, occurred in greater numbers on longer than shorter utterances; and (c) for most CWS, change in revisions corresponded positively to change in MLU, but not *vocd*, over time. Although the study should be regarded as an exploratory investigation of trends within the data, findings suggest that the pattern of stalls and revisions seen in CWS is similar to the pattern seen in children who are typically fluent. Even for CWS, revisions do appear to signal growth in syntax and may indicate that CWS use similar mechanisms of sentence planning as their fluent peers. Consistent with interpretations offered in previous psycholinguistic work (e.g., MacWhinney & Osser, 1977; Rispoli et al., 2008; Wijnen, 1990), the increased use of revisions over time in our group of CWS likely indicates a growing sophistication with formulating language. While this is most apparent with our syntactic measure of MLU, it is plausible that other measures of language growth that tap into morphosyntactic/lexical changes or represent the development of more sophisticated speech monitoring processes may also correspond to changes in revision use.

Rispoli et al. (2008) suggest that, based on their data, stalls and revisions should be considered distinct categories of speech disruptions. The present study supports the extension of this assertion to CWS. There is some evidence that change in stuttering over time is positively related to change in lexical diversity (Wagovich & Hall, 2007). Thus, the possibility that stuttering, another type of speech disruption, corresponds more directly to lexical diversity than to morphosyntax deserves additional consideration in future studies.

Several limitations of the present research should be noted. First, admittedly, the sample size is quite small, so the generalizability of findings is limited. However, the approach involved considerable language sampling over time, resulting in data that were likely representative of the children's day to day speech and language performance—more so than studies measuring children's speech and language in one or two sessions. Because of the small sample size, we were limited to trend analysis and descriptive analysis. However, the findings, as presented, enable some statements of group performance while emphasizing the individual variation across children. We would argue that this information is as vital as the identification of commonalities across participants.

Second, descriptive data related to the children's treatment is incomplete. Parents were asked at the outset of the study to indicate whether their children were enrolled in fluency treatment; one child was. Although we did not re-administer the questionnaire each month of the study, we were aware that some of the children's parents sought fluency treatment over the course of the study. Unfortunately, we do not have sufficiently complete data on the nature of the treatment or its duration to perform analyses of its potential impact on the speech disruptions observed over time in the present study.

Third, MLU was selected as a rough measure of morphosyntax. Although more detailed measures exist (e.g., *Developmental Sentence Scoring*, Lee, 1974; *Index of Productive Syntax*, Scarborough, 1990), we opted to use MLU because of its efficiency and wide use clinically. It appears that MLU was a reasonably sensitive measure, in this case, given the observed correspondence between it and the use of revisions for most participants.

As Rispoli et al. (2008) suggest, we chose to limit speech disruption analyses (although not MLU and *vocd* analyses) to ADSs and to limit length of the sentences to seven phonological words, rather than include all utterances of all lengths. Arguably, this choice strengthened our findings, in that we were able to examine disruptions while placing careful controls on variables that may impact the occurrence and frequency of disruptions. Nonetheless, had we used ADSs of all lengths, instead of limiting the analysis set to those with seven or fewer phonological words, length findings may have been even stronger. It is noteworthy, therefore, that, despite length restrictions, it still appears that stuttering and stalls occurred more frequently on the longer ADSs, as predicted.

Finally, we did not employ a comparison group of children with typical fluency; therefore, comparative statements between populations are somewhat speculative. However, there are several studies that employed rather large samples of typically fluent children; such studies help to place the present findings in context. Thus, it seems appropriate, within limits, to compare the present exploratory study's findings with CWS to those larger studies of CWNS.

There is much left to understand about the occurrence of speech disruptions, including stuttering, in relation to young children's developing language. For example, future research might seek to examine children's language development early on (i.e., at around 27 months), as stuttering and revisions emerge. Examining (a) a narrower window of language acquisition and (b) children who are closer to the onset of stuttering would provide greater insight into how language growth and speech disruptions co-occur in early development.

In addition, future studies might employ a large group comparative design to probe the findings of the present exploratory study. Examination and characterization of (a) correspondence between revisions and growth in MLU, and (b) correspondence between stuttering and growth in lexical diversity could lead to a more comprehensive and accurate understanding of the ways in which these speech disruptions might signal growth in language development.

CONTINUING EDUCATION

Speech disruptions in relation to language growth in children who stutter: An exploratory study

QUESTIONS

1. Which of the following is true of both stalls and revisions?
   (a) they are both speech disruptions
   (b) they are produced by both CWS and CWNS
   (c) they are both types of stuttered disfluencies
   (d) both a and b above
   (e) all of the above
2. In the present study, only active declarative sentences (ADSs) were analyzed for disruptions:
   (a) because they were the only sentences that contained disruptions
   (b) so that disruption types could be examined while controlling for sentence type
   (c) so that the analysis set would be smaller and more manageable
   (d) because stuttering occurs almost entirely on ADSs
   (e) none of the above
3. The *vocd* analysis was selected because:
   (a) it enables morphosyntactic analysis while taking into account vocabulary diversity
   (b) it enables analysis of disruptions while taking into account the length of a language sample
   (c) it enables lexical analysis while taking into account the length of the language sample
   (d) it enables analysis of stuttering while taking into account morphosyntax
   (e) none of the above
4. A central finding of this study is that, as a group:
   (a) CWS showed increased use of revisions over time
   (b) CWS showed increased use of stalls over time
   (c) CWS showed increased stuttering over time
   (d) a and b
   (e) none of the above
5. According to the present findings, which type(s) of disruptions occur(s) more frequently in longer utterances?
   (a) revisions
   (b) stalls
   (c) stuttering
   (d) both b and c above
   (e) all of the above

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