ELSEVIER

Journal of Fluency Disorders 30 (2005) 219–253

Journal of FLUENCY DISORDERS

# Childhood stuttering and dissociations across linguistic domains

Julie D. Anderson[a,*], Mark W. Pellowski[b], Edward G. Conture[c]

[a] *Indiana University, Department of Speech and Hearing Sciences, 200 South Jordan Avenue, Bloomington, Indiana 47405, USA*
[b] *Towson University, USA*
[c] *Vanderbilt University, USA*

Received 4 April 2005; received in revised form 13 May 2005; accepted 15 May 2005

**Abstract**

The purpose of this investigation was to evaluate the possible presence of dissociations in the speech and language skills of young children who do (CWS) and do not stutter (CWNS) using a correlation-based statistical procedure [Bates, E., Appelbaum, M., Salcedo, J., Saygin, A. P., & Pizzamiglio, L. (2003). Quantifying dissociations in neuropsychological research. *Journal of Clinical and Experimental Neuropsychology, 25,* 1128–1153]. Participants were 45 preschool CWS and 45 CWNS between the ages of 3;0 and 5;11 (years;months), with the two groups matched by age, gender, race, and parental socioeconomic status. Children participated in a parent–child interaction for the purpose of disfluency analysis and responded to four standardized speech-language tests for subsequent analyses as main dependent variables. Findings indicated that CWS were over three times more likely than CWNS to exhibit dissociations across speech-language domains, with 44 cases of dissociation for CWS and 14 for CWNS across 10 possible comparisons. Results suggest that there may be a subgroup of CWS who exhibit dissociations across speech-language domains, which may result in a greater susceptibility to breakdowns in speech fluency.

***Educational objectives:*** The reader will be able to: (1) summarize findings from previous studies examining differences in speech and language performance between children who do and do not stutter; (2) describe what is meant by "dissociations" in the speech and language skills of young

* Corresponding author. Tel.: +1 812 856 1240; fax: +1 812 855 5531.
*E-mail address:* judander@indiana.edu (J.D. Anderson).


doi:10.1016/j.jfludis.2005.05.006

children who do and do not stutter; and (3) discuss three hypotheses that could account for the present findings that suggest CWS, more often than CWNS, exhibit dissociations in their speech-language system.


*Keywords:* Stuttering; Dissociation; Preschool; Language

---

The issue of whether children who stutter (CWS) differ from children who do not stutter (CWNS) in terms of linguistic abilities has been a topic of much interest and controversy (see Ratner, 1997 for review). However, findings from descriptive studies of the speech and language abilities of CWS have been less than consistent. On the one hand, some literature reviews and empirical studies have suggested that CWS may have less developed phonology, vocabulary, or overall language abilities than their normally-fluent peers (Anderson & Conture, 2000, 2004; Byrd & Cooper, 1989; Louko, Conture, & Edwards, 1999; Paden, Yairi, & Ambrose, 1999; Pellowski, Conture, Anderson, & Ohde, 2001; Silverman & Ratner, 2002). On the other hand, some empirical studies have found no evidence to suggest that the speech or language abilities of CWS are less robust than those of CWNS (e.g., see Nippold, 2002 for review). For example, Howell, Davis, and Au-Yeung (2003) reported that CWS and CWNS (aged 2–10 years) performed similarly on the Reception of Syntax Test, a measure of syntactic development. To further challenge any clear-cut interpretation of this area of empirical investigation, some studies have reported that CWS may have above average expressive language abilities relative to their developmental expectations (Watkins & Yairi, 1997; Watkins, Yairi, & Ambrose, 1999).

Nevertheless, despite apparent differences in findings among descriptive studies of the speech and language abilities of CWS, most would appear to agree that the linguistic characteristics associated with instances of stuttering are relatively consistent in their distribution and loci. That is, instances of stuttering exhibited by CWS tend to occur on (a) low frequency words (Anderson, 2005; Soderberg, 1966; Palen & Peterson, 1982), (b) first three words of an utterance (Bernstein, 1981; Howell & Au-Yeung, 1995; Wall, Starkweather, & Cairns, 1981), (c) function words (Bernstein, 1981; Bloodstein & Grossman, 1981; Graham, Conture, & Camarata, 2005; Howell, Au-Yeung, & Sackin, 1999; Natke, Sandreiser, van Ark, Pietrowsky, & Kalveram, 2004), and (d) longer or more syntactically complex utterances (Ratner & Sih, 1987; Howell & Au-Yeung, 1995; Kadi-Hanifi & Howell, 1992; Logan & Conture, 1995, 1997; Melnick & Conture, 2000; Yaruss, 1999). These linguistic factors have also been shown to influence the fluency with which words are produced in adolescents and adults who stutter (e.g., Bergmann, 1986; Brown, 1945; Danzger & Halpern, 1973; Hubbard & Prins, 1994; Klouda & Cooper, 1988; Natke, Grosser, Sandrieser, & Kalveram, 2002; Prins, Hubbard, & Krause, 1991; Ronson, 1976; Wingate, 1984). However, unlike young CWS, older children and adults tend to stutter more on content words than function words (e.g., Brown, 1938a,b; Dayalu, Kalinowski, Stuart, Holbert, & Rastatter, 2002; Howell et al., 1999). Taken together, the relatively consistent association observed between certain utterance characteristics and the loci of stuttering seems to suggest that there may be an interaction between linguistic processing and instances of stuttering.

Findings that the linguistic characteristics of stuttering events are fairly predictable, along with evidence from some studies suggesting that CWS may have less developed linguistic skills than CWNS has prompted some theorists to speculate that CWS may have dissociations or asynchrony within or between subcomponents of their linguistic formulation processes. For example, speculation associated with the Neuropsycholinguistic Theory of Stuttering (Perkins, Kent, & Curlee, 1991) suggests that people who stutter experience asynchrony between linguistic and paralinguistic processing components as a result of linguistic uncertainty or inefficient neural resources. This asynchrony induces disfluencies that are transformed into stuttering events under conditions of time pressure; the speaker is required to initiate and accelerate the disrupted utterance and experiences loss of control in the process. More generally, this theory suggests that stuttering occurs as a function of reduced efficiency in one or more processing systems (linguistic, paralinguistic, integrative, and segmental), resulting in an imbalance in the production of language "as different components arrive at a central language integrator at different times and thus have a mistimed impact on the motor production of speech" (Tetnowski, 1998; p. 243).

The notion that CWS may have temporal asynchrony or disequilibrium between components of their speech-language processing systems is also indirectly reflected in the Covert Repair Hypothesis (Postma & Kolk, 1993). The basic premise of this theory is that CWS have slower-than-normal phonological encoding systems, which increases the probability that their phonetic plans will include more phoneme errors. If these errors are detected by the internal speech monitoring system, then there will be more error correction opportunities prior to overt execution of speech. It is this "covert repair reaction" to errors in the phonetic plan that is thought to disrupt the forward flow of speech production, resulting in hesitations, repetitions, and prolongations. This theory generally implicates speech-language production *planning* processes as a potential source of difficulty for CWS. If these linguistic planning processes were, indeed, problematic for CWS, then there would seem to be potential for the presence of dissociations among components of their speech-language systems. In this way, the phonological processing systems of CWS would be considerably less efficient or more susceptible to disruptions than other linguistic formulation processes, leading to dissociations in performance. Such dissociations in the speech-language systems of young children, who may already be vulnerable to errors and/or delays in processing as they work to develop more abstract, adult-like linguistic representations, could potentially contribute to the onset and development of stuttering (see Savage & Lieven, 2004; cf. Anderson & Musolino, 2004; Demuth, 2004).

The two aforementioned psycholinguistic theories are based on the notion that the loci of dissociation is relatively static for all CWS—that is, dissociations exist between linguistic and paralinguistic components (Neuropsycholinguistic Theory) or, more indirectly, between phonological encoding and other processing domains (Covert Repair Hypothesis). However, it may be, as suggested by Smith and Kelly (1997) that no single factor can be conclusively identified in the etiology of stuttering. In other words, different factors may be responsible for the development of stuttering in different CWS (see e.g., Schwartz & Conture, 1988, for similar discussion and data pertaining to behavioral subgroups among young children who stutter). According to this line of thinking, CWS may experience a range of potential dissociations across speech-language domains. If this is the case, then perhaps models that focus more generally on the interaction among speech-language domains may be more germane to speculation concerning the role of linguistic dissociations in developmental stuttering. For example, linguistic trade-off models (e.g., Crystal's (1987) "bucket" theory) commonly presume that increased demands or complexity requirements in one speech-language domain are associated with decreases in complexity or accuracy in another domain (e.g., speech fluency). Thus, the mere presence of a dissociation (regardless of its nature) in the speech-language systems of CWS could, at least theoretically, lead to a greater expenditure of resources being directed towards linguistic processes. With more resources being allocated towards managing these dissociations, fewer resources would be available for the production of fluent speech, with the net effect being an increase in speech disfluencies.

Although there has been a considerable amount of speculation regarding the potential role that linguistic dissociations may play in developmental stuttering, few research studies have examined whether CWS do, in fact, exhibit more dissociations across speech and language domains than CWNS. However, the concept of dissociations has played a significant role in neuropsychological research, particularly with respect to examining the relationship between specific brain regions and their behavioral functions (Bates, Appelbaum, Salcedo, Saygin, & Pizzamiglio, 2003). For example, a dissociation in performance can be said to exist when Clinical Population X exhibits low performance on one behavioral task (Task A) and high performance on another behavioral task (Task B) when compared to Clinical Population Y who exhibits high performance on Task A and low performance on Task B (Bates et al., 2003). More specific to the fields of speech-language pathology and neuropsychology, dissociations between object (noun) and action (verb) naming have been reported in the aphasia literature, such that nonfluent aphasics tend to exhibit high performance on noun naming and low performance on verb naming, whereas fluent aphasics tend to have the opposite pattern of performance (verb > noun; Caramazza & Hillis, 1991; Damasio, Grabowski, Tranel, Hichwa, & Damasio, 1996; Zingeser & Berndt, 1990). Alternatively, the probability of a proposed dissociation in a single clinical population can be evaluated by comparing the clinical population with a normal control population on several behavioral measures (Bates et al., 2003). For example, although children with language disorders have been found to perform similarly to children with typical language development on prosodic tasks, they score lower on measures of segmental phonology, suggesting a dissociation between lexical and prosodic phonology (Snow, 2001).

While dissociations in brain-damaged individuals are an important source of evidence in the study of the neural bases of behavioral functions, they have, as previously suggested, less often been studied in other clinical conditions, such as developmental stuttering. However, one study attempted to quantify the presence of language dissociations in childhood stuttering by examining differences in performance between speech and language measures in CWS and CWNS. In particular, Anderson and Conture (2000) found that CWS, when compared to CWNS, exhibit a significantly greater difference between standardized measures of receptive/expressive language and receptive vocabulary, with receptive/expressive language being better developed than receptive vocabulary. On average, CWS scored almost 30 percentile points higher on the receptive/expressive language measure than on the receptive vocabulary measure. Likewise, CWNS exhibited the same relative trend of lexical development lagging that of syntactic development, but there was only an average of a 13 percentile point difference between the two measures. Anderson and Conture took these findings to suggest that preschool CWS may have an imbalance among components of their speech-language systems.

Although Anderson and Conture (2000) appear to be among the first to directly examine the notion of dissociations in the speech and language skills of CWS, language dissociations have been previously observed for children with language disorders who are "highly disfluent" (Hall, Yamashita, & Aram, 1993). In specific, Hall et al. investigated the relationship between fluency and language in 60 children with language disorders and found that "highly disfluent" children ($n = 10$; 8.04% or higher total disfluencies) had significantly greater semantic than morphosyntactic capacities. The authors concluded that for these children, "the automaticity with which they are able to produce the more rule based components of spoken language, such as morphology and syntax is not as efficient as their capacity to manage semantic parameters or vocabulary" (p. 577). In a follow-up study of these children, Hall (1996) found that while the overall frequency of speech disfluencies tended to decrease over time, most of these children continued to exhibit higher-than-average frequencies of total disfluencies. Further, Hall reported that the overall decrease in speech disfluencies over time tended to be associated with improvements in overall language skills (i.e., the dissociation between semantic and syntactic capabilities diminished).

Although the frequency and type of speech disfluencies exhibited by these "highly disfluent" children with language disorders may not be quantitatively or qualitatively the same as those exhibited by children with developmental stuttering, these findings, along with those of Anderson and Conture (2000), provide some preliminary evidence to suggest that childhood stuttering could be associated with linguistic dissociations, at least for some children who stutter. In this way, whether the dissociation is, for example, between linguistic and paralinguistic inputs or between lexical and morphosyntactic abilities, such dissociations may disrupt the forward flow of speech-language planning and production, resulting in hesitations, repetitions, and prolongations of sounds, syllables, or words. Any proposed dissociations, however, need not reflect a significant delay or disorder in one component of the system. Indeed, it is quite possible that dissociations could exist among components of the system even though the system is, overall, well within or even above normal limits. In other words, an individual could be classified ". . .as a dissociated case, where Y is abnormally low for that patient's value of X, even though this individual is performing close to the group mean on both measures" (Bates et al., 2003; p. 1144). In essence, the present authors neither explicitly nor implicitly imply that dissociations cannot be a part of normal speech-language development; rather the issue these authors seek to explore is whether CWS differ from CWNS in the quantity and/or quality of any potential dissociation(s).

One problem with using high versus low performance profiles (see Anderson & Conture, 2000) to identify dissociations in one or more clinical populations, according to Bates et al. (2003), is that the probability of finding a proposed dissociation by chance is typically not taken into consideration. Further, when using this "high versus low performance" approach in conjunction with inferential statistics, some researchers may make faulty assumptions about the independence and equivalence of variances and means between measures, thereby increasing the risk of false positives and/or false negatives. In other words, this approach is based on the assumption that the measures are independent of one another, meaning that they are not correlated. Measures that are weakly correlated more closely approximate the assumption of measurement independence, a necessary prerequisite for statistical testing.

However, when this assumption is violated because the measures are highly correlated, it has a significant effect on the level of significance (results in incorrectly small *p*-values) and statistical power, leading to an increased risk of false negatives and false positives. And, the higher the correlation between measures, the greater the effect it will have on the results.

As an alternative to techniques that assume measurement independence (i.e., examining high versus low performance profiles), Bates et al. (2003) developed a statistical procedure to determine the probability of dissociations that takes the means and standard deviations of the population into account, along with the correlation between behavioral measures. As Bates and her colleagues suggest, if the correlation between two measures is low, then there will be little difference in outcomes between this correlation technique and those that assume measurement independence. On the other hand, if the correlation between two measures is high, as is often the case with speech-language measures, then this correlation-based technique will increase the probability of finding dissociations that may be of interest theoretically. In addition to protecting against false positives and false negatives, this correlation-based procedure has the advantage of enabling identification of individual differences in performance profiles.

In summary, given the aforementioned observations, further empirical study of possible dissociations between linguistic variables in CWS and CWNS is warranted. If such dissociations exist, it will be important to examine how they relate to childhood stuttering. Therefore, the purpose of this investigation was to use the correlation-based procedure developed by Bates et al. (2003) to evaluate whether CWS and CWNS have dissociations between or within components of their speech-language systems. In specific, the primary goal was to assess whether CWS and CWNS differ in terms of differences between standardized measures of (a) one-word receptive and expressive vocabulary; (b) overall receptive and expressive language; and (c) speech sound articulation. Although standardized measures may not be the most precise or direct means of examining children's performance across linguistic domains (see Hakim & Ratner, 2004 for commentary), the use of these measures along with the Bates et al. (2003) correlation-based procedure represents, at the very least, a first step towards further examining the empirical reality of theoretical notions of potential dissociations in CWS. A secondary goal of this study was to determine whether children who exhibit dissociations differ from children who do not exhibit dissociations in speech disfluency and speech-language measures.

## 1. Method

### 1.1. Participants

Participants were two groups of 45 children ($N = 90$) between the ages of 3;0 and 5;11 (years;months) who do (CWS) ($M = 49.1$ mos.) and do not stutter (CWNS) ($M = 49.1$ mos.). Children in both groups were matched by age (±4 months), gender (29 boys, 16 girls in each group), race (1 Asian, 4 black or African American, 40 white in each group), and parental socioeconomic status. Parental socioeconomic status was determined by using the Hollingshead Two-Factor Index of Social Position (Myers & Bean, 1968), which is based on the "head of household's" occupation and educational level (the child's father in dualparent families [96.7% of the sample] and the mother in single-parent families [3.3% of the sample]). Children in each group were matched by their Hollingshead classification level (each group had 18 class I, 12 class II, 8 class III, and 7 class IV classifications). There was no significant difference in terms of social position between CWS ($M = 25.4$, S.D. = 14.4, Hollingshead classification II) and CWNS ($M = 24.6$, S.D. = 15.3, Hollingshead classification II), $t(88) = .26$, $p = .80$.

All participants were volunteers in an ongoing series of studies examining the relationship between stuttering and language/phonology/temperament conducted at the Vanderbilt Bill Wilkerson Hearing and Speech Center (VBWC; e.g., Anderson & Conture, 2004; Zackheim & Conture, 2003). Parents were made aware of this study through an advertisement in a widely read, parent-oriented magazine; referral from professionals in the community (e.g., speech-language pathologists, day care centers, etc.); or referral from VBWC for the initial assessment of stuttering.

#### *1.1.1. Criteria for participant inclusion*

All participants were native speakers of Standard American English with no history of neurological, speech-language (other than stuttering), hearing, or intellectual problems per parent report and examiner observation. To participate, children from both groups were required to pass a hearing screening (described below) and a general/oral motor functioning screening test (the *Selected Neuromotor Task Battery* [SNTB; Wolk, 1990]). Children who do not stutter were also required to score at the 20th percentile or higher on four standardized speech-language tests to ensure that children with speech and/or language delays/disorders were not included as participants. No child from either group received prior treatment for articulation, language, or stuttering at the time they participated in this study.

#### *1.1.2. Criteria for group classification*

Children were placed into one of two groups (CWS or CWNS) based on the following criteria: (a) number of stuttering-like disfluencies (part-word repetitions, single-syllable word repetitions, sound prolongations, blocks, and tense pauses) per 100 words of conversational speech (see Pellowski & Conture, 2002; Yairi & Ambrose, 1992 for the description and use of this measure); and (b) total overall score on the *Stuttering Severity Instrument-3* (SSI-3; Riley, 1994). A child was classified as a CWS if he/she exhibited *three or more* stuttering-like disfluencies and had a score of 11 or higher (at least "mild" in severity) on the SSI-3 (18 were classified as "mild", 23 "moderate", 2 "severe", and 2 "very severe"). In addition, the parent(s) or caregiver(s) of these children had all expressed concern about their child's speech fluency and believed that their child stuttered. Using the previously described "bracketing" procedure (e.g., Anderson, Pellowski, Conture, & Kelly, 2003; Yairi & Ambrose, 1992), the average time since parental-reported onset of stuttering for the CWS was determined to be 13.1 months (S.D. = 8.2 months; range = 3 to 38 months).

A child was classified as a CWNS if he/she had *two or fewer* stuttering-like disfluencies and a score of 10 or lower (a severity rating no higher than "very mild") on the SSI-3. All parent(s) or caregiver(s) of these children believed that their child was normally-fluent and had no prior history of stuttering.

### *1.2. Procedures*

Participants were assessed on two occasions—in the home and clinic. First, the third investigator and two doctoral students (all of whom are certified Speech-Language Pathologists) visited the child's home and administered three standardized speech-language tests, along with the SNTB. Approximately one week later, the child and his/her parent(s) visited the clinic to respond to an additional standardized speech-language test, participate in a parent–child interaction, and complete a hearing screening.

#### *1.2.1. Standardized speech-language tests and hearing screening*

*1.2.1.1. Standardized speech-language tests.* Standardized speech-language tests were used to assess the preschool children's receptive-expressive language and vocabulary abilities, along with their articulation abilities for subsequent analyses as main dependent variables. Four standardized speech-language measures were administered: (a) the *Peabody Picture Vocabulary Test-III* (PPVT-III; Dunn & Dunn, 1997), (b) the *Expressive Vocabulary Test* (EVT; Williams, 1997), (c) the *Test of Early Language Development-3* (TELD-3; Hresko, Reid, & Hamill, 1999), and (d) the "Sounds in Words" subtest of the *Goldman-Fristoe Test of Articulation-2* (GFTA-2; Goldman & Fristoe, 2000). Age-based standard scores were obtained for the PPVT-III, EVT, TELD-3, and the GFTA-2 subtest using the scoring methods outlined in each test manual. What follows is a brief description of each of these four standardized tests, as described in each test manual.

The PPVT-III assesses spoken word comprehension (i.e., receptive vocabulary), whereas the EVT measures both expressive vocabulary and word retrieval (Dunn & Dunn, 1997; Williams, 1997). In other words, for the PPVT-III, the child must be able to demonstrate knowledge or understanding of words. However, for the EVT, the child must also have the ability to retrieve words from memory, as well as demonstrate word knowledge. The PPVT-III and EVT were co-normed using a sample of 2725 participants between the ages of $2\frac{1}{2}$ and 90 years, and have median internal consistency (coefficient alpha method) reliabilities of .95 and .95, respectively, and mean test–retest reliabilities of .92 and .84, respectively.

The TELD-3 measures spoken language development (semantics, syntax, and morphology) in young children between the ages of 2;0 and 7;11 (years;months) and is divided into two subtests—Receptive and Expressive (Hresko et al., 1999). The Receptive Language subtest assesses language comprehension, including the ability to identify vocabulary, make decisions about the acceptability of syntactic constructions, and follow directions. The Expressive Language subtest measures oral communication and, as such, it examines young children's ability to actively participate in a conversation, answer questions, use diverse vocabulary, and generate complex sentences. The TELD-3 was standardized on a normative sample of 2217 children and has a median coefficient alpha of .92 and test-retest reliability of .87 for both subtests combined.

The "Sounds-in-Words" subtest of the GFTA-2 is an assessment of speech sound articulation in single words (Goldman & Fristoe, 2000). Specifically, the GFTA-2 examines an individual's articulation of consonant sounds in Standard American English via spontaneous single-word elicitation in response to pictures. The GFTA-2 was standardized on a normative sample of 2350 participants aged 2;0 to 21;11 and has a median coefficient alpha reliability of .94 and .96 for males and females, respectively, and a median test-retest reliability of .98 for initial, medial, and final sounds.

*1.2.1.2. Hearing screening.* Each child's hearing was screened for participant inclusion purposes in a sound-proofed room using bilateral pure tone testing at 20 dB SPL from 500 to 4000 Hz (American Speech-Language-Hearing Association, 1990). Impedance audiometry was also performed in the range of 800 to 3000 ohms.

### *1.2.2. Parent–child conversational interaction*

Children participated in an informal parent–child conversational interaction for the analysis of stuttering (CWS) and speech disfluency (CWNS). The parent(s) and child verbally interacted with each other for approximately 15–30 min while seated at a small table with several toys. The 300-word speech sample obtained for each participant was analyzed for (a) mean frequency of stuttering-like disfluencies (part-word repetitions, single-syllable word repetitions, sound prolongations, blocks, and tense pauses), (b) other disfluencies (polysyllabic word repetitions, phrase repetitions, and revisions), (c) total disfluencies (stuttering-like plus other disfluencies) per 100 words, and (d) stuttering severity, as measured by the SSI-3.

### *1.2.3. Data analysis*

Performance on standardized speech-language tests across the two groups was compared using a multivariate analysis of variance (MANOVA). Bonferroni corrections were applied (based on an alpha level of .05) in determining significance. For the correlation-based analyses of the main dependent variables (GFTA-2, PPVT-III, EVT, TELD-3 Expressive and Receptive), standard scores were transformed into *z*-scores, so that each variable had a mean score of zero and the individual scores represented standard deviations from the mean. Correlation analyses were conducted to examine relationships between performances on the speech-language measures. Any apparent dissociations were identified using density ellipses with a confidence interval of 95% (see Results for further details). A density ellipse shows the extent of data, the center of mass, the linear fit line, and the degree of correlation between two selected variables (Sall, Creighton, & Lehman, 2004). Correlation coefficients were interpreted according to Newton and Rudestam (1999).

Performance on the speech disfluency measures (stuttering-like, other, and total speech disfluencies; and SSI-3) was compared across the two groups using the Mann-Whitney test. This nonparametric test was chosen as the method of statistical analysis, since data from all three measures violated the normality assumption for parametric tests. The Mann-Whitney test and MANOVA were also used to examine differences in speech disfluency and speech-language measures between children who exhibit dissociations and children who do not exhibit dissociations. All analyses were performed using JMP (Sall et al., 2004) and SPSS version 12.0 (SPSS, 2003) statistical programs.

### *1.2.4. Intra- and interjudge measurement reliability*

Intra- and interjudge measurement reliability was calculated for judgments of stuttering-like and other disfluencies based on 12 randomly selected conversational speech samples (representing 14% of the total data corpus). Six of these speech samples were obtained from the group of CWS and six were obtained from the group of CWNS. The total data corpus for measurement reliability purposes consisted of 3600 total words, with 300 words obtained per participant in each group. The first and second authors re-observed videotape recordings of the conversational speech samples from the 12 children and re-identified all instances of stuttering-like and other disfluencies within each sample. Utilizing the following measurement reliability index, $(A+B/[A+B]+[C+D]) \times 100$, where $A$, number of words judged stuttered on both occasions; $B$, number of words judged nonstuttered on both occasions; $C$, number of words judged stuttered on one occasion; and $D$, number of words judged nonstuttered on one occasion, the intrajudge (and interjudge) measurement reliability percentages included the following: (a) stuttering-like disfluencies: 99% (90%) and (b) other disfluencies: 99% (91%).

## 2. Results

### 2.1. Between-group differences for speech disfluency measures

Speech disfluency measures (stuttering-like, other, and total speech disfluencies; and SSI-3) were analyzed using the Mann-Whitney test. As expected (based on selection criteria), when compared to CWNS, CWS exhibited significantly more stuttering-like disfluencies ($z = -7.95$, $p < .05$) and total disfluencies ($z = -7.51$, $p < .05$), and scored significantly higher on the SSI-3 ($z = -8.25$, $p < .05$). However, there was no significant difference between the two groups in other speech disfluencies ($z = -1.04$, $p = .29$).

### 2.2. Between-group differences for speech-language measures

Between-group differences in standard scores for the four standardized speech-language tests (TELD-3, GFTA-2, EVT, and PPVT-III) were analyzed using a MANOVA (see Fig. 1). Findings of the MANOVA (Bonferroni corrected) indicated that CWS scored significantly lower than CWNS on the TELD-3 Expressive subtest, $F(1, 88) = 9.96$, $p < .05$, and the TELD-3 Receptive subtest, $F(1, 88) = 17.25$, $p < .05$. Bonferroni corrected statistical analyses indicated no significant differences between CWS and CWNS on the GFTA-2, $F(1, 88) = 3.27$, $p = .07$; EVT, $F(1, 88) = 1.79$, $p = .19$; and PPVT-III, $F(1, 88) = 5.33$, $p = .02$, although the latter approached significance. Thus, even though both groups exhibited standardized speech and language test scores well within normal limits, findings suggest that the overall language abilities (as based on the TELD-3) of CWS may be lower than those of appropriately matched CWNS (findings similar to other empirical studies in this area reported by the authors, e.g., Pellowski et al., 2001). Findings further revealed that CWS consistently scored lower than CWNS on all other speech-language measures (vocabulary and speech sound development), although these differences were not statistically significant.

### 2.3. Associations/dissociations in performance across speech-language measures

Relationships across speech-language measures for CWS and CWNS were examined using correlation analyses (see Bates et al., 2003). In specific, analyses were conducted for

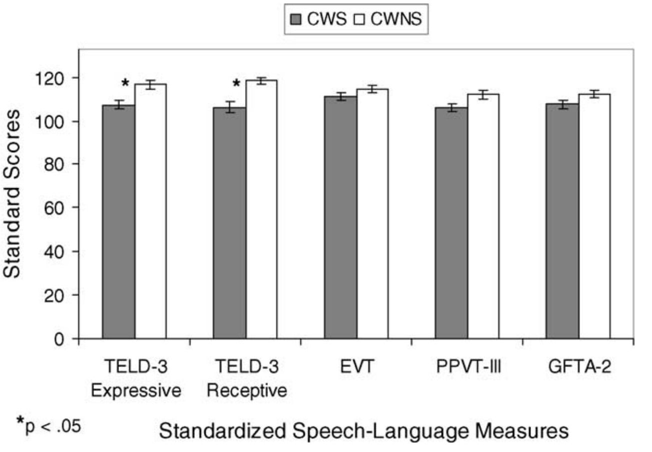


Fig. 1. Mean standard scores (S.E.M. = brackets) on the standardized speech-language measures (TELD-3 Expressive and Receptive subtests, PPVT-III, EVT and GFTA-2) for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$).

two variables within the domains of vocabulary, language, oral communication, comprehension, and speech sound development. In an attempt to provide comprehensive coverage of all possible dissociations, several ancillary analyses were also performed for two variables across domains (language versus vocabulary) and modalities (expressive versus receptive). Density ellipses, which were constructed for the group of CWNS using a confidence interval of 95%, were used to identify outliers in performance across measures (Sall et al., 2004). Thus, the density ellipses represent 95% of the normal population or the "typical cases," while the 5% of cases that fall outside of the ellipsoid are considered to be the "unusual cases" or outliers (Bates et al., 2003). Density ellipsoids were *constructed* for the group of typically-developing children (i.e., CWNS), because they served as the basis for evaluating the probability of dissociations in CWS, and then *applied* to the data for both groups of children.

While this correlation-based method quantitatively examines potential dissociations by identifying outliers in a dataset, the actual process of determining whether or not a "true dissociation" exists is more qualitative in nature (Saygin, Dick, Wilson, Dronkers, & Bates, 2003). For example, a child who performs two standard deviations below the mean on both variables may fall outside the density ellipsoid and while this may be of interest considering that few children may exhibit this pattern of low performance on both variables, it does not represent a dissociation in the true sense of the word. That is, the child's performance on the two measures does not dissociate or "come apart" in any interesting or meaningful way.

Thus, in attempts to provide some quantitative support for the typically qualitative process of determining whether or not a true dissociation exists, an outlier (i.e., a participant) was considered to exhibit a true dissociation if there was a difference of at least one standard deviation between the two selected variables. A criterion of one standard deviation difference between two variables was chosen, because it provided an additional measure to delineate dissociations. Therefore, to be classified as a true dissociation, an individual child's performance on the two variables had to (a) fall outside the ellipses, in the space occupied by 5% of the population (this 5% probability is also referred to as the significance level or alpha value), *and* (b) be separated by at least one standard deviation. For example, a child who fell outside the ellipse would be categorized as a case of dissociation if he/she performed at the mean on one variable and one or two standard deviations below the mean on the other variable.

#### *2.3.1. Associations/dissociations in vocabulary: EVT versus PPVT-III*

Performance in one-word expressive and receptive vocabulary for CWS ($r = .62$, $p < .05$) and CWNS ($r = .61$, $p < .05$) was moderately-to-strongly, positively correlated (Newton & Rudestam, 1999). Thus, children's performance on these two measures are reasonably consistent with one another, such that a high performance on the EVT tends to be associated with a high performance on the PPVT-III and vice versa, a finding that is not altogether surprising given that the two tests were co-normed with one another. However, by calculating a density ellipse with a confidence interval of 95%, outliers in the dataset seemingly become apparent. As may be seen in Fig. 2a, 4 CWS (4/45 = 8.9% of CWS) remained outside the ellipse, whereas only 1 CWNS (1/45 = 2.2% of CWNS) fell outside the ellipse. Three of the four CWS outliers met the criteria for dissociation, with 2 CWS exhibiting profiles of receptive vocabulary < expressive vocabulary and 1 CWS exhibiting the opposite profile (receptive vocabulary > expressive vocabulary). The single CWNS outlier, who had a profile of receptive vocabulary > expressive vocabulary, also met the criteria for dissociation.

#### *2.3.2. Associations/dissociations in language: TELD-3 Expressive versus TELD-3 Receptive*

As with the previous comparison, overall expressive and receptive language were moderately-to-strongly, positively correlated for CWS ($r = .61$, $p < .05$) and CWNS ($r = .53$, $p < .05$). Thus, as one might expect, given that these two subtests both measure aspects of language development, high performance on one language variable tends to be associated with high performance on the other language variable and vice versa. The density ellipse, which is depicted in Fig. 2b, revealed a non-trivial number of outliers in this sample of children, with 12 CWS (12/45 = 26.7% of CWS) and 3 CWNS (3/45 = 6.7% of CWNS) falling outside the ellipse. However, only four of the twelve CWS actually met the criteria for dissociation, with 3 CWS exhibiting a profile of expressive language > receptive language and 1 exhibiting the opposite pattern of performance (expressive language < receptive language). Of the 3 CWNS outliers, only 1 was identified as a case of dissociation, with a profile of expressive language > receptive language.

#### *2.3.3. Associations/dissociations in oral communication: TELD-3 Expressive versus EVT*

Performance in overall expressive language and one-word expressive vocabulary was also positively correlated for CWS ($r = .54$, $p < .05$) and CWNS ($r = .45$, $p < .05$). Because the TELD-3 Expressive subtest has a vocabulary component, although limited in scope, the moderate-to-strong positive correlation between this subtest and the EVT is not altogether surprising. Nevertheless, the density ellipse revealed that 6 CWS (6/45 = 13.3% of CWS) fell outside the ellipse, while only 1 CWNS (1/45 = 2.2% of CWNS) was identified as

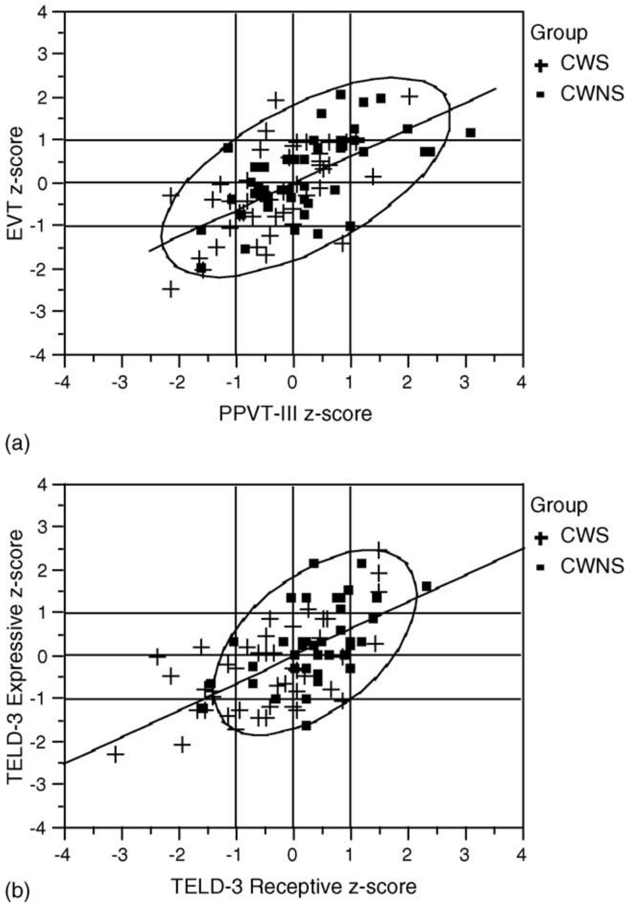


Fig. 2. Correlation between (a) receptive and expressive vocabulary and (b) receptive and expressive language for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$). Linear fit (for CWS and CWNS combined) and density ellipses (CI = 95%) are shown.

an outlier (see Fig. 3a). Five of the 6 CWS met the criteria for dissociation, along with the single CWNS. Of the five cases of CWS dissociation, 3 had a profile of expressive language > expressive vocabulary, while 2 had a profile of expressive language < expressive vocabulary. The only CWNS who met the criteria for dissociation performed two standard deviations above the mean in expressive language and slightly below the mean in expressive vocabulary (i.e., expressive language > expressive vocabulary).

#### *2.3.4. Associations/dissociations in comprehension: TELD-3 Receptive versus PPVT-III*

The association in performance for overall receptive language and one-word receptive vocabulary was also significantly, moderately correlated for both CWS ($r = .58$, $p < .05$) and CWNS ($r = .44$, $p < .05$), suggesting that performance on these two measures tend to go

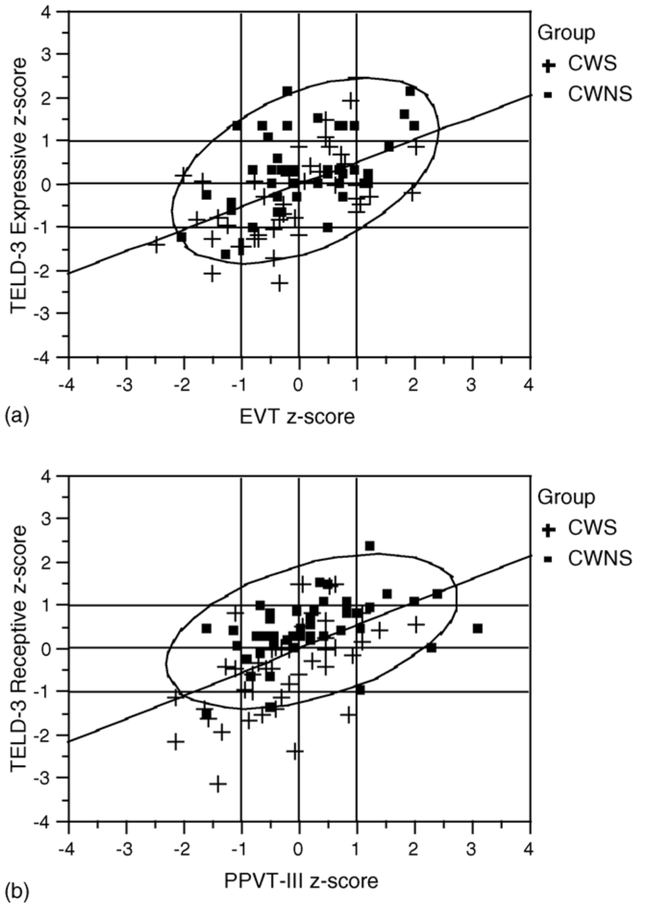


Fig. 3. Correlation between (a) expressive language and vocabulary and (b) receptive language and vocabulary for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$). Linear fit (for CWS and CWNS combined) and density ellipses (CI = 95%) are shown.

hand in hand, as would be expected considering that part of the TELD-3 Receptive subtest requires the identification of vocabulary items. As indicated in Fig. 3b, the outlier analysis revealed that 11 CWS (11/45 = 24.4% of CWS) and 6 CWNS (6/45 = 13.3%) fell outside the density ellipse, but only 5 CWS and 4 CWNS met the criteria for dissociation. Four CWS and 3 CWNS had profiles of receptive vocabulary > receptive language, while 1 CWS and 1 CWNS exhibited the opposite pattern of performance (receptive vocabulary < receptive language).

### *2.3.5. Associations/dissociations in speech sound development: GFTA-2 versus Expressive and Receptive language variables*

For both CWS and CWNS combined, the correlations between speech sound development and all other language variables, including expressive and receptive vocabulary and

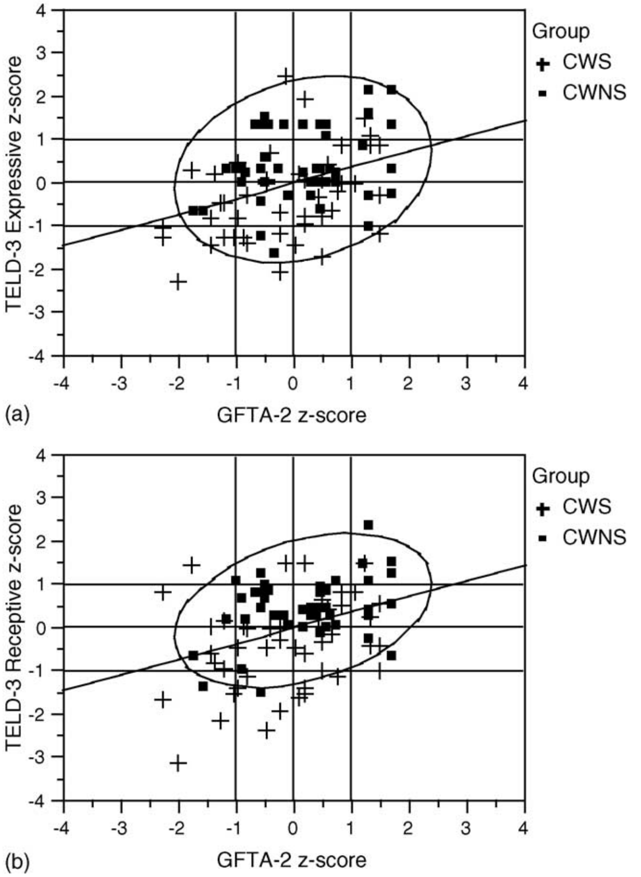


Fig. 4. Correlation between speech sound development and (a) expressive language and (b) receptive language for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$). Linear fit (for CWS and CWNS combined) and density ellipses (CI = 95%) are shown.

language, were significant, but the strength of the associations was only weak-to-moderate ($r = .31$ to .36, $p < .05$). For speech sound development and overall *expressive* language (see Fig. 4a), the density ellipses indicated that although 8 CWS (8/45 = 17.8% of CWS) remained outside the ellipse, all CWNS fell within the 95% confidence interval. Six of the eight CWS were identified as cases of dissociation. Half of the CWS ($n = 3$) exhibited a profile of speech sound development > expressive language, while the other 3 CWS had the opposite pattern of performance (speech sound development < expressive language). Findings for speech sound development and overall *receptive* language was even more striking, with 14 CWS (14/45 = 31.1% of CWS) and only 4 CWNS (4/45 = 8.9% of CWNS) falling outside the density ellipse (see Fig. 4b). Ten CWS and 3 CWNS met the criteria for dissociation, with 8 CWS and 2 CWNS exhibiting a profile of speech sound development > receptive language. The remaining 2 CWS and 1 CWNS exhibited the opposite profile of speech sound development < receptive language.

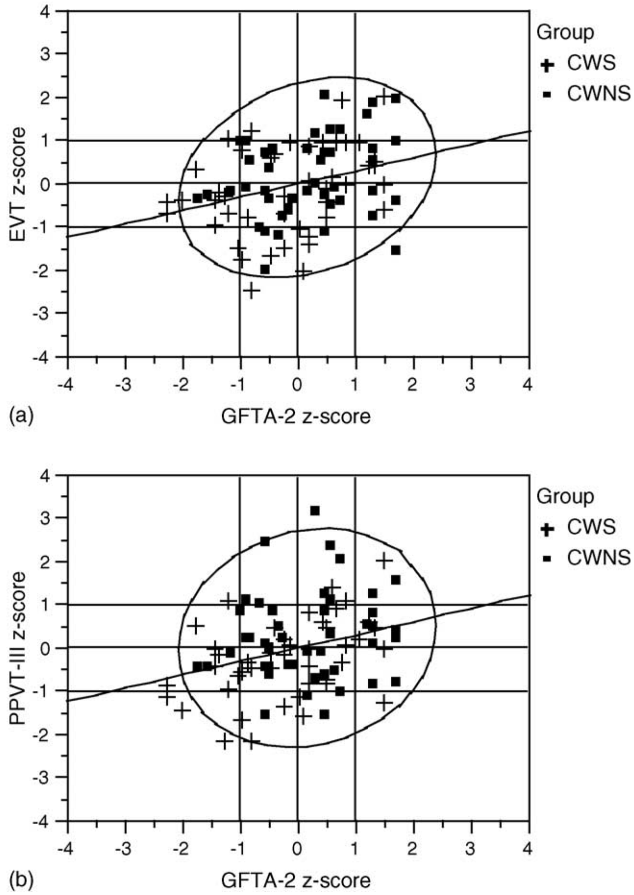


Fig. 5. Correlation between speech sound development and (a) expressive vocabulary and (b) receptive vocabulary for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$). Linear fit (for CWS and CWNS combined) and density ellipses (CI = 95%) are shown.

### *2.3.6. Associations/dissociations in speech sound development: GFTA-2 versus Expressive and Receptive vocabulary*

Findings from the correlation analysis for speech sound development and one-word expressive vocabulary was much less striking (see Fig. 5a), at least in terms of the number of participants who exhibited dissociation. However, of the 3 CWS (3/45 = 6.7% of CWS) and 1 CWNS (1/45 = 2.2% of CWNS) who had been identified as outliers, all met the criteria for dissociation. One CWS and the single CWNS had profiles of speech sound development > expressive vocabulary, whereas the other 2 CWS had profiles of speech sound development < expressive vocabulary. The analysis for speech sound development and one-word receptive vocabulary revealed similar findings, with only 4 CWS and 1 CWNS remaining outside the ellipse (see Fig. 5b). However, findings revealed that only 2 CWS and the one CWNS actually met the criteria

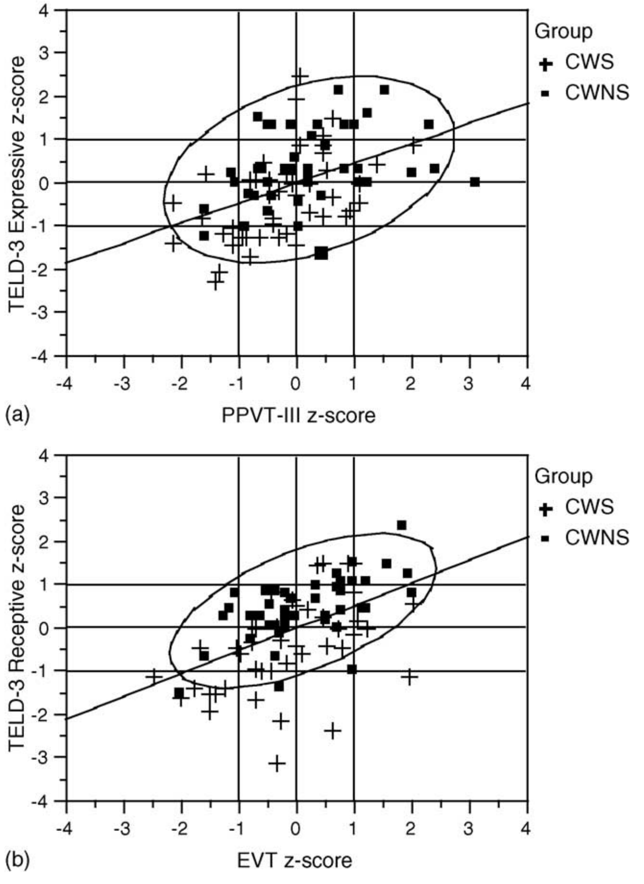


Fig. 6. Correlation between (a) expressive language and receptive vocabulary and (b) receptive language and expressive vocabulary for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$). Linear fit (for CWS and CWNS combined) and density ellipses (CI = 95%) are shown.

for dissociation, all of whom had a profile of speech sound development < receptive vocabulary.

### *2.3.7. Ancillary comparisons*

*2.3.7.1. TELD-3 Expressive versus PPVT-III.* The strength of the association between overall expressive language and one-word receptive vocabulary was weak-to-moderate for CWS ($r = .46$, $p < .05$) and CWNS ($r = .36$, $p < .05$). Considering that these two measures differentially assess performance across various domains and modalities, this weak-to-moderate association is not completely unexpected. As shown in Fig. 6a, the density ellipse revealed that 4 CWS (4/45 = 8.9% of CWS) and 2 CWNS (2/45 = 4.4% of CWNS) fell outside the ellipse, but only 1 CWS and 1 CWNS actually met the criteria for dissociation. The single CWS evidenced a pattern of expressive language > receptive vocabulary, while the CWNS displayed the opposite pattern of performance (expressive language < receptive vocabulary).

*2.3.7.2. TELD-3 Receptive versus EVT.* The association between overall receptive language and one-word expressive vocabulary was slightly stronger than the previous comparison, but still relatively weak-to-moderate for children in both groups (CWS: $r = .49$, $p < .05$; CWNS: $r = .57$, $p < .05$). However, the density ellipse revealed a considerable number of outliers in this sample, with 12 CWS (12/45 = 26.7% of CWS) and 4 CWNS (4/45 = 8.9% of CWNS) falling outside the ellipse (see Fig. 6b). The 5 CWS and 1 CWNS who met the criteria for dissociation all exhibited a profile of expressive vocabulary > receptive language.

*2.3.8. Summary*

*2.3.8.1. Standardized speech-language tests.* In general, findings indicated that even though CWS performed within the average to slightly above average range on all standardized speech-language measures, they still performed consistently lower than their normally-fluent peers, particularly with respect to overall expressive and receptive language. Furthermore, the standardized speech language measures were, for the most part, moderately-to-strongly correlated with one another, suggesting that development among the various linguistic domains does tend to go “hand-in-hand.” As previously mentioned, this finding is not altogether surprising, since the content of some measures, such as the TELD-3 Expressive and the EVT, do overlap to some degree. However, since none of the correlations were even close to perfect (the highest $r$-value was .62), it is clear that these measures are, indeed, tapping into different components of the speech-language system.

*2.3.8.2. Number of outliers.* With respect to the correlation-based analyses, findings revealed that of the 78 outliers for CWS, 44 (56.4%) met the criteria for dissociation, while 14 (60.9%) of the 23 outliers for CWNS were considered dissociations. Thus, CWS were just over three times more likely than CWNS to exhibit cases of “true dissociation” across speech-language domains. The 44 cases of dissociation for CWS were produced by 16 different children among the 45 CWS, 12 (75.0%) of whom exhibited dissociations across more than one speech-language domain. The 14 cases of dissociation for CWNS were produced by 8 different children among the 45 CWNS, with 4 CWNS (50.0%) exhibiting more than one dissociation across speech-language domains. In other words, 35.6% (16/45) of the CWS produced dissociations that met criteria compared to only 17.8% (8/45) of the CWNS.

*2.3.8.3. Number of outliers that met criteria for dissociation.* Of the 44 outliers that met criteria for dissociation for CWS, 21 (47.7%) cases were below the mean on both measures, 20 (45.4%) were below the mean on at least one measure, and 3 (6.8%) were at or above the mean on both measures. On the other hand, of the 14 cases of dissociation for CWNS, only 1 (8.3%) case was below the mean on both measures, while 5 (35.7%) were below the mean on one measure and 8 (58.3%) were at or above the mean on both measures. A chi-square analysis revealed that this association between group and performance distribution was statistically significant, $\chi^2(2, N = 58) = 19.0$, $p < .05$. Thus, CWS were significantly more likely to perform below the mean on one or more measure(s), while CWNS were more likely to perform above the mean on one or more measure(s). Finally, findings indicated that CWS tended to have the greatest number of dissociations in the domain of speech sound development and overall receptive language ($n = 10$; see Fig. 7), with most CWS exhibiting

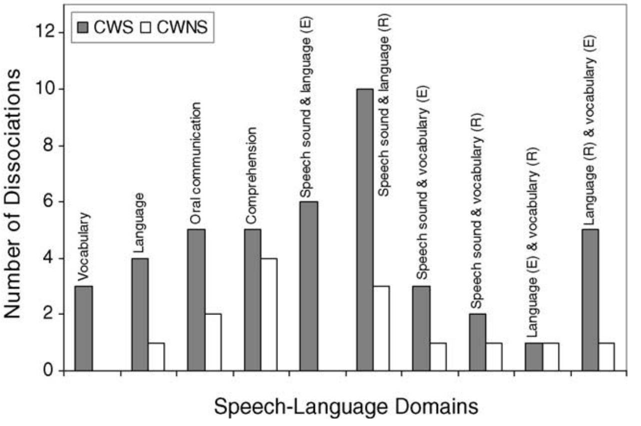


Fig. 7. Number of dissociations across speech-language domains for children between the ages of 3;0 and 5;11 (years;months) who do (CWS; $n = 45$) and do not stutter (CWNS; $n = 45$).

patterns of greater speech sound development than receptive language. The greatest number of dissociations for CWNS ($n = 4$) was in the domain of comprehension, with receptive vocabulary tending to be greater than receptive language.

## 2.4. Dissociations in performance in language-matched children

Upon consideration of the above analyses, one might contend that the group of CWS may have been more likely to experience "gaps" in the development of their speech-language skills mainly because they scored significantly lower than CWNS on the Expressive and Receptive subtests of the TELD-3. To assess whether the overall language abilities of CWS actually had an impact on the current findings, the probability of dissociations was examined in a subset of children matched by overall oral language abilities, as well as age, gender, race, and SES. Children in each group were matched by standard score ratings on the TELD-3 Spoken Language quotient, a composite of the Expressive and Receptive subtests (see Hresko et al., 1999; p. 61, for a description of standard score ratings), which reduced the sample size to 18 children per group ($N = 36$). Each group included four children who had dissociations from the initial, non-language-matched analyses ($N = 90$). An independent-samples *t*-test revealed no significant difference between this subset of CWS ($M = 114.6$, S.D. = 16.1) and CWNS ($M = 114.7$, S.D. = 11.7) on the TELD-3 Spoken Language standard scores, $t(31) = -0.02$, $p = .98$.

Results of the correlation-based analysis revealed that the language-matched CWS ($n = 18$ outliers) were over 3.5 times more likely than CWNS ($n = 5$ outliers) to fall outside the density ellipse and almost 3 times more likely than CWNS to exhibit "true dissociations" across speech-language domains (CWS = 14 cases [77.8%]; CWNS = 5 cases [100%]). Thus, the proportion of dissociations across speech-language domains in this subset of language-matched children was highly consistent with those of the non-language-matched sample of children. This suggests that the greater number of dissociations exhibited by the CWS in this study was not appreciably due to the fact that they scored significantly lower than the group of CWNS in overall expressive and receptive language.

### 2.5. Dissociations in performance in comparable group samples

As will be recalled, CWNS were required to score at or above the 20th percentile on the four standardized speech-language measures to participate in this study, whereas CWS were allowed to freely vary on these measures. This procedure was chosen, because it permits the generalization of results to the entire population of CWS. On the other hand, this approach has the potential to underestimate the extent of dissociations in CWNS, while simultaneously allowing the entirety of the distribution for CWS (see Discussion for further commentary about the issue of participant inclusion criteria).

To determine whether the inclusion of CWS with speech-language scores at or below the 19th percentile had an influence on the current findings, the probability of dissociations was examined with these participants and their matched controls removed from the sample. This resulted in the removal of 5 participants from each group ($N = 80$). It should be noted that even after these participants were culled from the sample, CWS continued to score significantly lower than CWNS on the TELD-3 Expressive subtest, $F(1, 78) = 4.98$, $p < .05$, and TELD-3 Receptive subtest, $F(1, 78) = 11.17$, $p < .05$. CWS also scored lower than CWNS on the remaining speech-language measures (GFTA-2, EVT, and PPVT-III), but these differences were not statistically significant ($p$-values ranged from .18 to .41).

The correlation-based analysis revealed that the remaining group of 40 CWS (who produced 49 outliers) were just over 2.5 times more likely than the remaining group of 40 CWNS (who produced 19 outliers) to fall outside the density ellipse. These 40 CWS were also over 2.5 times more likely than CWNS to demonstrate dissociations across speech-language domains (CWS = 32 cases [65%]; CWNS = 12 cases [63%]). These findings indicate that the proportional difference between CWS and CWNS in the number of outliers and dissociations across speech-language domains is comparable with findings from the initial sample of children ($N = 90$), as well as the language-matched sample ($N = 36$). Thus, it would seem that allowing CWS to freely vary on the speech-language measures contributed very little to the initial, overall effect observed in this study.

### 2.6. Characteristics of children who do and do not exhibit dissociations across speech-language domains

Additional analyses were performed to determine whether children who exhibit dissociations across speech-language domains differed from children who do not exhibit dissociations in speech fluency and speech-language abilities. Specifically, performance on speech disfluency and standardized speech-language tests was compared between (a) CWS who exhibit dissociations (CWS-D; $n = 16$) versus CWS who do not exhibit dissociations (CWS-ND; $n = 29$), and (b) CWNS who exhibit dissociations (CWNS-D; $n = 8$) versus CWNS who do not exhibit dissociations (CWNS-ND; $n = 37$). In addition, performance on speech-language measures was analyzed for children in each group who exhibit dissociations (CWS-D and CWNS-D). For these analyses there was no significant difference between the four groups of children in age, $F(3, 86) = .30$, $p = .83$, or SES, $F(3, 86) = 1.05$, $p = .36$.

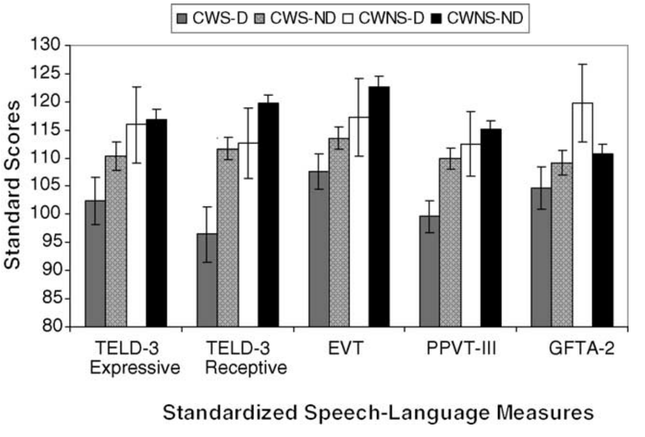


Fig. 8. Mean standard scores (S.E.M. = brackets) on the standardized speech-language measures (TELD-3 Expressive and Receptive subtests, PPVT-III, EVT and GFTA-2) for children who stutter who do (CWS-D; $n = 16$) and do not (CWS-ND; $n = 29$) exhibit dissociations, as well as children who do not stutter who do (CWNS-D; $n = 8$) and do not (CWNS-ND; $n = 37$) exhibit dissociations across speech-language domains.

### *2.6.1. Within-group differences in speech disfluency measures*

A Mann-Whitney test was used to compare CWS-D and CWS-ND on the speech disfluency measures (stuttering-like, other, and total disfluencies; and SSI-3), as well as time since parental-reported onset of stuttering. Findings revealed no significant difference between CWS-D and CWS-ND in stuttering-like disfluencies ($z = -1.72$, $p = .08$), other disfluencies ($z = -1.46$, $p = .14$), total disfluencies ($z = -.59$, $p = .55$), SSI-3 ($z = -.56$, $p = .56$), and time since parental-reported onset of stuttering ($z = -.24$, $p = .81$). Additional analyses revealed no significant difference between CWNS-D and CWNS-ND in stuttering-like disfluencies ($z = -.30$, $p = .77$), other disfluencies ($z = -.09$, $p = .93$), and total disfluencies ($z = -.14$, $p = .89$). Thus, the frequency with which stuttering-like and other speech disfluencies are produced does not appear to readily distinguish children who exhibit dissociations from those who do not exhibit dissociations. In addition, the severity of stuttering and the length of time in which a child has reportedly been stuttering do not differentiate CWS-D from CWS-ND.

### *2.6.2. Within-group differences in speech-language measures*

Differences in standardized speech-language test scores for CWS-D and CWS-ND were analyzed using a MANOVA (see Fig. 8). The MANOVA (Bonferroni corrected) indicated that CWS-D scored significantly lower than CWS-ND on the TELD-3 Receptive subtest, $F(1, 43) = 11.01$, $p < .05$, and the PPVT-III, $F(1, 43) = 9.53$, $p < .05$. There were no significant differences between CWS-D and CWS-ND on the EVT, $F(1, 43) = 2.70$, $p = .11$, GFTA-2, $F(1, 43) = 1.21$, $p = .28$, and the TELD-3 Expressive subtest, $F(1, 43) = 3.09$, $p = .08$. Thus, these findings indicate that CWS-D have lower overall receptive language and one-word receptive vocabulary abilities than CWS-ND, which could potentially play a role in the greater susceptibility of some CWS to exhibit dissociations across speech-language domains. A MANOVA was also used to examine differences between

CWNS-D and CWNS-ND in standardized speech-language test scores (see Fig. 8). The MANOVA failed to reveal any significant differences between the two groups of normally-fluent children on any of the five speech-language measures (*p*-values ranged from .08 to .84).

### 2.6.3. Between-group differences in speech-language measures

Scores on speech-language measures for children in the two groups who exhibited dissociations (CWS-D and CWNS-D) were examined using a MANOVA. Findings revealed, after applying the Bonferroni correction, that the differences between CWS-D and CWNS-D in performance on the various speech-language measures were not significantly different (*p*-values ranged from .03 to .16). Thus, it would appear that individuals within each of the two groups who exhibited dissociations had similar speech and language abilities, although some of this lack of significant findings appears due to the relative stringency of the Bonferroni corrected alpha values.

A final comparison between CWS-ND and CWNS-ND (Bonferroni corrected) revealed that even when CWS-D were removed from the data set, CWS continued to score significantly lower than their normally-fluent peers on the Receptive, $F(1, 43) = 11.54$, $p < .05$, and Expressive, $F(1, 64) = 10.86$, $p < .05$, subtest of the TELD-3 (see Fig. 8). No significant differences, after Bonferroni correction, were found for the remaining speech-language measures, with *p*-values ranging from .03 to .60. Thus, the previously reported significant difference between CWS and CWNS on the measure of overall expressive and receptive language was not apparently influenced by the "subgroup" of CWS who exhibited dissociations.

## 3. Discussion

The purpose of this investigation was to evaluate the possible presence of dissociations in the speech and language skills of young CWS and CWNS using a correlation-based statistical procedure (Bates et al., 2003). Two main findings resulted from this study. First, the overall expressive/receptive language abilities of CWS ($n = 45$), as indicated by their performance on standardized tests of speech-language, were generally lower than those of their age-, gender-, race- and SES-matched CWNS ($n = 45$) controls/counterparts, although still within normal limits. Second, based on the correlation-based procedure developed by Bates et al. (2003), CWS had three times as many dissociations as CWNS across the various speech-language domains, many of which were below the mean. What follows is a further discussion of these findings.

### 3.1. Some speech-language abilities of CWS may not be as well developed as CWNS

As indicated above, CWS scored lower than CWNS on all measures of speech and language, although statistical significance was achieved only for the measure of overall expressive and receptive language. However, both groups of children had fairly high standard scores across all speech and language measures, with means ranging from 106 to 118. These scores would seem to suggest that, on average, the children who participated in this study, especially the group of CWNS, had above average speech and language skills relative to the normative data. While it may really be the case that the children sampled in this study had above average speech and language skills, it is equally possible that other factors, such as sampling bias (unbeknownst to the authors), could have resulted in the unusually high standard scores. These high standard scores may also bring to light problems with the validity of the standardized speech and language measures. In fact, other authors have reported higher than average scores among typically-developing preschool children for three measures used in this study—the PPVT-III, EVT, and/or GFTA-2 (Alt, Plante, & Creusere, 2004; Arvedson, 2002; Edwards, Beckman, & Munson, 2004; McGregor, Newman, Reilly, & Capone, 2002; Rvachew, Ohberg, Grawburg, & Heyding, 2003; Storkel, 2003). Similar findings were also reported for an earlier version of the TELD-3 (Plante & Vance, 1994). This indicates that an average standard score of 100 may not apply equally across tests, and the relatively high scores of the children in this study may simply represent the failure of the standardized tests to generalize to local norms.

Nevertheless, the CWS in this study still performed significantly lower in overall expressive and receptive language than their normally-fluent peers, a finding consistent with several studies that have found that CWS tend to score lower than CWNS on measures of expressive and/or receptive language (Anderson & Conture, 2004; Byrd & Cooper, 1989; Murray & Reed, 1977; Silverman & Ratner, 2002; Ryan, 1992; Westby, 1974). On the other hand, present findings are seemingly inconsistent with those of Howell et al. (2003), who reported that CWS and CWNS did not differ in their receptive syntax abilities. These contradictory findings, however, can most likely be traced to the fact that the present study and Howell et al. employed different methodology with respect to the age of the participants and the type of test used to measure receptive language. At first glance, present findings would also appear to contradict those of Watkins and her colleagues (Watkins & Yairi, 1997; Watkins et al., 1999), who reported that the expressive language abilities of young CWS close to the age of onset of stuttering are above developmental expectations. However, present findings are, in fact, consistent with the above-referenced studies in that CWS did perform within the average to above-average range of abilities, even though they scored lower on all of the standardized tests of speech-language abilities relative to their matched normally-fluent peers.

It should be noted that the current study and those of Watkins and her colleagues used different methodology and data collection methods. Whereas the current study compared the performances of CWS to a matched control group of normally-fluent children, Watkins' studies did not report using a control group, but rather appeared to employ published normative data for comparison. If a control group had not been used in the present study, then the authors would have simply concluded that the CWS had high average speech and language skills. However, the control group of normally-fluent children (CWNS) to which the CWS were compared actually performed, on average, one to two standard deviations above the mean on all speech and language measures. As previously mentioned, this calls into question the validity and the generality of the standardized tests, as one would expect to find a mean standard score closer to 100 for the control group. Thus, in the absence of a control group, an important piece of the standardized test score puzzle would appear to be missing, leading one to, perhaps, erroneously conclude that the CWS have high average speech and language skills.

As previously noted, the present study failed to reveal any significant differences between the two groups of children on the PPVT-III, EVT, and GFTA-2. This finding is consistent with the findings of some studies (Anderson & Conture, 2004; Silverman & Ratner, 2002; cf. Nippold, 2002), but seemingly inconsistent with those of others (e.g., Anderson & Conture, 2000; Louko et al., 1999; Paden et al., 1999; Pellowski & Conture, in press; Pellowski et al., 2001; Yaruss & Conture, 1996). These contradictory findings across studies may be related to differences in sample size and associated issues of statistical power, or they may simply reflect the fact that high variability in the speech and language abilities of individual preschool CWS makes it difficult to achieve statistical significance. Although this latter explanation, in particular, may not be the most satisfying explanation, individuals who stutter are typically highly variable across many behavioral domains—a fact which has often confounded interpretation of research endeavors in the field of stuttering.

### *3.2. A non-trivial number of CWS may exhibit dissociations across speech-language domains*

Perhaps the most salient finding from the present investigation is that CWS exhibited just over three times as many instances of dissociation as CWNS across speech-language domains. In fact, the strength of these findings is supported by the fact that even when the children were matched in overall language abilities, the proportion of CWS who exhibited dissociations relative to CWNS remained consistent. Although CWS exhibited more dissociations than CWNS across all domains assessed in this study, the greatest number of dissociations was found in speech sound development and overall language (receptive and expressive), with CWS tending to perform higher in speech sound articulation than overall language. CWS also exhibited a proportionally greater number of dissociations in the domain of oral communication, with a slight tendency for CWS to have greater overall expressive language than one-word expressive vocabulary skills, a finding similar to those of Anderson and Conture (2000).

The concept of dissociations in developmental stuttering is interesting, in part, because it has the potential to reconcile some of the divergent findings in descriptive studies of the speech and language abilities of CWS. That is, it may be the case that whether CWS perform above or below their normally-fluent peers on measures of speech and language is not as important as the degree of *correspondence* or *congruence* among their speech and language skills. In addition, the *nature* of the dissociation may be less important than the *presence* of a dissociation across domains, regardless of whether it is, for example, in the domain of oral communication or comprehension (Anderson & Conture, 2000). For example, one CWS may have above average expressive language skills for his/her age, but only average receptive vocabulary skills, whereas another CWS may have below average receptive vocabulary skills and average expressive language skills.

Perhaps, as suggested by Hall (2004), it is the child's attempt to reconcile or manage these dissociations in speech and language that contributes to disruptions in their speech-language production, which in combination with a genetic predisposition towards stuttering or, perhaps, a temperamental disposition that is relatively intolerant of any such disruptions, results in the emergence of persistent stuttering. Of course, not all CWS exhibited dissociations in their speech-language abilities. In fact, only 16 (36%) of the 45 CWS who participated in this study actually exhibited dissociations, many of whom had more than one dissociation across the speech-language domains. This suggests the possibility that there may be a subgroup of CWS who are more susceptible, vulnerable or apt to exhibit to dissociations in speech and language. Of course, the notion of subgroups in developmental stuttering has been posited, as well as empirically studied by several investigators in an attempt to account for the apparent heterogeneity among individuals who stutter (e.g., Poulos & Webster, 1991; Preus, 1981; Schwartz & Conture, 1988; Yairi, 1990; Yairi & Ambrose, 1996).

Based on present findings, it is tempting to speculate that CWS who exhibit speech-language dissociations may be more likely to *continue* to stutter, as potential dissociations may reflect a system that is not going to develop or change, at least quickly. This speculation is supported, in part, by the fact that the CWS who exhibited dissociations in this study performed even more poorly than the CWS who did not exhibit dissociations on measures of overall receptive language and one-word receptive vocabulary. On the other hand, it would seem that such a speculation would also lead one to predict that the CWS who exhibited dissociations would have had longer time since onsets of stuttering than the CWS who had not exhibited dissociations, a prediction that was not supported by the present findings. Nevertheless, the failure to find a difference between CWS who exhibited dissociations and CWS who did not exhibit dissociations in terms of time since stuttering onset need not be detrimental to this speculation, as the CWS in this study were close to the age of onset of stuttering, during a time in which it is not yet clear who will persist in stuttering and who will eventually recover, with or without intervention. Of course, the validity of this speculation can be best tested by examining dissociations over the course of time, similar to the longitudinal designs of Yairi and his colleagues (e.g., Yairi & Ambrose, 1992, 1999). However, it is interesting to note that 36% of the CWS in this study exhibited dissociations, as this figure approximates the persistency rates reported in the stuttering literature (see Yairi & Ambrose, 1999).

Another equally plausible explanation for the fact that time since stuttering onset failed to differentiate the group of CWS who exhibited dissociations from those who did not is that whatever factors are involved in the onset of stuttering need not necessarily be those that maintain the disorder. That is, the presence of dissociations in the speech-language systems of young CWS could conceivably contribute to the onset and development of stuttering. However, once stuttering has developed, other internal or external factors (e.g., temperament, emotional arousal, home environment, etc.) may begin to influence stuttering, resulting in its perpetuation. Thus, a child who stutters could eventually "outgrow" any potential dissociations across speech and language domains, and yet continue to stutter, in part, as a result of other internal or external influences (for similar argumentation see Conture & Zackheim's (2003) "gone but not forgotten" hypothesis, pp. 20–23). On the other hand, CWS could continue to have subtle difficulty within or between linguistic domains well into adulthood, a difficulty that may not become overtly evident until the system is "taxed" by increases in processing demands. Such a speculation would be consistent with findings from several recent studies that have reported that the speech-language processing systems of adults who stutter are more susceptible to interference from increases in cognitive processing load (e.g., Bosshardt, Ballmer, & de Nil, 2002; Cuadrado & Weber-Fox, 2003; Kleinow & Smith, 2000; Weber-Fox, Spencer, Spruill, & Smith, 2004).

### *3.3. Theoretical implications of findings*

At least three interrelated, alternative hypotheses can be put forth to account for the present findings: (a) trade-off effects between language and fluency, (b) the "goodness-of-fit" or match between speech-language abilities, and (c) automaticity in speech-language production planning operations. These three hypotheses are similar in that they all either directly or indirectly suggest that CWS, more often than CWNS, exhibit dissociations in their speech-language system, which may result in a greater susceptibility to breakdowns in speech fluency. However, as will be discussed below, these hypotheses differ with respect to those factors that are believed to precipitate or lead to this mismatch in speech-language planning and production systems.

#### *3.3.1. Trade-off effects between language and fluency*

One potential explanation for the present findings concerns the notion of trade-off effects between language and fluency. Trade-off effects among linguistic components, as based on Crystal's (1987) "bucket" theory of language impairment, suggest that increases in complexity requirements in one component are associated with decreases in performance in another component. Thus, as some CWS attempt to deal with or manage the effect of dissociations in their speech-language systems, subsequent decreases in fluency occurs, as more resources are being allocated to "shore up" less developed speech-language planning processes. In addition, if a CWS who exhibits speech-language dissociations attempts to speak in an environment of communicative time pressure (e.g., parents "talking over" their children's utterance, see Kelly & Conture, 1992), this confluence between an "overly taxed" speech-language system and, for example, a hurried environment may set the stage for further disruptions in speech-language production.

#### *3.3.2. "Goodness-of-fit" between productive language output and inherent linguistic abilities*

A second, alternative explanation suggests that present findings reflect a "goodness-of-fit" (or lack thereof) among (sub)components of the speech-language system. That is, when a child's ability in one component of the speech-language system is not congruent with his/her ability in another speech-language component, this may put a strain on the child's speech-language production system, resulting in less fluent speech as more time and energy are being devoted to linguistic formulation processes. This notion of "goodness-of-fit" is similar to Just and Carpenter's (1992) capacity theory of comprehension, which posits that individual differences in language comprehension may reflect differences in capacity for or supply of working memory, processing efficiency, or both. According to this theory, limitations in capacity for working memory would affect performance ". . .only when the resource demands of the task exceed the available supply" (p. 124). Thus, in the face of high task requirements, individuals who have a smaller capacity for working memory would be expected, for example, to perform less accurately and/or efficiently (i.e., more errors or longer processing time) on a reading comprehension task. In terms of the present findings, one might suggest that some CWS may have more limitations in available resources for linguistic functions than appropriately matched CWNS. So, in the face of a dissociation among components of the speech-language system, some aspect of their conversational performance—namely that of speech fluency—may become less consistent.

### 3.3.3. Automaticity in speech-language planning processes

Perhaps the fact that more CWS than CWNS appear to exhibit dissociations in speech and language abilities make CWS somewhat more susceptible than CWNS to the effects of processing demands. In this way, the speech and language systems of CWS may not be as "automatic" as those of CWNS, resulting in their having to expend more attention, effort or resources toward language formulation processes. This emphasis on controlled processing may place more strain on their limited processing abilities, drawing resources away from speech fluency and leading to more speech disfluencies (see Bock, 1982, for a discussion of automaticity and controlled processing). The child may, for example, produce numerous hesitations, interjections, and/or phrase repetitions to "buy time" for linguistic processing functions; in other words, these hesitations, repetitions, etc. may give the child more time to perform necessary linguistic planning operations. This speculation is similar to that of Au-Yeung and Howell (1998) in terms of how stuttering on function words, for young children, may be used as a delaying strategy when the plan for following content words is incomplete.

The notion that stuttering may be related to a failure in automaticity for speech has featured prominently in several early conceptualizations of stuttering (Bloodstein, 1995; Mysak, 1960; West, 1958). More recently, the concept of automaticity has reemerged in Wijnen's (1990) Development of the Formulator Hypothesis, which generally suggests that stuttering in young children may be related to a failure to develop automaticity in planning for speech-language production. According to this hypothesis, normal speech disfluencies occur when children begin expanding their multi-word productions using new or more complex syntactic forms, as more processing resources are being extracted from speech motor processing components. However, as children begin to master new or difficult syntactic constructions, they experience an increase in automaticity in sentence formulation, thereby reducing the resources allocated to the process of speech-language planning. This leaves more resources available for speech motor processing. On the other hand, if a child fails to develop automaticity in speech-language planning processes, then he/she may have ongoing difficulties with speech fluency.

Whether findings from this investigation are viewed in the context of trade-off effects, "goodness-of-fit," automaticity, or some other interpretation, one thing is clear—the presently observed dissociations across speech-language domains in some CWS occurs within the context of *normal* speech and language development. A child could have above-average abilities in one speech-language component, but if other components of the speech language system are average or below average, then his or her speech-language production may be less than rapid and/or efficient, making the child's output more susceptible to fluency failure or errors. For example, a child may perform within the average range on a measure of expressive vocabulary, but it may take him/her significantly longer to produce the "correct" responses, resulting in asynchrony in speech-language planning operations. This possibility is supported, in part, by Anderson and Conture's (2004) finding that CWS may have difficulty rapidly and efficiently planning and/or retrieving sentence-structure units. Whatever the case, the idea is that when CWS place undue cognitive and/or linguistic stress on their already vulnerable speech-language systems, they will become more susceptible to fluency failures.

Present findings also make it clear that potential dissociations across speech-language domains represent an intensely individual phenomenon that may not be directly related to actual stuttering behavior, at least as measured in this study. CWS not only vary in whether or not a dissociation is present, but also in the type (i.e., domain), direction, and degree of dissociation observed. Further, even though all of these children have fluency concerns, the presence of a dissociation does not appear to be directly related to the length of time in which a child has been stuttering or to the frequency and severity of stuttering. To further complicate matters, it is apparent that some CWNS also exhibit dissociations in speech and language, and yet these children do not have fluency concerns. These findings lead to the conclusion that a dissociation in and of itself may be only one factor of many that may be related to the onset and development of stuttering for some CWS. In other words, a dissociation is not *necessary* to develop stuttering, but may be a *sufficient* precipitating event for at least some CWS. It is tempting to speculate, as previously mentioned, that CWS who exhibit dissociations may be among those who are most likely to persist in stuttering. Such speculation underscores the need for continued study of dissociations in CWS, preferably over the course of time (i.e., longitudinal studies), so as to better understand how potential dissociations may be related to fluency disorders in young children.

### *3.4. Caveats*

There are several ways to develop participant exclusion criteria for speech and language measures in a study of this nature. One way is to ensure that both groups of participants have identical exclusionary criteria—for example, requiring that all participants in both groups score at or above the 20th percentile on standardized speech-language measures. The advantage of this procedure is that the two groups of children differ by only one dimension—the presence or absence of stuttering. On the other hand, this procedure may be somewhat problematic in that by trimming the lower ends of the distribution (i.e., removing all CWS who scored at or below the 19th percentile), the risk that the findings will only apply to a subset of the population of CWS is increased. In other words, the findings may not be generalizable to the entire population of CWS.

As an alternative to this procedure, the group of CWS could be allowed to freely vary in their scores on the speech-language measures, while simultaneously maintaining the group of CWNS within normal limits on these same measures (i.e., at or above the 20th percentile). This procedure has the advantage of allowing one to examine the entirety of the distribution of CWS, making the findings more generalizable to the population of CWS as a whole. The concern, however, with this approach is that the two groups of participants no longer differ by just one dimension—that is, the two groups differ on the presence or absence of stuttering, as well as, for some participants (albeit it small number, at least in this study), their scores on the speech-language measures. In addition, this procedure may underestimate the extent of dissociations in CWNS, since the lower end of the distribution of CWNS is excluded from analysis.

For the current study, the second of these two alternative procedures was selected for participant inclusion/exclusion purposes. As previously mentioned, this was done, in large part, to increase the extent to which the findings can be generalized to the entire distribution of CWS. However, it would seem that one potential consequence of using this procedure is that the probability of finding dissociations might increase with the inclusion of CWS who scored below the 20th percentile on speech and language measures. To determine whether this was indeed the case, the correlation-based statistical analyses were computed with the CWS who scored below the 20th percentile removed from the sample, along with their matched controls. These analyses revealed that the inclusion of these participants had a relatively negligible effect on the data, a testament to the credibility of the notion that some CWS may be disproportionally subject to dissociations in their speech and language skills relative to CWNS, even though their overall speech-language abilities, at least on the basis of standardized tests, were within normal limits.

### *3.5. Conclusions*

It is still less than clear whether there are quantitative as well as qualitative differences in linguistic abilities and development between CWS and CWNS. What the findings of this study appear to make clear, however, is that rather than simply assessing the absolute difference between CWS and CWNS on measures of speech and language, we may want to consider how different parts of the speech-language planning and production whole interrelate with one another. Although more empirical research is definitely needed to further understand these interrelations—particularly during functional language usage—present findings are suggestive of the possibility that there may be a subgroup of CWS who exhibit dissociations across speech-language domains. Perhaps, for members of this subgroup, such dissociations could make it difficult for them to easily, efficiently, and rapidly establish and/or maintain normally-fluent speech-language production. Thus, even in the presence of "normal" speech-language abilities, it may be the case that differences between CWS and CWNS do not have to be clinically significant to be significant clinically.

## Acknowledgements

This research was supported, in part, by a research grant (DC00523) from the National Institute on Deafness and Other Communication Disorders. The authors would like to thank the parents and children who participated in this study, as well as Corrin Graham for her assistance with analysis of participant description data. We would also like to thank Dr. Herman Kolk for his initial help, encouragement, and support to pursue this line of inquiry and Dr. Kay Bock for her many insightful comments about our methodological as well as theoretical exploration of this topic.

## CONTINUING EDUCATION

### Childhood stuttering and dissociations across linguistic domains

QUESTIONS

1. Previous research has indicated that stuttering tends to occur on:
   a. the initial phoneme of a word

   b. low frequency and unfamiliar words
   c. the first three words of an utterance
   d. longer or more syntactically complex utterances
   e. all of the above
2. The concept of “dissociations” has previously played a significant role in what type of research?
   a. physiological
   b. neuropsychological
   c. psychological
   d. language learning
   e. phonological
3. Anderson and Conture (2000) examined differences in performance between speech and language measures in CWS and CWNS. Their findings suggested that CWS, when compared to CWNS, exhibit a significantly greater difference between standardized measures of:
   a. receptive/expressive language and receptive vocabulary
   b. receptive/expressive language and expressive vocabulary
   c. receptive/expressive vocabulary and expressive language
   d. receptive/expressive vocabulary and receptive language
   e. articulation and phonology
4. Findings from the current investigation indicated that CWS performed consistently lower than their normally-fluent peers on measures of:
   a. expressive language and receptive vocabulary
   b. expressive vocabulary and receptive vocabulary
   c. expressive language and receptive language
   d. receptive language and expressive vocabulary
   e. none of the above
5. Which of the following hypotheses was not discussed that could potentially explain the present results:
   a. trade-off effects between language and fluency
   b. the “goodness-of-fit” or match between speech-language abilities
   c. automaticity in speech-language production planning operations
   d. the covert repair hypothesis
   e. none of the above

## References

Alt, M., Plante, E., & Creusere, M. (2004). Semantic features in fast-mapping: Performance of preschoolers with specific language impairment versus preschoolers with normal language. *Journal of Speech, Language, and Hearing Research*, *47*, 407–420.

American Speech-Language-Hearing Association (1990, April). Guidelines for screening for hearing impairment and middle-ear disorders. *ASHA*, *32* (suppl. 2), 17–24.

Anderson, J. D., & Conture, E. G. (2000). Language abilities of children who stutter: A preliminary study. *Journal of Fluency Disorders*, *25*, 283–304.

Anderson, J. D., & Conture, E. G. (2004). Sentence-structure priming in young children who do and do not stutter. *Journal of Speech, Language, and Hearing Research*, *47*, 552–571.

Anderson, J. D. (2005). *Phonological neighborhood effects in the speech disfluencies of children who stutter*. Manuscript submitted for publication.

Anderson, J. D., & Musolino, J. (2004). How useful is the usage based approach to stuttering research? *Stammering Research*, *1*, 295–296.

Anderson, J. D., Pellowski, M. W., Conture, E. G., & Kelly, E. M. (2003). Temperamental characteristics of young children who stutter. *Journal of Speech, Language, and Hearing Research*, *46*, 1221–1233.

Arvedson, P. J. (2002). Young children with specific language impairment and their numerical cognition. *Journal of Speech, Language, and Hearing Research*, *45*, 970–982.

Au-Yeung, J., & Howell, P. (1998). Lexical and syntactic context and stuttering. *Clinical Linguistics & Phonetics*, *12*, 67–78.

Bates, E., Appelbaum, M., Salcedo, J., Saygin, A. P., & Pizzamiglio, L. (2003). Quantifying dissociations in neuropsychological research. *Journal of Clinical and Experimental Neuropsychology*, *25*, 1128–1153.

Bergmann, G. (1986). Stuttering as a prosodic disturbance. *Journal of Speech and Hearing Research*, *29*, 290–300.

Bernstein, N. E. (1981). Are there constraints on childhood disfluency? *Journal of Fluency Disorders*, *6*, 341–350.

Bloodstein, O. (1995). *A handbook on stuttering* (5th ed.). San Diego, CA: Singular Publishing Group, Inc.

Bloodstein, O., & Grossman, M. (1981). Early stuttering: Some aspects of their form and distribution. *Journal of Speech and Hearing Research*, *24*, 298–302.

Bock, J. K. (1982). Toward a cognitive psychology of syntax: Information processing contributions to sentence formulation. *Psychological Review*, *89*, 1–47.

Bosshardt, H.-G., Ballmer, W., & de Nil, L. (2002). Effects of category and rhyme decisions on sentence production. *Journal of Speech, Language, and Hearing Research*, *45*(5), 844–857.

Brown, S. F. (1938a). Stuttering with relation to word accent and word position. *Journal of Abnormal and Social Psychology*, *33*, 112–120.

Brown, S. F. (1938b). A further study of stuttering in relation to various speech sounds. *Quarterly Journal of Speech*, *24*, 390–397.

Brown, S. F. (1945). The loci of stutterings in the speech sequence. *Journal of Speech Disorders*, *10*, 181–192.

Byrd, K., & Cooper, E. B. (1989). Expressive and receptive language skills in stuttering children. *Journal of Fluency Disorders*, *14*, 121–126.

Caramazza, A., & Hillis, B. (1991). Lexical organization of nouns and verbs in the brain. *Nature*, *349*, 788–790.

Conture, E. & Zackheim, C. (2003). Stuttering: The long and winding road from the womb to the tomb. In: K. Baker & D. Rowley, (Eds.), *Proceedings of the Sixth Oxford Dysfluency Conference* (pp. 7–42). Leicester, UK: KLB Publications.

Crystal, D. (1987). Towards a "bucket" theory of language disability: Taking account of interaction between linguistic levels. *Clinical Linguistics and Phonetics*, *1*, 7–22.

Cuadrado, E. M., & Weber-Fox, C. (2003). Atypical syntactic processing in individuals who stutter: Evidence from event-related brain potentials and behavioral measures. *Journal of Speech, Language, and Hearing Research*, *46*, 960–976.

Damasio, A., Grabowski, T. J., Tranel, D., Hichwa, R. D., & Damasio, A. R. (1996). A neural basis for lexical retrieval. *Nature*, *380*, 499–505.

Danzger, M., & Halpern, H. (1973). Relation of stuttering to word abstraction, part of speech, word length, and word frequency. *Perceptual Motor Skills*, *37*, 959–963.

Dayalu, V., Kalinowski, J., Stuart, A., Holbert, D., & Rastatter, M. (2002). Stuttering frequency on content and function words in adults who stutter: A concept revisited. *Journal of Speech, Language, and Hearing Research*, *45*, 871–878.

Demuth, K. (2004). Production approaches to stuttering. *Stammering Research*, *1*, 297–298.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test-III (PPVT-III)* (3rd ed.). Circle Pines, MN: American Guidance Service, Inc.

Edwards, J., Beckman, M., & Munson, B. (2004). The interaction between vocabulary size and phonotactic probability effects on children's production accuracy and fluency in nonword repetition. *Journal of Speech, Language, and Hearing Research*, *47*, 421–436.

Goldman, R., & Fristoe, M. (2000). *Goldman-Fristoe Test of Articulation-2 (GFTA-2)*. Circle Pines, MN: American Guidance Service, Inc.

Graham, C., Conture, E., & Camarata, S. (2005). *Relationship of function and content words in the utterances of young children who stutter*. Manuscript in preparation.

Hakim, H. B., & Ratner, N. B. (2004). Nonword repetition abilities of children who stutter: An exploratory study. *Journal of Fluency Disorders, 29,* 179–199.

Hall, N. E. (1996). Language and fluency in child language disorders: Changes over time. *Journal of Fluency Disorders, 21,* 1–32.

Hall, N. E. (2004). Lexical development and retrieval in treating children who stutter. *Language, Speech, and Hearing Services in Schools, 35,* 57–69.

Hall, N. E., Yamashita, T. S., & Aram, D. M. (1993). Relationship between language and fluency in children with developmental language disorders. *Journal of Speech and Hearing Research, 36,* 568–579.

Howell, P., & Au-Yeung, J. (1995). Syntactic determinants of stuttering in the spontaneous speech of normally-fluent and stuttering children. *Journal of Fluency Disorders, 20,* 317–330.

Howell, P., Au-Yeung, J., & Sackin, S. (1999). Exchange of stuttering from function words to content words with age. *Journal of Speech, Language, and Hearing Research, 42,* 345–354.

Howell, P., Davis, S., & Au-Yeung, J. (2003). Syntactic development in fluent children, children who stutter, and children who have English as an additional language. *Child Language Teaching and Therapy, 19,* 311–337.

Hresko, W., Reid, D., & Hamill, D. (1999). *Test of Early Language Development-3 (TELD-3)*. Austin, TX: PRO-ED.

Hubbard, C. P., & Prins, D. (1994). Word familiarity, syllabic stress pattern, and stuttering. *Journal of Speech and Hearing Research, 37,* 564–571.

Just, M., & Carpenter, P. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99,* 122–149.

Kadi-Hanifi, K., & Howell, P. (1992). Syntactic analysis of the spontaneous speech of normally-fluent and stuttering children. *Journal of Fluency Disorders, 17,* 151–170.

Kelly, E. M., & Conture, E. G. (1992). Speaking rates, response time latencies, and interrupting behaviors of young stutterers, nonstutterers, and their mothers. *Journal of Speech and Hearing Research, 35,* 1256–1267.

Kleinow, J., & Smith, A. (2000). Influences of length and syntactic complexity on the speech motor stability of the fluent speech of adults who stutter. *Journal of Speech, Language, and Hearing Research, 43,* 548–559.

Klouda, G. V., & Cooper, W. E. (1988). Contrastive stress, intonation, and stuttering frequency. *Language and Speech, 31,* 3–20.

Logan, K. J., & Conture, E. G. (1995). Length, grammatical complexity, and rate differences in stuttered and fluent conversational utterances of children who stutter. *Journal of Fluency Disorders, 20,* 35–62.

Logan, K. J., & Conture, E. G. (1997). Temporal, grammatical, and phonological characteristics of conversational utterances produced by children who stutter. *Journal of Speech and Hearing Research, 40,* 107–210.

Louko, L. J., Conture, E. G., & Edwards, M. L. (1999). Treating children who exhibit co-occurring stuttering and disordered phonology. In R. F. Curlee (Ed.), *Stuttering and related disorders of fluency* (2nd edition). (pp. 124–138). New York, NY: Thieme Medical Publishers, Inc.

McGregor, K. M., Newman, R. M., Reilly, R. M., & Capone, N. C. (2002). Semantic representation and naming in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 45,* 998–1014.

Melnick, K. S., & Conture, E. G. (2000). Relationship of length and grammatical complexity to the (non)systematic speech errors and stuttering of children who stutter. *Journal of Fluency Disorders, 25,* 21–45.

Murray, H. L., & Reed, C. G. (1977). Language abilities of preschool stuttering children. *Journal of Fluency Disorders, 2,* 171–176.

Myers, J. K., & Bean, L. L. (1968). *A decade later: A follow-up of social class and mental illness*. New York: John Wiley & Sons Inc.

Mysak, E. D. (1960). Servo theory and stuttering. *Journal of Speech and Hearing Disorders, 25,* 188–195.

Natke, U., Grosser, J., Sandrieser, P., & Kalveram, K. Th. (2002). The duration component of the stress effect in stuttering. *Journal of Fluency Disorders*, *27*, 305–318.

Natke, U., Sandreiser, P., van Ark, M., Pietrowsky, R., & Kalveram, K. (2004). Linguistic stress, within-word position and grammatical class in relation to early childhood stuttering. *Journal of Fluency Disorders*, *29*, 109–122.

Newton, R. R., & Rudestam, K. E. (1999). *Your statistical consultant: Answers to your data analysis questions*. Thousand Oaks, CA: SAGE Publications, Inc.

Nippold, M. A. (2002). Stuttering and phonology: Is there an interaction? *American Journal of Speech-Language Pathology*, *11*, 99–110.

Paden, E. P., Yairi, E., & Ambrose, N. G. (1999). Early childhood stuttering II: Initial status of phonological abilities. *Journal of Speech and Hearing Research*, *42*, 1113–1124.

Palen, C., & Peterson, J. M. (1982). Word frequency and children's stuttering: The relationship to sentence structure. *Journal of Fluency Disorders*, *7*, 55–62.

Pellowski, M. W., & Conture, E. G. (2002). Characteristics of speech disfluency and stuttering behaviors in 3- and 4-year-old children. *Journal of Speech, Language, and Hearing Research*, *45*, 20–34.

Pellowski, M. W. & Conture, E. G. (in press). Lexical encoding in young children who do and do not stutter. *Journal of Speech, Language, and Hearing Research*.

Pellowski, M. W., Conture, E. G., Anderson, J. D. & Ohde, R. N. (2001). Articulatory and phonological assessment of children who stutter. In: H. G. Bosshardt, J. S. Yaruss & H. F. M. Peters (Eds.), *Proceedings of the Third World Congress on Fluency Disorders: Theory, Research, Treatment, and Self-help* (pp. 248–252). Nijmegen, The Netherlands: University of Nijmegen Press.

Perkins, W. H., Kent, R. D., & Curlee, R. F. (1991). A theory of neuropsycholinguistic function in stuttering. *Journal of Speech and Hearing Research*, *34*, 734–752.

Plante, E., & Vance, R. (1994). Selection of preschool language tests: A data-based approach. *Language, Speech, and Hearing Services in Schools*, *25*, 15–24.

Postma, A., & Kolk, H. (1993). The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech and Hearing Research*, *36*, 472–487.

Poulos, M., & Webster, W. (1991). Family history as a basis for subgrouping people who stutter. *Journal of Speech and Hearing Research*, *34*, 5–10.

Preus, A. (1981). *Identifying subgroups of stutterers*. Oslo: Universitetsforlaget.

Prins, D., Hubbard, C. P., & Krause, M. (1991). Syllabic stress and the occurrence of stuttering. *Journal of Speech and Hearing Research*, *34*, 1011–1016.

Ratner, N. B. (1997). Stuttering: A psycholinguistic perspective. In R. Curlee & G. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (2nd ed., pp. 99–127). Boston, MA: Allyn & Bacon.

Ratner, N. B., & Sih, C. C. (1987). Effects of gradual increases in sentence length and complexity on children's dysfluency. *Journal of Speech and Hearing Disorders*, *52*, 278–287.

Riley, G. D. (1994). *Stuttering Severity Instrument for Children and Adults-3 (SSI-3)* (3rd ed.). Austin, Tx: Pro-Ed.

Ronson, I. (1976). Word frequency and stuttering: The relationship to sentence structure. *Speech and Hearing Research*, *19*, 813–819.

Rvachew, S., Ohberg, A., Grawburg, M., & Heyding, J. (2003). Phonological awareness and phonemic perception in 4-year-old children with delayed expressive phonology skills. *American Journal of Speech-Language Pathology*, *12*, 463–471.

Ryan, B. P. (1992). Articulation, language, rate, and fluency characteristics of stuttering and nonstuttering preschool children. *Journal of Speech and Hearing Research*, *35*, 333–342.

Sall, J., Creighton, L., & Lehman, A. (2004). *JMP start statistics: A guide to statistics and data analysis using JMP and JMP IN software* (3rd ed.). Belmont, CA: Thomson Learning.

Savage, C., & Lieven, E. (2004). Can the Usage-Based Approach to language development be applied to analysis of developmental stuttering? *Stammering Research*, *1*, 83–100.

Saygin, A. P., Dick, F., Wilson, S. W., Dronkers, N. F., & Bates, E. (2003). Neural resources for processing language and environmental sounds: Evidence from aphasia. *Brain*, *26*, 928–945.

Schwartz, H. D., & Conture, E. G. (1988). Subgrouping young stutterers: Preliminary behavioral observations. *Journal of Speech and Hearing Research*, *31*, 62–71.

Silverman, S., & Ratner, N. B. (2002). Measuring lexical diversity in children who stutter: Application of *vocd*. *Journal of Fluency Disorders, 27*, 289–304.

Smith, A., & Kelly, E. (1997). Stuttering: A dynamic, multifactorial model. In R. F. Curlee & G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (pp. 204–217). Needham Heights, MA: Allyn & Bacon.

Snow, D. (2001). Imitation of intonation contours by children with normal and disordered language development. *Clinical Linguistics & Phonetics*, *15*, 567–584.

Soderberg, G. A. (1966). The relations of stuttering to word length and word frequency. *Journal of Speech and Hearing Research*, *9*, 584–589.

SPSS Inc. (2003). *SPSS Base 12.0 for Windows User's Guide*. Chicago, IL: SPSS Inc.

Storkel, H. L. (2003). Learning new words II: Phonotactic probability in verb learning. *Journal of Speech, Language, and Hearing Research*, *46*, 1312–1323.

Tetnowski, J. A. (1998). Linguistic effects on disfluency. In R. Paul (Ed.), *Exploring the speech-language connection: 8* (pp. 227–251). Baltimore, MD: Paul Brooks Publishing Co.

Wall, M. J., Starkweather, C. W., & Cairns, H. S. (1981). Syntactic influences on stuttering in young child stutterers. *Journal of Fluency Disorders*, *6*, 283–298.

Watkins, R. V., & Yairi, E. (1997). Language production abilities of children whose stuttering persisted or recovered. *Journal of Speech, Language & Hearing Research*, *40*, 385–399.

Watkins, R. V., Yairi, E., & Ambrose, N. G. (1999). Early Childhood Stuttering III: Initial status of expressive language abilities. *Journal of Speech, Language, and Hearing Research*, *42*, 1125–1135.

Weber-Fox, C., Spencer, R. M., Spruill, J. E., & Smith, A. (2004). Phonological processing in adults who stutter: Electrophysiological and behavioral evidence. *Journal of Speech, Language, and Hearing Research*, *47*, 1244–1258.

West, R. (1958). An agnostic's speculations about stuttering. In J. Einsenson (Ed.), *Stuttering: A symposium*. New York: Harper & Row.

Westby, C. E. (1974). Language performance of stuttering and nonstuttering children. *Journal of Communications Disorders*, *12*, 133–145.

Wijnen, F. (1990). The development of sentence planning. *Journal of Child Language*, *17*, 651–675.

Williams, K. T. (1997). *Expressive Vocabulary Test (EVT)*. Circle Pines, MN: American Guidance Service, Inc.

Wingate, M. E. (1984). Stutter events and linguistic stress. *Journal of Fluency Disorders*, *9*, 295–300.

Wolk, L. (1990). An investigation of stuttering and phonological difficulties in young children (Doctoral dissertation, Syracuse University 1990). *Dissertation Abstracts International, 51*(04), 1772.

Yairi, E. (1990). Subtyping child stutterers for research purposes. *ASHA Reports*, *18*, 50–57.

Yairi, E., & Ambrose, N. (1992). A longitudinal study of stuttering in children: A preliminary report. *Journal of Speech and Hearing Research*, *35*, 755–760.

Yairi, E., & Ambrose, N. (1996). Genetics of stuttering: A critical review. *Journal of Speech and Hearing Research*, *39*, 771–785.

Yairi, E., & Ambrose, N. (1999). Early childhood stuttering I: Persistency and recovery rates. *Journal of Speech, Language & Hearing Research*, *42*, 1097–1112.

Yaruss, J. S. (1999). Utterance length, syntactic complexity, and childhood stuttering. *Journal of Speech and Hearing Research*, *42*, 329–344.

Yaruss, J. S., & Conture, E. G. (1996). Stuttering and phonological disorders in children: Examination of the covert repair hypothesis. *Journal of Speech and Hearing Research, 39,* 349–364.

Zackheim, C., & Conture, E. G. (2003). The influence on childhood stuttering and speech disfluencies of select utterance characteristics in relationship to children's mean length of utterance. *Journal of Fluency Disorders, 28*, 115–142.

Zingeser, L. B., & Berndt, R. S. (1990). Retrieval of nouns and verbs in agrammatism and anomia. *Brain and Language, 39,* 14–32.

**Julie D. Anderson** is an Assistant Professor in the Department Speech and Hearing Sciences at Indiana University, Bloomington, Indiana. Her current research focuses on examining the relationship between psycholinguistic variables and speech fluency in young children who stutter. She is particularly interested in identifying those variables that may be associated with the onset, development, and perhaps maintenance of childhood stuttering.

**Mark W. Pellowski** is an Assistant Professor in the Department of Audiology, Speech Language Pathology, and Deaf Studies at Towson University, Towson, Maryland. His current research focuses on the linguistic processing abilities of children, adolescents, and adults who stutter. His clinical interests involve the assessment and treatment of fluency disorders in individuals across the lifespan.

**Edward G. Conture** is Professor and Director of Graduate Studies in the Department of Hearing and Speech Sciences at Vanderbilt University, Nashville, Tennessee. His current research interests involve investigating the linguistic and emotional determinants of developmental stuttering in young children. The linguistic aspect of his research program is in its 11th year of NIH funding.