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Research Article

Attention, Speech-Language Dissociations, and Stuttering Chronicity

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Summary: The purpose of this study was to investigate the singular and joint contributions of speech-language dissociations and attention (i.e., distractibility and attention span) to stuttering chronicity.
Method: Participants, aged 3;0–4;11 (years;months) at an initial visit, were classified as persisting (n = 10; 9 boys), recovered (n = 32; 23 boys), and nonstuttering (n = 28; 19 boys) based on multiple speech and language evaluations spread across 2 years. The evaluations included assessments of articulation, receptive and expressive vocabulary, and omnibus receptive and expressive language. These measures were used to identify speech-language dissociations using a correlation-based statistical approach. Attentional characteristics, which included measures of distractibility and attention span, were based on parent report. Analyses investigated between-group differences related to dissociations and attentional characteristics as well as the relation between these indices.
Results: There were no significant between-group differences for the persisting and recovered groups on measures of speech-language dissociations; however, the recovered group was found to exhibit less optimal attention span than the persisting group. In addition, children with dissociations exhibited less optimal distractibility and attention spans at the final time point than children without dissociations.
Conclusions: Present results indicate that attention is related to both stuttering chronicity and the presence of speech-language dissociations; however, they do not support the notion that dissociations are associated with stuttering persistence. These results provide novel insights into the complex nature of the association between developmental stuttering, speech-language dissociations, and attention.

The onset of developmental stuttering is typically observed when children are between 2 and 5 years of age, with 5%–8% of preschool children affected (e.g., Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Månsson, 2000). Approximately 75% of affected children eventually drop below the diagnostic criteria for stuttering (for a review, see Yairi & Ambrose, 2013). Many longitudinal studies have explored the role of speech and language skills in the developmental trajectory of stuttering (Ambrose, Yairi, Loucks, Seery, & Throneburg, 2015; Singer, Walden, & Jones, 2019; Yairi & Ambrose, 1999), often focusing on abilities in isolation as opposed to how various skills and abilities relate. Emerging work suggests children who stutter exhibit "imbalances among subcomponents of speech-language planning and production" (i.e., dissociations; Clark, Conture, Walden, & Lambert, 2015, p. 481) more frequently than children who do not stutter (e.g., Anderson, Pellowski, & Conture, 2005; Clark et al., 2015; Coulter, Anderson, & Conture, 2009). There has been speculation that these "imbalances," also referred to as *dissociations*, may contribute to stuttering persistence (e.g., Anderson et al., 2005); however, no empirical study has investigated this possibility. Furthermore, recent evidence indicates that attention differs between children who do and do not stutter (e.g., Ofoe, Anderson, & Ntourou, 2018) and is also related to speech-language dissociations (Clark et al., 2015). This study was designed to extend this body of knowledge and evaluate the role that speech-language dissociations and attentional characteristics may play in stuttering chronicity.

Speech-Language Dissociations as a Potential Marker of Stuttering Chronicity

Speech-language dissociations are measures of between-test variability and are often identified using a correlational approach (Bates, Appelbaum, Salcedo, Saygin, & Pizzamiglio,

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2003) that requires at least a 1-*SD* difference between the two scores and that the data point falls outside a 95% confidence ellipsoid (based on the typically developing sample). This measure provides a different perspective on speech-language abilities than the study of any one component (e.g., vocabulary, articulation; e.g., Anderson et al., 2005), which may be important to stuttering chronicity considering theoretical speculation suggesting that stuttering is impacted by the dynamic interaction of subcomponents of speech-language as opposed to a deficit in any one area (Anderson & Conture, 2000; Anderson et al., 2005). Furthermore, it is also possible that this measure may be related to neuroanatomical structures (Choo, Burnham, Hicks, & Chang, 2016) shown to contribute to stuttering development (e.g., Chow & Chang, 2017).

Cross-Sectional Findings

Mounting evidence indicates that children who stutter exhibit speech-language dissociations more frequently than children who do not (e.g., Anderson et al., 2005; Choo et al., 2016). Table 1 presents main findings of studies that investigated speech-language dissociations for children who do and do not stutter (only nonoverlapping participant data are included). Findings show that children who stutter are two to three times more likely to exhibit speech-language dissociations than those who do not stutter.

Although all the above studies investigated dissociations across varying age ranges, none investigated the possibility that dissociations may be influenced by age and changes across development (i.e., 2 years in early childhood). Clark et al. (2015) speculated that some children may outgrow their dissociations, but there is no empirical evidence, and it is also possible that some children continue to exhibit dissociations throughout development. It is plausible that speech-language dissociations may be associated with patterns of either persistent stuttering or recovered stuttering (for related speculation, see Anderson et al., 2005; Clark et al., 2015). This study investigated the possible association between speech-language dissociations and stuttering chronicity, as well as developmental changes in dissociations during early childhood.

The Role of Attention

Clark et al. (2015) advanced work on speech-language dissociations by exploring whether attention is a third-order variable that relates to both dissociations and stuttering. The authors investigated associations between attention, speech-language ability, and childhood stuttering. We briefly review each relation below.

Attention and Speech-Language Ability

Attention is related to speech-language abilities (e.g., Dixon, Salley, & Clements, 2006; Salley & Dixon, 2007) and language development (Slomkowski, Nelson, Dunn, & Plomin, 1992). Typically developing children with more optimal attention (e.g., longer attention spans, less distractibility) exhibit higher scores on measures of language (e.g., Dixon & Smith, 2000) and articulation (Locke & Goldstein, 1973). Relative to dissociations of speech-language abilities, Clark et al. (2015) found that distractibility, one attentional characteristic, impacts the relation between speech-language dissociations and stuttering. Specifically, the authors reported that, for the children who stutter that exhibit dissociations, more optimal (i.e., less) distractibility was associated with a greater number of dissociations. Clark et al. discussed the possibility that dissociations may

Table 1. Summary of empirical cross-sectional studies investigating speech-language dissociations in children who do and do not stutter.

Studies	Participants					
	Sample size		Age	Language criteria	Test battery	Findings
Anderson et al. (2005)	CWS	45 (16 F)	3–5;11	Scores could freely vary	PPVT, EVT, TELD-R, TELD-E, GFTA	CWS three times more likely to exhibit speech-language dissociations than CWNS
	CWNS	45 (16 F)	3–5;11	Score at the 20th percentile or higher		
Choo et al. (2016)	CWS	66 (23 F)	3–10;0	Typical scores	PPVT, EVT, RL composite, GFTA	CWS more likely to exhibit speech-language dissociations than CWNS
	CWNS	53 (26 F)	3–10;0	Typical scores		
Clark et al. (2015)	CWS	82 (13 F)	3–5;11	Score at the 17th percentile or higher	PPVT, EVT, TELD-R, TELD-E, GFTA	CWS two times more likely to exhibit speech-language dissociations than CWNS
	CWNS	120 (61 F)	3–5;11	Score at the 17th percentile or higher		
Coulter et al. (2009)[a]	CWS	40 (15 F)	3–5;11	Scores could freely vary	PPVT, EVT, TELD-R, TELD-E, GFTA	CWS over two times more likely to exhibit speech-language dissociations than CWNS
	CWNS	40 (15 F)	3–5;11	Score at the 20th percentile or higher		

Note. CWS = children who stutter; F = female; CWNS = children who do not stutter; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; TELD-R = Test of Early Language Development, Receptive subtest; TELD-E = Test of Early Language Development, Expressive subtest; GFTA = Goldman-Fristoe Test of Articulation; RL = receptive language based on select subtests from the Fluharty Preschool Speech and Language Screening Test, Test of Language Development, and Test for Auditory Comprehension of Language.

[a]This study was both an extension and replication of Anderson et al. (2005); only data from nonoverlapping participants are reported in this table.

be associated with speech-language "glitches and errors" that require attentional monitoring, and in turn, children who stutter with dissociations may "exert greater attentional vigilance (i.e., becoming less distractible) to detect and repair errors as well as anticipate future errors" (p. 496). However, Clark et al. acknowledged that their design did not allow them to determine the directionality of the effect (for a discussion on this issue, see Conture, Kelly, & Walden, 2013), for example, whether distractibility "caused, resulted from or simply co-occurred with CWS's speech-language dissociations" (p. 497). Therefore, at this point, the evidence seems to suggest that speech-language abilities, including dissociations, are related to attention, but the nature of the association remains an open empirical question.

In this longitudinal study, we investigated whether attention characteristics are associated with the presence versus absence of dissociations (cf. Clark et al.'s [2015] investigation of the association between attention and the number of dissociations exhibited) and whether there are developmental changes in the nature of this association for all children. Given the evidence that more optimal attention is associated with better speech-language development (e.g., Slomkowski et al., 1992) and the notion that dissociations may represent incongruencies in speech-language abilities (e.g., Anderson et al., 2005), our overarching theoretical perspective is that children with dissociations will exhibit less optimal attention over the course of development.

Attention and Stuttering

Evidence supports speculation that attention contributes to stuttering. Less optimal attention can hinder error monitoring (Engelhardt, Ferreira, & Nigg, 2009; Meyer, Wheeldon, & Krott, 2007) and has been associated with an increased frequency of disfluencies (Engelhardt, Corley, Nigg, & Ferreira, 2010). Similarly, attention has been found to moderate the relation between emotional regulation and stuttering; specifically, stuttering of children with more optimal executive functions (a composite measure including attention) is less impacted by decreases in regulation compared to children with less optimal executive functions (Jones et al., 2017). Additionally, less optimal effortful control is associated with increased stuttering severity (Kraft, Ambrose, & Chon, 2014; Kraft, Lowther, & Beilby, 2019).

Many studies have also found that children who stutter exhibit less optimal attention than children who do not stutter (e.g., Anderson, Pellowski, Conture, & Kelly, 2003; Eggers & Jansson-Verkasalo, 2017; Embrechts, Ebben, Franke, & van de Poel, 2000; Kefalianos, Onslow, Ukoumunne, Block, & Reilly, 2014; Lewis & Goldberg, 1997; Ofoe et al., 2018; Schwenk, Conture, & Walden, 2007). To date, however, attention has only been minimally compared in children who stutter and persist versus children who stutter and recover. Specifically, Ambrose et al. (2015) found no difference in effortful control between children who persist and those who recover; however, this measure represents a composite of attentional and behavioral regulation and does not isolate attention. Novel insights may emerge between attention and stuttering chronicity when a "pure" measure of attention is used (cf. effortful control; Ambrose et al., 2015).

Attention might be related to persistent and/or transient stuttering. As described by the multifactorial dynamic pathways theory (Smith & Weber, 2017), the interaction between attention and other childhood characteristics may influence stuttering chronicity. We speculate that the dynamics of the interaction between attention and the speech planning and production system is one possible mechanism by which less optimal attention may be associated with either persistent or transient stuttering. On one hand, perhaps less optimal attention interferes with speech-language planning and production throughout childhood, resulting in persistent stuttering. On the other hand, perhaps the impact of less optimal attention on speech planning and production may lessen as the automaticity and development of speech-language skills strengthen and therefore may be related to transient stuttering.

This Study

The purpose of this study was to extend the work of previous studies that assessed the relation between speech-language dissociations, attention, and childhood stuttering. The present authors were motivated to study dissociations within the speech-language domain due to growing speculation that this within-subject variability might play a role in stuttering chronicity (Anderson et al., 2005; Choo et al., 2016; Clark et al., 2015; Coulter et al., 2009). The role of attention was also considered, given that it has also been found to contribute to developmental stuttering, as well as dissociated speech-language skills. Therefore, this represents the first longitudinal study to our knowledge that investigates possible relations between stuttering chronicity, speech-language dissociations, and attention. Based on the current literature, we posed four research questions: (a) "Is the presence of dissociations related to less optimal attention?" (b) "Is stuttering chronicity related to less optimal attention?" (c) "Is the development of speech-language dissociations related to stuttering chronicity as measured by differences in (1) the proportion of children who exhibit dissociations or (2) the average number of dissociations exhibited?" and (d) "Does the presence of speech-language dissociations decrease across 2 years of early childhood development?"

Method

Data were collected as part of a large-scale longitudinal investigation conducted at Vanderbilt University (Clark et al., 2015; Jones et al., 2014; Singer et al., 2019; Zengin-Bolatkale, Conture, & Walden, 2015). This study is both a replication and extension of Clark et al. (2015) and reports longitudinal data on those participants who were followed for at least 2 years, as well as includes an additional measure of attention (i.e., attention span).

Participants

Participants were informed of the study through advertisements in a free, monthly parent-oriented magazine available in Middle Tennessee; self-referrals; and referrals from health professionals. All participants were naive to the purposes and design of the study and had no known hearing, neurological, developmental, academic, intellectual, or emotional problems or speech and/or language disorders other than stuttering.

The large-scale study included 206 children, aged 3;0–8;0 (years;months). Children were excluded from that study after the initial visit if they fell below the 17th percentile on any speech and language measure (n = 25) or were noncompliant at the first visit (n = 5). Thus, 176 children participated in the large-scale study.

This study adopted additional inclusion criteria based on length of study participation and age at study entry. Children were excluded if they participated for fewer than 24 months (n = 66) based on attended visits spread approximately 7–10 months apart. Reasons that children did not complete the full study included family relocation (n = 5), parents could not be contacted for subsequent visits (n = 24), and parent request to withdraw from the study (n = 37). Based on these exclusions, the attrition rate was 37% (66/176). Children were excluded from this study if they began the study above the age of 4;11 (n = 12) to more narrowly explore the development of children close to stuttering onset. In total, 98 children met eligibility criteria for this study. As we further describe in the Classification and Inclusion Criteria section, we also gender matched groups, when possible, due to known gender effects related to the presence of speech-language dissociations (Choo et al., 2016) and attention (Else-Quest, Hyde, Goldsmith, & Hulle, 2006).

Classification and Inclusion Criteria

The primary measures used to classify children as stuttering were 3% stuttered disfluencies in a 300-word conversational play sample and 11 or higher on the Stuttering Severity Instrument (SSI; Riley, 1994, 2009). The 3% threshold has been found to provide the greatest sensitivity and specificity in classifying children who do and do not stutter (Tumanova, Conture, Lambert, & Walden, 2014). Tumanova et al. (2014) found that only children in the bottom fifth percentile of children who do not stutter exhibited 0% stuttered disfluencies, indicating that children not diagnosed as stuttering have some stuttered disfluencies.

The SSI provides additional information regarding stuttering behavior beyond frequency (i.e., physical concomitants and duration of stuttered disfluencies), and the threshold of 11 has previously been used to categorize children who do and do not stutter (e.g., Anderson et al., 2005; Chow & Chang, 2017). This threshold was used to ensure that children who had low stuttering frequency (almost precisely 3% stuttering), but other salient features and characteristics of stuttering (i.e., increased duration, tension; Ambrose & Yairi, 1999), were accurately identified as stuttering. Similar classification methods have been used in other longitudinal studies of stuttering (Chow & Chang, 2017; Erdemir, Walden, Jefferson, Choi, & Jones, 2018; Singer et al., 2019).

Children Who Stutter

At study entry, children participated in a diagnostic visit that yielded a classification of stuttering or not. There were no children with at least 3% stuttered disfluencies who scored below 11 on the SSI. The 47 children who met criteria for stuttering were further divided into two groups based on repeated assessment of stuttering across study participation.

Children were classified as "persisting" if they met criteria for stuttering at each visit. Children were classified as "recovered" if (a) they produced below three stuttered disfluencies per 100 words in two play samples 1–2 weeks apart, (b) they scored 10 or below on the SSI, and (c) parents were not concerned about stuttering at the final visit.

Five children did not meet criteria for either group due to SSI scores at the final visit that indicated they were exhibiting behaviors associated with stuttering despite low stuttering frequency (e.g., facial tension or long durations of stuttering). Based on these criteria, 10 children (nine boys) were considered persisting and 32 children (23 boys) recovered. Due to the small sample sizes of the persisting and recovered groups, we did not further exclude children to balance male-to-female ratios in the groups. Per parent report, 23% of children who met criteria for recovery (n = 6) and 20% who met criteria for persistence (n = 2) received treatment for stuttering during this study.

Children Who Do Not Stutter

Children were classified as "nonstuttering" if they (a) exhibited fewer than three stuttered disfluencies per 100 words in a play sample and (b) scored 10 or below on the SSI and (c) there was no parent concern of stuttering at all visits. Due to emerging stuttering at the second or third visits, eight children were unclassified. Forty-three children met criteria for classification as nonstuttering, but 15 girls were excluded to better match female-to-male gender ratios of the persisting and recovered groups. Twenty-eight children (19 boys) were included in the nonstuttering group.

Procedure

Visits for each participant were scheduled every 7–10 months for approximately 24 months. The number of visits varied due to missed visits or an optional fifth visit, conducted for participants with missing data. All participants completed at least three visits (i.e., initial, second, and final visits), but some completed as many as five visits (e.g., if a participant had significant missing data at a prior time point).

At each visit, testing was completed in a controlled, clinical environment. While one examiner interviewed the parent and administered parent questionnaires in an observation room, another engaged the child in a play-based conversation before conducting speech-language testing.

Following speech and language testing, a bilateral pure-tone hearing and tympanometric screening were conducted.

Measures

Attention Measures

Attentional characteristics were evaluated from caregiver responses on the Behavioral Style Questionnaire (McDevitt & Carey, 1978) at every visit. The 100-item questionnaire assesses caregiver report of temperament in children aged 3–7 years. A 1–6 scale measures how frequently the child exhibits each characteristic; here, 1 represents *almost never* and 6 represents *almost always*. Higher scores reflect less optimal attentional characteristics (e.g., greater distractibility, shorter attention span). This study used the following scales related to attention:

> Distractibility: The likelihood that extraneous stimuli draw attention away from ongoing behaviors. Sample question: The child stops an activity because something else catches his or her attention.
>
> Attention span/persistence: The length of time during which a child pursues a particular activity (attention span) and his or her ability to continue the activity despite distractions (persistence). Sample question: The child says he or she is "bored" with his or her toys and games.

These attentional characteristics are thought to index distinct aspects of attention. In support of this notion, we found that these were not significantly correlated in our sample, $r(67) = -.070$, $p = .576$, based on responses collected at the initial visit.

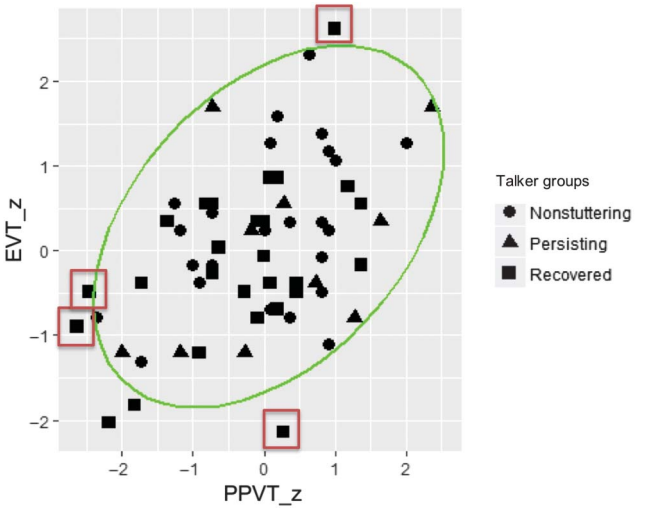
Speech-Language Measures

A comprehensive speech-language battery was administered to children using four norm-referenced speech-language tests at each visit. Participants' articulation skills at the word level were assessed with the Sounds in Words subtest of the Goldman-Fristoe Test of Articulation–Second Edition (Goldman & Fristoe, 2000). Receptive and expressive vocabulary skills were assessed with the Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 1997) and Expressive Vocabulary Test–Second Edition (Williams, 1997), respectively. Participants' receptive and expressive language skills were assessed with the Receptive and Expressive subtests of the Test of Early Language Development–Third Edition (Hresko, Reid, & Hammill, 1999). For all tests, higher standard scores indicate better skills relative to same-age peers.

Speech-Language Dissociation Measures

Dissociations were identified (depicted in Figure 1) using a correlation-based approach (Anderson et al., 2005; Clark et al., 2015; Coulter et al., 2009). For each pair of assessments (e.g., Expressive Vocabulary Test–Second Edition and Peabody Picture Vocabulary Test–Fourth Edition), a four-step procedure was followed: (a) Transform standard scores of all participants into *z* scores, (b) create a scatter plot of participants' scores, (c) superimpose 95% confidence interval density ellipses based on scores of the nonstuttering group, and (d) identify dissociations based on (1) a point falling outside the ellipse and (2) at least 1-*SD* difference between scores. In total, we explored 10 potential types of dissociations based on the five speech-language measures (i.e., all possible pairings of the five assessments).

Figure 1. Scatter plot depicting the correlation between performance on the Expressive Vocabulary Test (EVT) and Peabody Picture Vocabulary Test (PPVT). The 95% density ellipse is based on performance of the nonstuttering group only. Boxes identify dissociations in which there is at least a 1-*SD* difference between the two test scores and the scatterpoint based on the two scores falls outside the ellipse.



Data Analysis

Seventeen total one-way analyses of variance (ANOVAs) assessed between-group differences in age, socioeconomic status, speech disfluencies, SSI scores, time since stuttering onset, speech-language skills (i.e., five skills at both the initial and final visits), and attentional characteristics. Two chi-square analyses assessed group differences in gender and four levels of race: Asian, Black, White, and multiracial. Due to the descriptive nature of these analyses and the fact that they are not related to our research questions, the significance level was set at $p < .05$.

To address whether the presence of dissociations is related to less optimal attention, we conducted one-way ANOVAs comparing the attention of children with and without dissociations. For the initial and final visits, two ANOVAs were conducted with the attentional characteristic as the dependent variable (i.e., distractibility or attention span) and dissociation group (i.e., children with dissociations and children without dissociations regardless of talker group) as the independent variable.

To address whether stuttering chronicity is related to less optimal attention, we conducted linear mixed models

comparing attention across study visits for the three talker groups. Separate models were analyzed for distractibility and attention span. For each model, the attentional characteristic was the dependent variable, talker group (i.e., nonstuttering, persisting, and recovered) was an independent variable, visit (i.e., initial, second, third, and final visits) was a repeated measure, and gender was a covariate.

To address whether the presence of dissociations is related to stuttering chronicity, chi-square analyses compared the proportion of children in each talker group (e.g., persisting, recovered, and nonstuttering) with at least one dissociation, separately for the initial and final visits. Post hoc power analyses showed sufficient power to detect large effects (h range: 0.72–1.03; Cohen, 1988).

To address whether the number of dissociations is related to stuttering chronicity, one-way ANOVAs compared the mean number of dissociations between talker groups. Separate models were conducted for the initial and final visits; children without dissociations were not included in either analyses. The number of dissociations was the dependent variable, and talker group (i.e., persisting, recovered, and nonstuttering) was the independent variable. Given that there were not equivalent male-to-female ratios for the persisting compared to the recovered and nonstuttering groups, gender was included as a covariate (Choo et al., 2016).

To address whether fewer children exhibit dissociations over time, McNemar chi-square analyses compared the proportion of children with dissociations at the initial and final visits. Two separate analyses were conducted: one for the nonstuttering group (n = 28) and one for the stuttering group (n = 42). Based on post hoc power analyses, there was power to detect medium to large effects (w range: 0.43–0.53; Cohen, 1988).

Results

Descriptive Statistics

Table 2 shows participants' demographic, speech fluency, and attentional characteristics at the initial visit. Table 3 shows participants' speech-language characteristics at the initial and final visits (i.e., the scores used to calculate speech-language dissociations). These findings, as well as follow-up comparisons that were conducted when there were significant effects, are described below.

Demographic Variables

There were no statistically significant between-group differences for gender or age between the three groups. No significant differences in race were found for the nonstuttering group (one Asian, two Black, two multiracial, and 23 White), the recovered group (one Black, four multiracial, and 27 White), and the persisting group (three Black, one multiracial, and six White).

Fluency Variables

At the initial visit, there was a main effect of talker group for stuttering frequency and total SSI score. Based on follow-up comparisons, there were no significant differences between the persisting group and the recovered group on stuttering frequency (B = 2.312, p = .081) or SSI total score (B = 0.831, p = .614). As expected, the nonstuttering group was significantly lower on the SSI than the persisting group (B = −12.522, p < .001) and the recovered group (B = −11.691, p < .001) and had significantly lower stuttering frequency than the persisting (B = −8.629, p < .001) and recovered (B = −6.316, p < .001) groups at the initial visit.

Attentional Variables

At the initial visit, a main effect of talker group was found for distractibility. The nonstuttering group scored higher on the distractibility scale than the recovered group (B = 0.477, p = .001) and the persisting group (B = 0.522, p = .034). There were no differences between the persisting and recovered groups (B = −0.045, p = .851). The main effect of talker group on attention span was not significant, as seen in Table 2.

Speech-Language Variables

There were no between-group differences for receptive or expressive vocabulary, articulation, or receptive or expressive language at the initial visit. There was a significant between-group difference only for articulation at the final visit. Post hoc pairwise comparisons indicated that the nonstuttering group scored higher on articulation than both the persisting (B = 2.58, p = .033) and recovered (B = 1.81, p = .04) groups. There was no significant difference between the recovered and persisting groups (B = −1.83, p = .473). For full results, see Table 3.

Main Results

Speech-Language Dissociations and Attentional Characteristics

Figure 2 depicts mean attentional scores for children with and without exhibited dissociations, regardless of whether they stuttered, at the initial and final visits. At the initial visit, children with (n = 21) and without (n = 46) dissociations did not differ in distractibility, $F(1, 66) = 0.007$, p = .935, η_p^2 < .001, or attention span, $F(1, 66) = 0.797$, p = .375, η_p^2 = .012. In contrast, at the final visit, children with dissociations (n = 17) scored higher on the distractibility, $F(1, 44) = 6.294$, p = .016, η_p^2 = .130, and attention span, $F(1, 44) = 4.727$, p = .035, η_p^2 = .101, scales than children without dissociations (n = 28).

Stuttering Chronicity and Attentional Characteristics

There was a significant main effect of talker group on attention span, $F(2, 164) = 5.372$, p = .005, d = 0.362. As seen in Figure 3, the recovered group scored higher on the attention span scale than the nonstuttering (B = 0.243, SE = 0.080, p = .003) and persisting (B = 0.258, SE = 0.114, p = .025) groups. Contrary to the prediction, no difference in distractibility was found between the groups, $F(2, 186) = 1.799$, p = .168, d = 0.197.

Table 2. Demographic, speech fluency, and attentional characteristics of the nonstuttering group, the recovered from stuttering group, and the persisting stuttering group at the initial visit.

Variable	Nonstuttering (n = 28) M (SD)	Recovered (n = 32) M (SD)	Persisting (n = 10) M (SD)	F (df)	Wald χ^2 (df)	p	η_p^2
Chronological age (months)	46.1 (6.9)	45.0 (6.8)	46.6 (4.5)	0.31 (2, 69)		.736	.009
Gender	19 boys	23 boys	9 boys		1.86 (2)	.395	
Race					8.65 (6)	.194	
SES	47.1 (10.5)	44.8 (11.7)	45.2 (10.4)	0.33 (2, 69)		.721	.010
Speech fluency measures							
Stuttering frequency (%)	1.3 (0.8)	7.6 (3.8)	9.9 (6.5)	31.5 (2, 68)		< .001	.488
SSI-3 total score	6.8 (1.3)	18.4 (5.4)	19.3 (6.8)	55.1 (2, 68)		< .001	.629
Time since onset (months)		8.6 (4.9)	11.2 (5.3)	1.91 (1, 37)		.175	.052
Attention measures							
Distractibility	4.1 (0.6)	3.6 (0.6)	3.6 (0.9)	4.57 (2, 67)		.014	.125
Attention span	3.1 (0.5)	3.3 (0.6)	3.1 (0.5)	1.40 (1, 67)		.255	.042

Note. Attention measures were obtained from the Behavior Style Questionnaire; there were missing data for one participant from the nonstuttering group for stuttering frequency and SSI-3. SES = socioeconomic status; SSI-3 = Stuttering Severity Instrument–Third Edition.

Stuttering Chronicity and Dissociations

At the initial visit, a greater proportion of persisting and recovered children exhibited dissociations than the nonstuttering children, $\chi^2(1, 38) = 6.48$, $p = .009$ and $\chi^2(60) = 6.832$, $p = .009$, respectively. There was no significant difference in the proportion of persisting and recovered children who exhibited dissociations at the initial visit, $\chi^2(1, 42) = 0.273$, $p = .601$. At the final visit, there was no significant difference in the proportion of the persisting and nonstuttering groups with dissociations, $\chi^2(1, 38) = 0.81$, $p = .369$; in the proportion of the persisting and recovered groups, $\chi^2(1, 42) = 0.04$, $p = .834$; or in the proportion of the recovered and nonstuttering groups, $\chi^2(1, 60) = 2.31$, $p = .129$. Figure 4 depicts the proportion of children in each group with at least one dissociation at the initial and final visits, as well as the significant between-group comparisons.

Difference in Number of Dissociations

There was no difference in the mean number of dissociations at the initial visit between the nonstuttering ($M = 2.0$, $SE = 0.67$), recovered ($M = 2.1$, $SE = 0.32$), and persisting ($M = 2.6$, $SE = 0.52$) groups, $F(2, 20) = 0.416$, $p = .666$, $\eta_p^2 = .044$. No difference was detected at the final visit between the nonstuttering ($M = 3.8$, $SE = 0.64$), recovered ($M = 2.4$, $SE = 0.45$), and persisting ($M = 3.3$, $SE = 0.85$) groups, $F(2, 24) = 1.720$, $p = .200$, $\eta_p^2 = .136$. These findings did not support the prediction that the mean number of dissociations would differ among talker groups.

Development of Dissociations

There was no significant difference in the proportion of children with dissociations from the initial to final visits

Table 3. Speech-language characteristics (standard scores) of the nonstuttering, recovered, and persisting groups at the initial and final visits.

	Nonstuttering		Recovered		Persisting				
Variable	n	M (SD)	n	M (SD)	n	M (SD)	F (df)	p	η_p^2
Initial visit									
GFTA	28	112 (9.0)	32	110 (7.6)	10	108 (10.6)	1.3 (2, 69)	.28	.04
PPVT	28	119 (11.5)	32	114 (11.5)	10	121 (14.7)	2.2 (2, 69)	.12	.06
EVT	28	119 (9.7)	32	116 (9.3)	10	117 (10.8)	0.9 (2, 69)	.41	.03
TELD-R	27	119 (13.7)	29	124 (15.6)	10	116 (13.4)	1.9 (2, 65)	.16	.06
TELD-E	27	114 (12.4)	28	117 (18.2)	10	111 (16.7)	0.6 (2, 64)	.55	.09
Final visit									
GFTA	28	109 (5.2)	32	105 (7.4)	10	103 (9.9)	3.3 (2, 69)	.04	.09
PPVT	28	120 (10.7)	32	118 (11.2)	10	117 (11.2)	.49 (2, 69)	.61	.01
EVT	28	116 (9.0)	32	115 (9.5)	10	117 (9.4)	.16 (2, 69)	.85	.01
TELD-R	28	114 (8.6)	32	114 (9.4)	10	115 (6.7)	.06 (2, 69)	.94	< .01
TELD-E	28	107 (10.0)	32	107 (9.6)	10	108 (9.9)	.06 (2, 69)	.94	< .01

Note. Between-group differences were measured using omnibus analyses of variance. GFTA = Goldman-Fristoe Test of Articulation–Second Edition; PPVT = Peabody Picture Vocabulary Test–Fourth Edition; EVT = Expressive Vocabulary Test–Second Edition; TELD-R = Receptive Composite of the Test of Early Language Development–Third Edition; TELD-E = Expressive Composite of the Test of Early Language Development–Third Edition.

Figure 2. Group mean scores of distractibility and attention span for children who do and do not exhibit dissociations at the initial and final visits. Higher scores indicate less optimal attention (i.e., greater distractibility and shorter attention span). Error bars represent standard error.

for either the nonstuttering group, $\chi^2(1, 28) = 1$, $p = .317$, or the stuttering group, $\chi^2(1, 42) = 0.862$, $p = .350$. These findings did not support the prediction that fewer children would exhibit dissociations at the final visit compared to the initial visit of their 2-year participation.

Discussion

Summary of Findings

This study resulted in four main findings. First, stuttering chronicity does not appear to be related to the presence of speech-language dissociations. Second, stuttering chronicity is related to attention span, with children who recover exhibiting less optimal attention spans than persistent children. Third, the presence of speech-language dissociations is related to less optimal attention for both children who do and do not stutter later in development (i.e., at the final visit). Fourth, children do not appear to "outgrow" speech-language dissociations during this early stage of childhood. Implications of these four findings are discussed below.

Exploring Findings Related to Stuttering Chronicity

The present results indicate that attention span, but not the presence of speech-language dissociations, is related to stuttering chronicity. There was evidence that less

Figure 3. Mean distractibility and attention span scores for the persisting, recovered, and nonstuttering groups. Higher scores indicate less optimal attention (i.e., greater distractibility and shorter attention span). Error bars represent standard error.

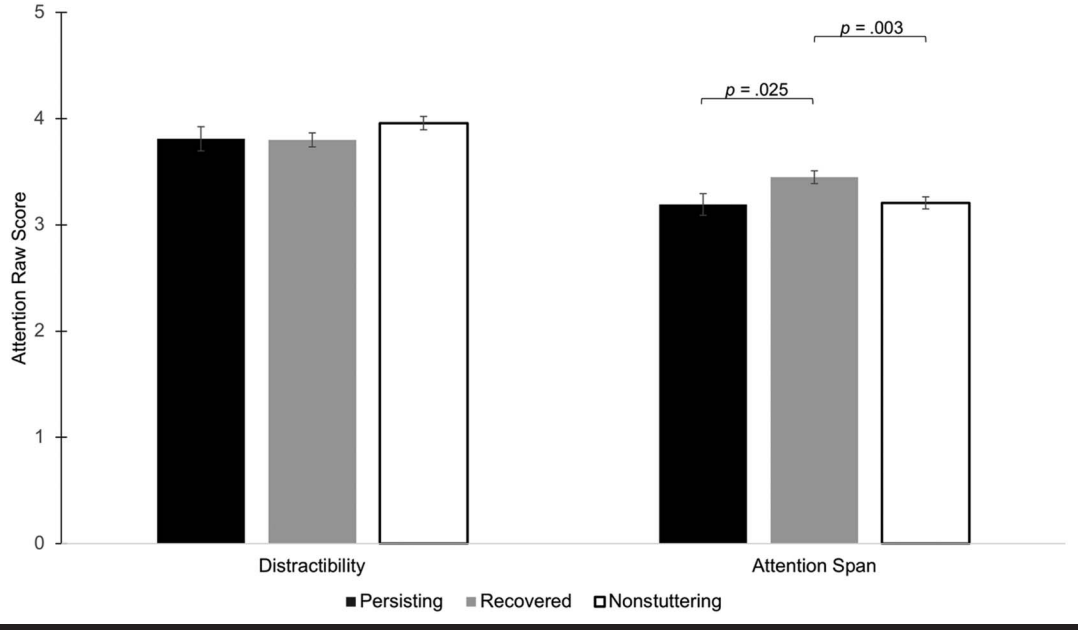
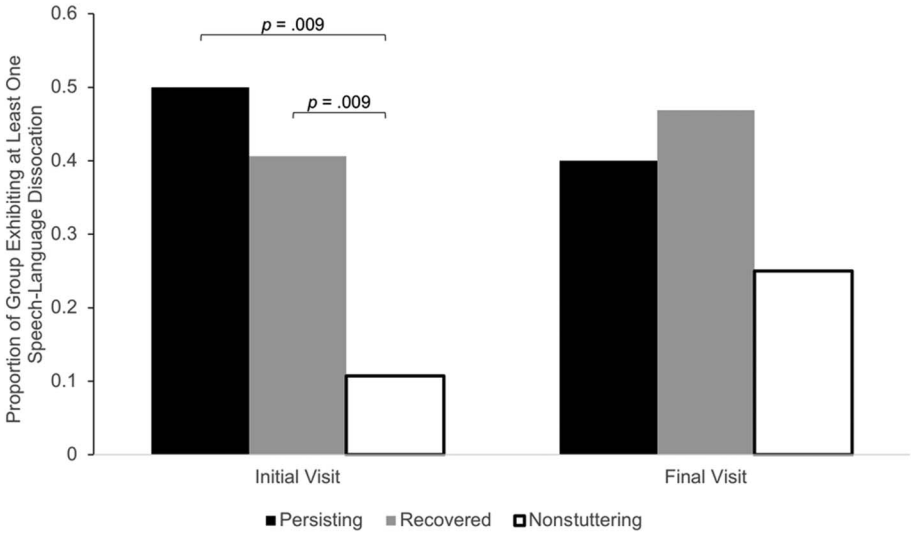


Figure 4. Proportion of children exhibiting at least one dissociation for each talker group at the initial and final visits.



optimal attention span may be associated with transient stuttering. As described in the multifactorial dynamic pathways theory, the interaction between attention and the speech planning and production system may be associated with stuttering chronicity. We speculate, as both Clark et al. (2015) and Smith and Weber (2017) have, that perhaps children with more optimal attention spans attend more to their past and present disfluencies and are less able to adopt new motor plans that result in fluent speech. Therefore, more optimal attention (and not less optimal attention) may be associated with persistent stuttering.

On the other hand, the presence of speech-language dissociations may be present near the onset of stuttering, but not involved in stuttering chronicity. Children who persist and recover did not differ in the likelihood of dissociations or in the number of mean dissociations. This provides evidence for Anderson et al.'s (2005) speculation that some factors associated with the onset of stuttering may not be associated with stuttering chronicity. Perhaps, the presence of dissociations is less disruptive to speech fluency later in childhood when the speech planning and production system is more well developed.

Speech-Language Dissociations and Attentional Characteristics

The third main finding is that the presence of speech-language dissociations is related to parents' ratings of both distractibility and attention span. Children who exhibit dissociations tended to exhibit less optimal distractibility and attention spans than children who do not exhibit dissociations at the final visit. Since distractibility and attention span were not correlated, findings may indicate that these measures independently influence dissociations or that attention, as a global cognitive construct, influences dissociations. This finding extends previous evidence linking attention to performance on speech-language assessments (e.g., Dixon et al., 2006; Locke & Goldstein, 1973; Salley & Dixon, 2007).

The present finding (i.e., the presence of dissociations is related to less optimal attention) seemingly contradicts the negative association between distractibility and number of dissociations within children who stutter that have dissociations found by Clark et al. (2015). However, the present finding is based on children who do and do not stutter when they are 5–7 years old (i.e., at the final time point), whereas Clark et al.'s finding is based on children who stutter when they are 3–5 years old (i.e., at the initial time point). There are at least two possible explanations for the difference in results. First, it is possible that differences in the developmental trajectories of stuttering might impact the relation (e.g., perhaps children who persist exhibit a different association than those who recover). However, we were unable to explore this possibility due to the small number of persistent children who exhibited a dissociation at the final time point ($n = 4$). Second, it is also possible that there may be a change in the association between attention and speech-language dissociations over time. This possibility would seem to align with the numerous findings of attentional and behavioral developmental changes during the age range covered in the current study (for a review, see Sameroff & Haith, 1996). Ultimately, further research is warranted to better understand the relation between these two findings.

Developmental Trajectory of Speech-Language Dissociations

The last finding indicated that children do not "outgrow" dissociations during this period of early childhood

development. We had predicted that dissociations would begin to resolve over the course of the study as children's speech-language skills developed. However, it appears as though the aspect of "unevenness" of speech-language development indexed by dissociations continues into later ages. The processes underlying dissociations may even out later in development than assessed in this study. Szaflarski et al. (2006) conducted a longitudinal study of language development in 5-, 6-, and 7-year-old children with typical language skills (i.e., similar to participants in this study) and found that language development continued through 11 years of age (i.e., study completion). Future studies might explore speech-language dissociations in a larger window of development to better capture when children first begin to develop dissociations and when children might no longer exhibit (i.e., outgrow) dissociations.

Methodological Considerations

This study and its longitudinal design resulted in many novel insights into the relation between attention, speech-language dissociations, and stuttering chronicity, but our understanding of these relations could be further expanded. Larger sample sizes would allow for additional exploration, such as whether talker group further influences the relation between attention and speech-language dissociations, and the detection of smaller effects that could be detected in this study. Furthermore, studies that include participants with concomitant language disorders, unlike this study, could explore whether the current findings are applicable to children with lower speech-language skills. Last, whereas the length of follow-up allowed us to identify recovery in many children, inherent to all longitudinal studies investigating young children who stutter, it is possible that children either recovered or relapsed following study participation.

Conclusion

This study indicates that attention may be associated with both development of speech-language dissociations and stuttering chronicity. Greater distractibility and shorter attention spans were related to the presence of dissociations. Furthermore, less optimal attention span was also related to transient stuttering. Speech-language dissociations do not appear to be related to stuttering chronicity.

Findings have both clinical and theoretical implications. The present findings suggest that a measure of attention should be included in a comprehensive fluency evaluation and considered regarding how it may relate to a child's speech-language development. Attention (attention span in particular) may be useful to consider when planning therapy and evaluating a child's risk for stuttering persistence. Future studies could determine the mechanism by which a shorter attention span may be related to stuttering. In summary, this study revealed significant and complex relations between attention, speech-language dissociations, and stuttering. Further explorations of these relations are warranted to further our understanding of the onset and development of stuttering.

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