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Expressive Language Intratest Scatter of Preschool-Age Children Who Stutter

Ryan A. Millager, **Edward G. Conture**, **Tedra A. Walden**, and **Ellen M. Kelly**
Vanderbilt University

Abstract

Purpose—The purpose of this study was to assess intratest scatter (variability) on standardized tests of expressive language by preschool-age children who do (CWS) and do not stutter (CWNS).

Method—Participants were 40 preschool-age CWS and 46 CWNS. Between-group comparisons of intratest scatter were made based on participant responses to the Expressive subtest of the *Test of Early Language Development – 3* (TELD-Exp; Hresko, Reid, & Hamill, 1999) and the *Expressive Vocabulary Test 2* (EVT-2; Williams, 2007). Within-group correlational analyses between intratest scatter and stuttering frequency and severity were also conducted for CWS.

Results—Findings indicated that, for CWS, categorical scatter on the EVT-2 was positively correlated with their stuttering frequency. No significant between-group differences in intratest scatter were found on the TELD-Exp or the EVT-2.

Conclusions—Consistent with earlier findings, variability in speech-language performance appears to be related to CWS' stuttering, a finding taken to suggest an underlying cognitive-linguistic variable (e.g., cognitive load) may be common to both variables.

Children who stutter (CWS), when compared to children who do not stutter (CWNS), have been shown to exhibit greater unevenness or dissociation between standardized measures of speech-language abilities (e.g., Anderson, Pellowski, & Conture, 2005; Coulter, Anderson, & Conture, 2009; Hall, 2004). Anderson and colleagues reported that CWS were over three times more likely than CWNS to exhibit inter-test speech-language dissociations (Anderson, Pellowski, & Conture, 2005). Coulter et al. (2009) took their findings to suggest that the speech-language processing systems of CWS might be "more vulnerable to interference from concurrent processing demands" (p. 274). Similarly, Anderson et al. (2005) suggested that disfluencies may increase as CWS attempt to manage or respond to the incongruencies in their developing speech-language systems.

Indications that asynchrony or unevenness of language development may be associated with childhood stuttering appear to be consistent with several theories and findings that link linguistic abilities to stuttering (see Anderson, Pelowski, & Conture, 2005). For example, Perkins, Kent, and Curlee (1991) speculated that stuttering is the product of a disruption in motor planning integration, resulting from inefficiency in language processing systems. Alternatively, others have suggested that linguistic trade-offs may occur, with stuttering

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emerging when weak and/or imbalanced language abilities possibly result in fewer cognitive-linguistic resources available for speech fluency (see Hall, 2004). Further, the act of stuttering itself appears to be correlated with several linguistic variables. For example, CWS are more likely to stutter on utterance-initial words, function words, or utterances of higher complexity (e.g., Buhr & Zebrowski, 2009; Richels, Buhr, Conture, & Ntourou, 2010). Additionally, Ntourou, Conture, and Lipsey's (2011) meta-analytical study of language and childhood stuttering indicated that CWS, on average, score 0.5 standard deviations below CWNS on a variety of standardized measures of language (cf. Nippold, 2012). Although none of the above studies proves that disruptions in language processes cause developmental stuttering, they do suggest that language is associated with stuttering and that the nature of this association warrants further empirical study. Given the above, it also seems reasonable to posit that cognitive-linguistic unevenness may not only be evident between tests of different speech-language domains, but also within a single test of speech-language.

Consistent with this notion, Walden, Frankel, Buhr, Johnson, Karrass, and Conture (2012) reported a significant correlation between frequency of disfluency and expressive language unevenness in CWS, as measured by the presence of “scatter” on the expressive subtest of the *Test of Early Language Development – 3* (TELD-Exp; Hresko, Reid, & Hamill, 1999). Walden et al. (2012) operationalized scatter on the TELD-Exp as the presence of multiple basal runs of correct items separated by one or more incorrect items. Intratest scatter has been broadly defined as an inconsistent pattern of response to items within a hierarchically organized test (Lezak, 1995), such that “a child who fails some easy items and then passes more difficult items may be considered to have intrasubtest scatter” (Dumont & Willis, 1995, p. 272). Furthermore, there is some neuropsychological research suggesting that intratest scatter may be a valid measure of certain attentional or cognitive constructs (see Godber, Anderson, & Bell, 2000).

Thus, there is some evidence that unevenness in the association between language and stuttering may be assessed by means of both *inter*test dissociations (Anderson et al., 2005; Coulter et al., 2009) and *intra*test scatter (Walden et al., 2012). Moreover, it seems likely that scatter may emerge not only within the TELD-Exp, but on other tests of expressive language, such as the *Expressive Vocabulary Test 2* (EVT-2; Williams, 2007).

The present study was designed to objectively assess intratest scatter of CWS and CWNS on standardized tests of expressive language abilities. In addition, for CWS, the relation among intratest scatter, stuttering frequency, and severity was examined. First, we assessed whether CWS and CWNS significantly differed in expressive intratest scatter on the TELD-Exp and EVT-2. It was hypothesized that CWS would exhibit significantly more intratest variability than CWNS on both measures. Second, within-group analyses were conducted for CWS, relating intratest scatter scores to frequency and severity of stuttering, to address the hypothesis of a positive correlation between intratest scatter and stuttering frequency.

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Method

Participants

Participants were monolingual speakers of English, including 40 children who stutter (CWS; 30 males and 10 females, *M* = 46.7 months, *SD* = 6.4) and 46 children who do not stutter (CWNS; 32 males and 14 females, *M* = 46.3 months, *SD* = 7.3). All participants were preschool-aged (3;0–5;3 years old), with no significant between-group differences in gender, χ^2 (1, *N* = 86) = 0.3, p = .58, or chronological age, t(84) = 0.26, p = .41.

Participants' data were collected as part of a large-scale empirical investigation of linguistic and emotional contributions to developmental stuttering (e.g., Arnold, Conture, Key, & Walden, 2011; Choi, Conture, Walden, Lambert, & Tumanova, 2013; Clark, Conture, Walden, & Lambert, 2013; Coulter, Anderson, & Conture, 2009; Karrass et al., 2006; Ntourou, Conture, & Walden, 2013; Walden et al., 2012). All were paid volunteers whose parents either learned of the study from an advertisement in a free, monthly parent magazine circulated throughout Middle Tennessee, were contacted from Tennessee State birth records, or were referred to the Vanderbilt Bill Wilkerson Hearing and Speech Center for speech evaluation. Informed consent by parents and assent by children were obtained.

The Hollingshead Four-Factor Index of Social Position (Hollingshead, 1975) was used in the present study to provide a descriptive/demographic measure classifying participants' socioeconomic status (SES). This index takes into account parents' self-reported education levels, occupation, gender, and marital status. Possible scores range from 8 to 66, with a higher score indicating a higher SES.

Classification and Inclusion Criteria

To minimize the possibility that results may be confounded by clinically-significant speech-language-hearing deficits, all participants were administered standardized measures of articulation, expressive/receptive language skills, and hearing ability. Participants were excluded from the study if they scored below the 16th percentile (i.e., one standard deviation below the mean) on any of the following: a) *Peabody Picture Vocabulary Test – Fourth Edition* (PPVT-4; Dunn & Dunn, 2007), b) *Expressive Vocabulary Test – 2* (EVT-2; Williams, 2007), c) the receptive and expressive subtests of the *Test of Early Language Development – 3* (TELD-Rec and TELD-Exp, respectively; Hresko et al., 1999), and d) "Sounds in Words" subtest of the *Goldman-Fristoe Test of Articulation-2* (GFTA-2; Goldman & Fristoe, 2000). Participants were also excluded if they did not perform within normal limits on a bilateral pure-tone hearing screening (ASHA, 1990). Furthermore, participants were excluded from the present investigation if they served as participants in the Walden et al. (2012) study, in order to provide an independent test of the relation between scatter and expressive language performance.

A child was assigned to the CWS talker group if he or she met both of the following criteria, as determined by a speech-language pathologist's assessment of the first 300 words in an unstructured conversation sample: a) three or more stuttered disfluencies (i.e., sound/syllable repetitions, sound prolongations, and monosyllabic whole-word repetitions) per 100 words of conversational speech (Conture, 2001), and b) a score of 11 or greater (i.e., severity of at

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least "mild") on the Stuttering Severity Instrument-3 (SSI-3; Riley, 1994). A child was assigned to the CWNS talker group if he or she a) exhibited two or fewer stuttered disfluencies per 100 words of conversational speech (Zebrowski & Conture, 1989) and b) received a score of 10 or lower (i.e., severity of less than "mild") on the SSI-3.

Measures

Intratest scatter of expressive language—Expressive vocabulary was measured by the EVT-2, and overall expressive language abilities were measured by the TELD-Exp. Patterns of response within these (sub)tests were evaluated for variability, discussed here as *intratest scatter*. As shown in Table 1 and described immediately below, two methods for evaluating intratest scatter were applied to participants' responses on the TELD-Exp and EVT-2.

The first, a *categorical* measure of scatter, was operationalized as the presence/absence of multiple basal runs of correct items separated by one or more incorrect items. This method divides participants into two groups, children with and children without scatter (Walden et al., 2012). The TELD-Exp has a basal rule of three correct consecutive responses, and the EVT-2 has a basal rule of five correct consecutive responses, defined by respective test developers as psychometrically significant (Hresko et al., 1999; Williams, 2007). For example, on the TELD-Exp, a child would be categorized as exhibiting scatter after scoring correctly (1) on three consecutive items, scoring incorrectly (0) on one or two, and then accurately responding to another three consecutive items before later reaching the ceiling of three consecutive incorrect responses (e.g., 1, 1, 1, 0, 1, 1, 1, 0, 0, 0; see Table 1 for further examples).

The second method of evaluating intratest scatter was an *ordinal* measure, a means of ranking participants' scatter scores by amount of response variability. Kaplan, Fein, Morris, & Delis (1991) quantified scatter by determining the absolute difference between consecutive item scores on a test ("scatter points"). Because items on the TELD-Exp and EVT-2 are scored as correct (score of 1) or incorrect (score of 0), scatter points on these tests are equivalent to the number of shifts from correct to incorrect consecutive responses given by the examinee. For example, on the TELD-Exp, if a child passed the first three items and subsequently reached the ceiling (1, 1, 1, 0, 0, 0), the child's scatter score would equal one (i.e., one change or shift from 1 to 0 or from 0 to 1). If, however, a child passed the first three items and then failed the fourth item, passed the fifth and sixth, and only then reached the ceiling (1, 1, 1, 0, 1, 1, 0, 0, 0), the scatter score would be three (i.e., three changes from 1 to 0 or from 0 to 1; see Table 1).

Stuttering frequency and severity—Frequency of stuttering was calculated as the mean number of stuttered disfluencies (i.e., per 100 words of conversational speech from the first 300 words of an unstructured conversation with the experimenter, Conture, 2001). Overall stuttering severity was assessed using the Stuttering Severity Instrument-3 (SSI-3; Riley, 1994), which considers stuttering frequency, physical concomitants, and stuttering duration.

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Procedure

Caregivers were interviewed for relevant information regarding family SES, history of speech-language disorder, as well as concerns about children's speech-language abilities. Simultaneously, another examiner administered standardized tests of speech and language to the participant, as well as bilateral pure tone screenings, and obtained an unstructured conversation sample. As mentioned above, results of this conversation sample were used to help determine each participant's talker group membership.

Measurement Reliability for Stuttering and Intratest Scatter

Approximately 20% of the final data corpus of each talker group (eight age-matched CWS and nine age-matched CWNS) was selected at random to assess inter- and intra-judge reliability for measurements of stuttering and intratest scatter. To assess inter-judge reliability for frequency of stuttering, the first author's measurements were compared with those of four trained graduate students of speech-language pathology. Comparisons among the coders' assessments of stuttering frequency indicated strong inter-judge reliability, with Spearman's rank-order correlations (ρ) ranging from $\rho = .76$ to $\rho = .85$, with mean $\rho = .81$. Comparison of the first author's initial measurements of stuttering frequency with subsequent re-measurements, taken at least one month later, also indicated strong intra-judge reliability, $\rho = .88$.

To assess the inter-judge reliability of the present author's intratest scatter measurements (categorical and ordinal), a speech-language pathology graduate student assessed categorical and ordinal scatter in the reliability sample. The reliability coder was unaware of talker group category. Comparisons for intratest scatter (average of results for TELD-Exp and EVT-2) indicated strong inter-judge reliability for categorical scatter, mean $\rho = .95$, and ordinal scatter, mean $\rho = .94$. Comparison of the first author's initial scatter measurements with subsequent remeasurements, taken at least one month later, indicated strong intra-judge reliability for categorical scatter, mean $\rho = .89$, and ordinal scatter, mean $\rho = .99$.

Results

Pre-analytic and Analytic Considerations

Pre-analytic assessment, by means of histograms, indicated normal distributions for standard scores on all tests of receptive and expressive language (i.e., TELD-Rec, TELD-Exp, PPVT-4, EVT-2). Similar assessment indicated non-normality of distribution for standard scores and measurements of demographics (i.e., SES and age), speech sounds (i.e., GFTA-2), and fluency (i.e., SSI scores, stuttering frequency). For variables with normal distributions, appropriate parametric statistics were employed (e.g., independent samples t-tests). Conversely, for variables with non-normal distributions, appropriate nonparametric statistics were employed (e.g., Mann-Whitney U test, Spearman's rho).

Descriptive and Demographic Information

SES and demographics—Parents of most participants ($N = 77$, 90% of total participants) provided SES information using the Four-Factor Index of Social Status (described above; Hollingshead, 1975). Based on calculated family averages for these SES

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scores (see Table 2), there was no significant difference between CWS (M = 42.7, SD = 12.3) and CWNS (M = 44.9, SD = 10.5), U (86) = 647.5, p = .34, d = −0.19.

Participants' race was also obtained via parental interview. CWS and CWNS participants were identified as follows: Caucasian (N = 41), African-American (N = 10), multi-racial (N = 1), and no response provided (N = 34).

Stuttering/speech disfluencies—As expected based on aforementioned talker group criteria, results of a Mann-Whitney U test (see Table 2) indicated that CWS (M = 8.6, SD = 4.9) exhibited significantly more stuttering than CWNS (M = 1.3, SD = 0.7), U(86) = 0.00, p < .001, d = 2.09. Likewise, Mann-Whitney U; U (86) = 0.00, p < .001, d = 2.7; indicated that CWS (M = 18.9, SD = 5.8) scored significantly higher on the SSI-3 than CWNS (M = 7.1, SD = 1.9).

Speech and language abilities—As shown in Table 2, there were no significant between-group differences for the GFTA-2, EVT-2, PPVT-4, TELD-Rec, and TELD-Exp standardized tests of speech and language.

Measures of Intratest Scatter

To assess the first hypothesis that CWS would exhibit significantly greater intratest scatter than CWNS, categorical and ordinal measures of scatter were analyzed separately for the TELD-Exp and the EVT-2.

Categorical scatter—Figures 1 illustrates the percentage of categorical scatter found in each talker group. Categorical scatter was analyzed with a chi-square test with results indicating no significant between-group differences in categorical scatter on the TELD-Exp, χ^2 (1, N = 86) = 1.9, p = .16, nor on the EVT-2, χ^2 (1, N = 86) = 2.6, p = .11.

Ordinal scatter—Mann-Whitney U tests were performed for the TELD-Exp and EVT-2, U (86) = 899, p = .85, d = −0.03 and U (86) = 910, p = .93, d = −0.03, respectively. Results indicated no significant between-group differences. Hence, the hypothesis which predicted talker group differences was not supported for either categorical or ordinal scatter.

Despite the present study's relatively large N (CWS = 40; CWNS = 46), its power to reject a false null hypothesis is relatively low (i.e., 1 – β = 0.61), as assessed by *G*Power* freeware (Erdfelder, Faul, & Buchner, 1996). To increase power to detect at least a "medium" effect size (d = 0.5), 1 – β = 0.80, d = 0.5, this study would have required N ≥ 134 (see Cohen, 1992).

Correlational Analyses

Stuttering and intratest scatter—To assess the second hypothesis that greater stuttering would be related to more intratest scatter, categorical and ordinal measures of scatter on the TELD-Exp and EVT-2 were assessed separately with respect to stuttering in CWS. Nonparametric point biserial analysis was utilized for categorical scatter, and Spearman's rho correlation analysis was used for ordinal scatter. For preschool-age CWS, a significant positive relation (ρ = .33, p = .04) between total number of stutterings and categorical scatter

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on the EVT-2 provided support for the second hypothesis. No significant correlation was found between stuttering and categorical scatter on the TELD-Exp, $\rho = -.12$, $p = .44$. Stuttering severity, as measured by the SSI, was correlated with categorical scatter on the EVT-2, $\rho = .28$, $p = .08$.

Ancillary scatter analyses—Prior studies of scatter have indicated possible relations between intratest scatter and other variables relating to test performance, such as age and overall test score. To investigate these relations, categorical and ordinal measures of scatter on the TELD-Exp and EVT-2 were assessed separately in relation to standard scores on each test, total number of items administered, and chronological age. Nonparametric point biserial analysis was utilized for categorical scatter, and Spearman's rho correlation analysis was used for ordinal scatter.

Results (see Table 4) indicated a significant positive correlation between scatter and TELD-Exp standard scores for CWS (for categorical scatter, $\rho = .41$, $p < .01$; for ordinal scatter, $\rho = .51$, $p < .01$) but not for CWNS (for categorical scatter, $\rho = .28$, $p = .06$; for ordinal scatter, $\rho = .19$, $p = .20$); however, a Fisher transformation indicated no significant difference between the two groups' correlations for categorical nor ordinal scatter and standard score, $Z = 0.66$, $p = .51$, and $Z = 1.65$, $p = .10$, respectively.

To assess whether number of items completed impacted participants' scatter, a series of correlations between the two variables was conducted. Results revealed significant positive correlations between number of items administered and all ordinal scatter scores, for CWS (on the TELD-Exp, $\rho = .79$, $p < .01$; on the EVT-2, $\rho = .72$, $p < .01$) and for CWNS (on the TELD-Exp, $\rho = .69$, $p < .01$; on the EVT-2, $\rho = .53$, $p < .01$), as well as with categorical scatter on the TELD-Exp (for CWS, $\rho = .45$, $p < .01$; for CWNS, $\rho = .39$, $p = .01$).

To assess whether the number of test items administered may have impacted between-group differences in scatter, Mann-Whitney U tests indicated no significant between-group differences in number of test items given on the TELD-Exp, $U(86) = 744$, $p = .60$, $d = -0.1$, nor on the EVT-2, $U(86) = 656$, $p = .35$, $d = -0.3$. No significant correlations were found for age and scatter.

Discussion

The present study investigated two main hypotheses. First, it was hypothesized that preschool-age CWS, when compared to their CWNS peers, would exhibit significantly more intratest scatter on the TELD-Exp and EVT-2. Results did not support this hypothesis, indicating no significant between-group differences in intratest scatter. Second, it was hypothesized that measures of intratest scatter would have a positive correlation with stuttering frequency for CWS. Results indicated that, for CWS, categorical intratest scatter on the EVT-2 was significantly correlated with stuttering frequency. Further discussion of these and other findings follows immediately below.

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No Significant Between-Group Differences in Scatter

No significant between-group differences in intratest scatter were found on either test of expressive language, contrary to our first hypothesis. Using a similar measure of ordinal scatter ("scatter points") on the WAIS-R, Godber, Anderson, and Bell (2000) found no significant differences between children with and without cranial irradiation treatment, although their measure of scatter points correlated highly with other ordinal measures of scatter, including a more sensitive computer-assisted measure derived from Item Response Theory. Current findings of a significant relation between stuttering frequency and scatter on the EVT-2 suggest that the present methods are a valid option for quantifying scatter in CWS. Discrepancies between findings for categorical and ordinal scatter highlight the need to better understand and standardize intratest scatter.

The psychometric properties of the TELD-Exp and EVT-2 may have contributed to the lack of difference between the two talker groups on intratest scatter. For example, the TELD-Exp and EVT-2 include many different types of test items. The TELD-Exp consists of a particularly varied sequence of both semantic and syntactic items. Specifically, the test includes a mixture of naming tasks, sentence repetition tasks, grammatical completion tasks, and various other expressive language tasks. Although the EVT-2 attempts to solely target semantic knowledge, it presents a variable sequence of prompts, progressing from the more straightforward item-label prompt, "What do you see?" to questions requesting synonyms, such as "What's another word for 'printing'?" interspersed with the item-labeling questions. Although these variable test items and prompts would seem to challenge young children's cognitive-linguistic processes, the absence of significant test-related time pressure may, at least in part, compensate for the impact of attentional, emotional, or cognitive difficulties, if indeed they are present. Perhaps scatter would be better examined on a more homogenous, continuous, and rapidly-changing task, such as the Conners' Continuous Performance Test (Conners & MHS Staff, 2000) or the Attention Network Test (Fan, McCandliss, Sommer, Rz, & Posner, 2002).

Correlation Between CWS' Stuttering Frequency and Categorical Scatter on the EVT-2

For the preschool-age CWS, categorical scatter on the EVT-2 was significantly positively related to stuttering frequency. This finding may be taken to suggest that CWS exhibit subtle disturbances in their developing speech-language systems, with more frequent stuttering associated with greater vulnerabilities related to planning and production of expressive language. Consistent with this speculation, Ntourou et al. (2011) have suggested that, "when planning/formulating sentences, CWS may experience subtle but important difficulties in quickly and efficiently encoding and retrieving lexical items" (p.174). These difficulties may manifest as intratest scatter in a testing context, and be associated with instances of stuttering in a conversational context.

Consistent with present findings, Walden et al. (2012) also reported that stuttering frequency was correlated with categorical scatter, albeit on the TELD-Exp. Those findings were not replicated in the present study for the TELD-Exp, but were observed for the EVT-2. In the present study, the degree of scatter in both talker groups was found to be greater on the EVT-2 than on the TELD-Exp (see Figures 1 and 2). This is probably due to the fact that the

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EVT-2 has a higher ceiling requirement of five missed items (rather than three), and is normed for a much broader age range than the TELD-Exp. Ancillary analysis indicated significant positive correlations between number of items administered and scatter within-tests, which may support this notion. However, further empirical study will be required to better understand these differences in scatter between the EVT-2 and the TELD-Exp.

General Discussion

As indicated by Dumont and Willis (1995), intratest scatter must be interpreted cautiously, and should not be the sole basis for clinical decision-making. Ancillary analyses for both talker groups revealed a positive correlation between intratest scatter and overall number of items administered during testing, indicating that scatter scores are linked to other variables such as test form, individual ability, and test length (see Godber, Anderson, & Bell, 2000). Other means for assessing scatter may be preferred; for example, analyzing responses to semantic and syntactic items on the TELD-Exp to identify possible dissociations of language domains. It also is possible that a longitudinal, rather than cross-sectional, study of scatter and stuttering may better reveal expressive language variability with respect to CWS and CWNS' development. Such longitudinal assessment, it is suggested, should help us to identify the relevant linguistic, cognitive, attentional, and/or emotional confluences that influence the course of stuttering. Other aspects of speech and language may also be considered (e.g., receptive language) independently (e.g. *intra*test scatter for other measures) or collectively (e.g., *inter*test scatter, cf., Anderson et al., 2005; Coulter et al., 2009).

Additionally, researchers may profit from considering the possible relation between intratest scatter and attention focusing, disengaging, shifting, and reengaging (Eggers et al., 2012; Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Johnson, Conture, & Walden, 2012). Standardized measures of speech and language require the test taker to adequately focus attention on specific items, as well as to shift his or her attention from one test item to the next (Leonard, Weismer, Miller, Francis, Tomblin, & Kail, 2007). CWS have been shown to differ from CWNS with respect to attentional processes (Eggers, DeNil, & Bergh, 2010, 2012; Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Heitmann, Asbjornsen, & Helland, 2004; Karrass et al., 2006; cf. Johnson et al., 2012). Moreover, Riley and Riley (2000) reported that pretreatment attentional difficulties were the single best predictor of poor fluency treatment outcomes for CWS, regardless of stuttering severity prior to treatment. If the attentional resources of preschool-age CWS are less robust than those of their CWNS peers, then, it is possible that such differences may contribute to "uneven" performances by CWS on standardized measures of speech and language. Finding an inverse correlation between attention regulation and intratest scatter would be compelling evidence for further considering scatter as a result of broader cognitive-linguistic processes.

Caveats

Although no significant between-group differences were found in age or gender, it is possible that these variables indirectly and/or subtly influenced present findings. Also in the present study, the total number of items administered for each test was correlated with intratest scatter. This potential confound suggests that future studies should consider scatter in relation to the quantity/quality of specific items to which children have responded.

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Moreover, this study's sample size ($N = 86$) had a relatively low power ($1 - \beta = 0.61$), indicating an increased probability of Type II error (i.e., increased chance of failing to reject a null hypothesis in error), suggesting the need for larger sample sizes in subsequent studies of scatter.

Conclusions

Whether measured by intratest scatter (present study; Walden et al., 2012) or by intertest dissociation (Anderson et al., 2005; Coulter et al., 2009), uneven performance between and/or within various tests of speech and language appears to be associated with childhood stuttering. However, this association is not always manifest during such testing, and the nature of the association is not yet clear. Perhaps the observed association between uneven performance on tests of speech-language and stuttering is due to the fact that both are related to a third variable, such as attention or cognitive load. By continuing to study this association and its possible relation to other variables, we may advance our understanding of the underlying processes involved with the onset, development, and maintenance of childhood stuttering.

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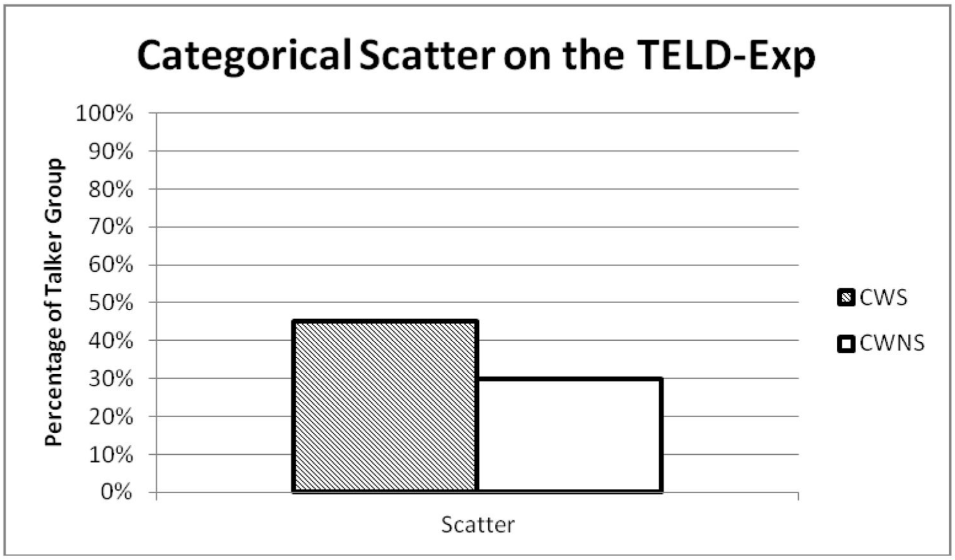
(A)



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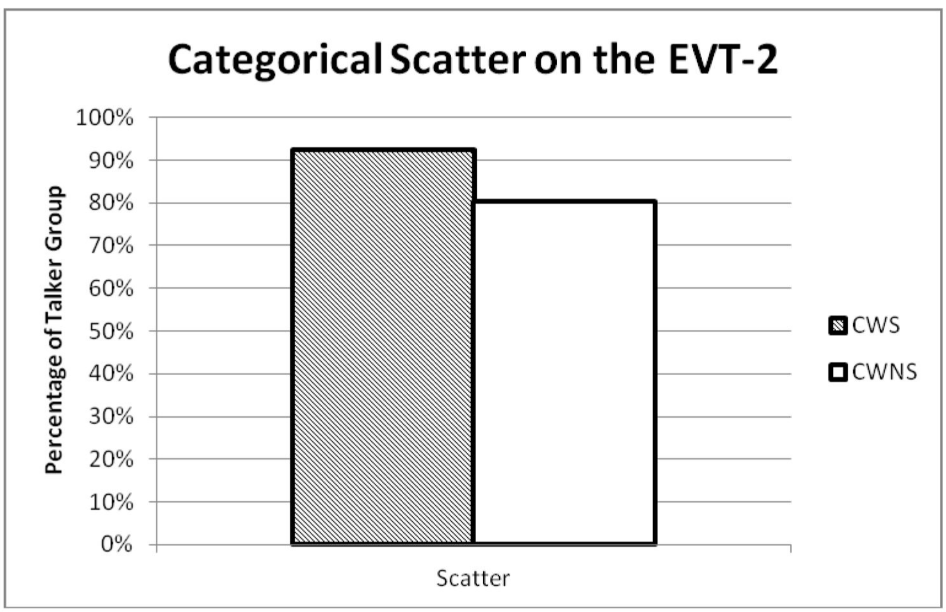

Figure 1.

Percentage of preschool-age children who do and do not stutter with categorical scatter on (A) the Test of Early Language Development 3 – Expressive subtest (TELD-Exp) and (B) the Expressive Vocabulary Test – 2 (EVT-2)

Note: CWS = children who stutter; CWNS = children who do not stutter.

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Table 1

Examples of categorical and ordinal scatter

Categorical scatter
(from Walden et al., 2012)
Presence/absence of multiple basal runs of correct items separated by one or more incorrect item
• Child A→ 1, 1, 1, 1, 1, 0, 0, 0 = no scatter
• Child B→ 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0 = scatter
Ordinal scatter
(from Kaplan et al., 1991)
Absolute difference between consecutive item scores on a test
• Child A→ 1, 1, 1, 1, 1, 0, 0, 0 = 1 scatter point
• Child B→1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0 = 5 scatter points

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Table 2

Demographic and descriptive information for preschool-age children who stutter (CWS) and preschool-age children who do not stutter (CWNS)

	CWS (*N*=40)		CWNS (*N*=46)		Sig. Δ (*CWS vs. CWNS*)
	M	***SD***	***M***	***SD***	
Individual differences					
Age (months)	46.7	6.4	46.3	7.3	p=.41
SES (4-factor score)	42.7	12.3	44.9	10.5	p=.34
Speech fluency					
Mean # stutterings	8.6	4.9	1.3	0.7	p<.001*
SSI Total	18.9	5.8	7.1	1.9	p<.001*
Speech-language abilities					
TELD-Exp	107.3	13.7	111.5	11.3	p=.62
TELD-Rec	114.1	13.5	120.1	13.1	p=.35
GFTA-2	106.6	10.4	109.0	12.1	p=.22
PPVT-4	109.5	12.3	114.2	11.3	p=.65
EVT-2	112.6	11.8	118.9	10.8	p=.71

Note: SES = socioeconomic status; TELD-Exp and TELD-Rec = Test of Early Language Development 3 – Expressive and Receptive subtests, respectively; GFTA-2 = Goldman-Fristoe Test of Articulation 2; PPVT-4 = Peabody Picture Vocabulary Test 4; EVT-2 = Expressive Vocabulary Test 2.

* significant at p < .05.

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Table 3

Spearman's rho correlation coefficients between measures of scatter (categorical and ordinal) and measures of stuttering severity and stuttering frequency

	Measures of Stuttering	
	SSI score	**Mean # stutterings**
TELD-Exp		
Categorical scatter, ρ (p)	.01 (.94)	−.12 (.44)
Ordinal scatter, ρ (p)	−.05 (.78)	−.03 (.87)
EVT-2		
Categorical scatter, ρ (p)	.28 (.08)	.33 (.04)*
Ordinal scatter, ρ (p)	.02 (.89)	−.02 (.91)

Note: CWS = children who stutter; TELD-Exp = Test of Early Language Development 3 – Expressive subtest; EVT-2 = Expressive Vocabulary Test 2.

*Significant at $p < .05$.

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Table 4

Nonparametric point biserial and Spearman's rho correlation coefficients for TELD-Exp and EVT-2 categorical scatter, ordinal scatter, and standard scores for preschool-age children who do and do not stutter

	TELD-Exp Standard Score		TELD-Exp # of Items Administered		Chronological Age	
	CWS	CWNS	CWS	CWNS	CWS	CWNS
TELD-Exp						
Categorical scatter, ρ (p)	.41 (.009)**	.28 (.06)	.45 (.005)**	.39 (.01)**	−.17 (.31)	−.05 (.76)
Ordinal scatter, ρ (p)	.51 (.001)**	.19 (.20)	.79 (<.001)**	.69 (<.001)**	−.10 (.52)	−.24 (.11)

	EVT-2 Standard Score		EVT-2 # of Items Administered		Chronological Age	
	CWS	CWNS	CWS	CWNS	CWS	CWNS
EVT-2						
Categorical scatter, ρ (p)	−.07 (.65)	.09 (.57)	.29 (.09)	.14 (.35)	−.21 (.19)	.08 (.61)
Ordinal scatter, ρ (p)	.31 (.049)*	.45 (.002)**	.72 (<.001)**	.53 (<.001)**	−.19 (.24)	.19 (.22)

Note: CWS = children who stutter; CWNS = children who do not stutter; TELD-Exp = Test of Early Language Development 3 – Expressive subtest; EVT-2 = Expressive Vocabulary Test 2.

* Significant at p < .05.

** Significant at p < .01.