Speech-Language Dissociations, Distractibility, and Childhood Stuttering

By

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To my parents, Matilda and Shalom, my brother, Erez, and sisters, Orit and Tzipi, who have been an endless source of love, laughter, support and strength.

To my best friend and dear husband, Trey, whose love, patience, wisdom and incredible sense of adventure motivate me to overcome and surpass any obstacle.

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CHAPTER I

INTRODUCTION

The onset of childhood stuttering—typically between two and four years of age—coincides with a time period of significant and relatively rapid growth in children’s phonology, vocabulary, morphology and syntax (e.g., Bloodstein & Bernstein Ratner, 2008; Reilly et al., 2009; Yairi & Ambrose, 2013). Therefore, not surprisingly, considerable empirical attention has been paid to the relation between speech-language development and childhood stuttering (e.g., Anderson, 2007; Ntourou, Conture, & Lipsey, 2011; Richels, Buhr, Conture, & Ntourou, 2010; Seery, Watkins, Mangelsdorf, & Shigeto, 2007). Findings of such studies have generally shown that various speech-language characteristics are related to instances, distribution, and loci of stuttering (e.g., Howell & Au-Yeung, 1995; Logan & Conture, 1997; Natke, Sandrieser, van Ark, Pietrowsky, & Kalveram, 2004; cf. Clark, Conture, Walden, Lambert, 2013; Nippold, 2012). For example, children who stutter (CWS) tend to stutter on longer, more syntactically complex utterances (e.g., Buhr & Zebrowski, 2009; Howell & Au-Yeung, 1995; Logan & Conture, 1995, 1997; Melnick & Conture, 2000; Richels et al., 2010; Sawyer, Chon, & Ambrose, 2008; Yaruss, 1999).

Empirical findings have also indicated that articulation, phonological and language disorders are more prevalent among CWS than children who do not stutter ([CWNS]; e.g., Arndt & Healy, 2001; Blood, Ridenour, Qualls, & Hammer, 2003; Yaruss, LaSalle, & Conture, 1998; cf. Nippold, 1990, 2001, 2004, 2012). Likewise, meta-analytical findings indicate that there are subtle differences between the overall language abilities of CWS and CWNS (Ntourou et al.,
Likewise, some have reported that compared to CWNS, CWS exhibit significantly lower language performance (e.g., Anderson & Conture, 2000; Anderson & Conture, 2004; Bernstein Ratner & Silverman, 2000; Murray & Reed, 1977; Pellowski & Conture, 2005; Westby, 1974), whereas others have reported that CWS exhibit greater language performance (e.g., Häge, 2001; Reilly et al., 2013; Reilly et al., 2009; Watkins, 2005; Watkins, Yairi, & Ambrose, 1999). However, others have challenged the above conclusions (e.g., Nippold, 2012), reporting no between-group differences in speech or language performance (e.g., Bernstein Ratner & Sih, 1987; Bonelli, Dixon, Bernstein Ratner, & Onslow, 2000; Clark et al., 2013; Nippold, 2012; Nippold, Schwarz, & Jescheniak, 1991).

Some have argued that mean speech-language differences between CWS and CWNS may not be as salient to childhood stuttering as the congruence among subcomponents of their speech-language skills (Anderson & Conture, 2000; Anderson, Pellowski, & Conture, 2005; Coulter, Anderson, & Conture, 2009). Such incongruence—commonly labeled as linguistic/language unevenness, imbalances, dyssynchronies, mismatches, or dissociations—refers to any discrepancy in the development of various subcomponents of speech-language planning and/or production. For example, some children might exhibit appreciably better expressive than receptive language, or better phonology than expressive language abilities. The following section further explores the concept of speech-language dissociations and its possible relation to childhood stuttering.

Speech-Language Dissociations

*Speech-Language Dissociations: Definition*
A speech-language dissociation is an imbalance among subcomponents of speech-language planning and production. The presence of such imbalance can be identified by employing specific correlational-based statistical procedures (see Method section below; Anderson et al., 2005; Bates, Applebaum, Sacedo, Saygin, & Pizzamiglio, 2003; Coulter et al., 2009). Speech-language dissociations have been found among typically as well as atypically developing children (e.g., late talkers or Williams Syndrome) during early stages of language development (e.g., Bates, Bretherton, & Snyder, 1988; Bates, Dale, Thal, 1995; Bates, Thal, Whitesell, Fenson, & Oakes, 1989; Hirsh-Pasek and Golinkoff, 1991). It is important to note that speech-language dissociations “need not reflect a significant delay or disorder in one component of the system…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” (Anderson et al., 2005, p. 223).

Speech-language dissociations and childhood stuttering: Current evidence and issues

Hall (2004) posited that “difficulties managing mismatches in language may lead to disruptions in fluency production” (p. 58). Indeed, empirical findings have shown that more preschool-age CWS tend to exhibit speech-language dissociations or uneven speech-language development compared to their fluent peers, even in the absence of frank or clinically significant speech-language disorders (Anderson et al., 2005; Anderson & Conture, 2000; Coulter et al., 2009; Hollister, Alpermann, & Zebrowski, 2012; Tumanova, Zebrowski, Brown, 2009). Importantly, such findings indicate no apparent pattern regarding the type/quality of dissociations (see Appendix A for a detailed review of extant findings). Thus, the present author
speculates that the mere presence of dissociations might be more salient to childhood stuttering than the quality or type of dissociations.

However, at least three issues raised by the abovementioned studies suggest that the mere presence of speech-language dissociations alone does not necessarily affect preschool-age children’s speech fluency. The first issue relates to the fact that “some CWNS also exhibit dissociations in speech and language, and yet these children do not have fluency concerns” (Anderson et al., 2005, p. 246), an observation reported by other investigators as well (e.g., Bates et al., 1995; Boscolo, Bernstein Ratner, & Rescorla, 2002; Hall, 1996; Hall & Burgess, 2000; Hall, Yamashita, & Aram, 1993; Supernaugh, & LaSalle, 2013). The second issue relates to findings regarding CWS, for whom there is no apparent relation between speech-language unevenness and measures of speech disfluency (e.g., frequency of total, stuttered, or non-stuttered disfluencies; Anderson et al. 2005; Anderson & Conture, 2000; Coulter et al., 2009; Hollister et al., 2012). The third issue relates to contradictory findings related to CWNS. Specifically, some have reported that CWNS exhibiting linguistic unevenness/dissociations tend to be highly disfluent (Boscolo et al., 2002; Hall, 1996; Hall, 1999; Hall & Burgess, 2000; Hall et al., 1993; Supernaugh, & LaSalle, 2013), whereas others have reported no apparent relation between language unevenness and measures of speech fluency exhibited by CWNS (Anderson et al. 2005; Anderson & Conture, 2000).

Taken together, it seems possible that at least one additional factor may underlie or contribute to the relation between speech-language unevenness and childhood stuttering. This speculation is consistent with Bates et al.’s (1989) general account for the presence of linguistic dissociations, indicating that some language processes interact or are involved with other cognitive processes. Similarly, Levelt’s (1983; 1989) model suggests that attention is one salient
process involved in fluent speech-language production. Taken together, the present author speculates that attention is one salient process involved in the relation between speech-language dissociations and childhood stuttering. Below is a brief summary of Levelt’s theoretical model and its possible application to the relation among speech-language dissociations, attentional processes, and childhood stuttering.

**Associations among speech-language dissociations, attention, and childhood stuttering: One relevant theory**

Levelt (1983; 1989) theorized that spontaneous, fluent speech-language production involves incremental progression of speech-language information between and within three essential speech-language sub-processors: the conceptualizer, formulator, and articulator.¹ According to Levelt’s model, the conceptualizer—the first processing component involved in developing speech-language output—conceives of one’s intended message and selects relevant information necessary to express that intention. Such conceptualization activities require the speaker’s attention to monitor the intended versus expressed speech-language information. This “conceptual structure” (i.e., the preverbal message) is then incrementally processed by the formulator, which translates the conceived message into linguistic structures by means of grammatical and phonological encoding. The end product of such incremental encoding—the phonetic plan or internal speech—“entails a certain degree of consciousness (McNeill, 1987)…it is attended to and interpreted by the speaker…to detect trouble [i.e., errors] in his own internal speech” (Levelt, 1989, pp. 12-13). The phonetic plan is subsequently processed by the articulator for execution, resulting in overt speech. “Overt speech can be, and normally is,

¹ See Levelt (1983; 1989) and Levelt, Roelofs & Meyer (1999) for a comprehensive description of the three sub-processes/components—conceptualization, formulation, and articulation—involved in speech-language planning/production.
monitored by the speaker for at least some features, such as pitch and vowel quality” (Levelt, 1983, p. 49).

Efficient versus disrupted incremental progression and their potential impact on speech-language output. From the above overview of Levelt’s model, it may be suggested that attention is one salient process more or less involved with each of the speech-language sub-processors. However, it should be noted that the speech-language planning and production system is largely automatic—particularly for those with well-established systems (e.g., older children and adults). Such automaticity requires the sub-processors to work in parallel with one another and temporally overlap in their functioning, at least to some degree. Thus, “higher level ones [e.g., grammatical encoding] need not complete their work on an utterance before the next level [e.g., articulation] begins” (Bock & Levelt, 2002; p. 410). Taken together, relatively precise temporal alignment, as well as automatic and parallel functioning of the sub-processors permit quick and efficient incremental progression of speech-language information, which, ultimately result in fluent speech-language production (Bock & Levelt; Kempen & Hoenkamp, 1987; Levelt, 1983). Figure 1A (adapted from Rispoli & Hadley, 2001, p. 1133) illustrates typical incremental progression of speech language information throughout the sub-processors, overlapping in time and resulting in fluent speech production.

Of course, it is possible for systems (speech-language or otherwise) to occasionally go awry. Levelt (1983) speculated that one’s monitoring or detection of an error could result in the creation of new or adjusted instructions for error repair, which could lead to “a complete halt-and-restart action [i.e., disfluencies]” (p. 50). Similarly, Rispoli and Hadley (2001) hypothesized that disfluent speech production results from any “glitch” (e.g., subtle to not-so-subtle difficulties
in syntactic construction or word retrieval) interrupting the smooth progression of information across sub-processes. Such glitches make the system more vulnerable to output errors. For example, as shown in Figure 1B (adapted from Rispoli & Hadley, p. 1133), a glitch occurring at the formulation processing level flows to “each successive, lower level of encoding” (Rispoli & Hadley, p. 1132). Eventually, earlier or higher-level processing glitches become apparent during speech output where they manifest as speech disfluencies.
Figure 1. (A) Precise incremental progression (——) of speech-language information *versus* (B) a glitch (-----) interfering with such progression. The left figure (A) depicts smooth progression with overlapping temporal alignment, resulting in fluent speech. In contrast, the right figure (B) depicts a glitch emerging at one sub-processor, which flows throughout subsequent sub-processors and results in speech disfluencies. Figure adapted from Rispoli and Hadley (2001).
Possible associations among incremental processing “glitches,” speech-language dissociations, attention and childhood stuttering. As described above, glitches have been theorized to interrupt the precise temporal alignment and/or incremental progression among the sub-processors of the speech-language system. Consequently, such glitches result in slower and inefficient incremental progression of speech-language information, and, ultimately, manifest as speech disfluencies during speech-language production (e.g., repetitions, prolongations, or hesitations). One might speculate that glitches in the incremental progression of speech-language information could result from a variety of sources, including one or both of the following: (1) uneven or imbalanced development of speech-language sub-components (e.g., a child exhibiting relatively immature lexical abilities compared to his/her more established syntactic abilities); and/or (2) inefficient use of attentional resources (e.g., over- or under-monitoring ongoing speech-language processing or output).

As previously mentioned, preschool-age children are rapidly and continuously developing their speech-language planning and production abilities, as they attempt to establish more adult-like speech-language systems. Thus, it is likely for some preschool-age children to exhibit imbalanced abilities across speech-language (sub)domains, with at least some sub-processes/components being less well established than others. Perhaps those preschool-age children exhibiting such imbalances or unevenness tend to experience more “glitches” or “errors” in their speech-language planning and production. Assuming that these subtle “glitches” or “errors” may be associated with greater temporal misalignments during the incremental progression of speech-language information, one might speculate that these errors may be associated with more speech disfluencies in their output (e.g., hesitations, stoppages, repetitions, and revisions).
However, as described above, extant finding suggest that the mere presence of speech-language dissociations *alone* does not necessarily relate to preschool-age children’s speech fluency (e.g., Anderson et al. 2005; Anderson & Conture, 2000; Coulter et al., 2009; Hollister et al., 2012). The present writer speculates that, given the salience of *attentional processes* in Levelt’s (1989) model, *attention* might, at least in part, contribute to association between speech-language dissociations and speech disfluencies. As Conture and Walden (2012) suggested, “with increased...requirements for...[spontaneous] speech-language—drawing on less than fully automatic [and more effortful] underlying speech-language processes—the potential for hesitations, pauses, disfluencies, etc. increases” (p. 115). Perhaps, for some children, more effortful “underlying speech-language processes” are associated with speech-language dissociations and inefficient use of attentional resources (e.g., exerting too much or too little attention), which might contribute to their speech disfluencies. Below, following a general discussion of attention, we present evidence supporting the notion that attentional processes might be associated with speech-language development and childhood stuttering.

**Attentional Processes**

*Attentional Processes: Definition*

The term “*attentional processes*” is relatively broad, encompassing attention regulation, effortful control, and various related networks (i.e., alerting, orienting, and executive attention; for comprehensive reviews, see Rothbart, 2011; Rueda, Posner, & Rothbart, 2005; Rueda et al., 2004). Different theoretical frameworks and attentional constructs have been put forth to account for various attentional processes (Buss & Plomin, 1975; Rothbart, 1981; 2011; Thomas & Chess,
1977, 1980). For the present, initial investigation of the association among speech-language
dissociation, attention and childhood stuttering, the present writer focuses on one attentional
construct—*distractibility*—conceptualized by Thomas and Chess (1977), which may be
assessed by the Behavioral Style Questionnaire (BSQ; McDevitt & Carey 1978). According to
Thomas and Chess, *distractibility* refers to how easily extraneous or irrelevant stimuli could
divert a child’s attention from a particular task.

**Attention, Speech-Language, and Childhood Stuttering**

The notion that an association exists among attention, speech-language, and childhood
stuttering is intriguing since all three variables significantly develop within similar time frames,
that is, between 3 and 5 years of age (e.g., Berger, Kofman, Livneh, & Henik, 2007; Bloodstein
& Bernstein Ratner, 2008; Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Reilly et al., 2009;
Rothbart, 2011; Yairi & Ambrose, 2013). Additionally, attention, speech-language and stuttering
are associated with similar gender differences. Specifically, (a) stuttering is more prevalent
among males than females (Yairi & Ambrose, 2013), (b) girls tend to exhibit better language
abilities than boys (Blair, Granger, & Peters Razza, 2005; Bornstein, Hahn & Haynes, 2004;
Leve et al., 2013), and (c) boys, compared to girls, tend to exhibit greater distractibility, poorer
attention shifting, as well as reduced attention span/persistence and focus (e.g., Blair et al., 2005;
Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Levelt et al., 2013; Murphy, Eisenberg,
Fabes, Shepard, and Guthrie, 1999; Stifter & Spinrad, 2002). In addition to their shared
developmental time frames and similar gender differences, current evidence supports the notion

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2 See Methods section for additional information about the BSQ.
3 In their review of the literature, Yairi and Ambrose (2013) note “a significant gender bias among adults who stutter
with a male-to-female ratio of 4:1 or larger…however…[such gender ratios] are considerably smaller…in very
young children near stuttering onset” (p. 68).
that attentional processes might be associated with speech-language development and childhood stuttering, as described below.

**Attention and Speech-Language Development.** Given Levelt’s (1983; 1989) suggestion that attentional processes play a salient role in speech-language planning and production, one might speculate that attention is associated with and facilitative of children’s speech-language development. Indeed, empirical findings have generally shown that young children’s attentional skills are associated with various aspects of their speech-language abilities (e.g., Blair & Razza, 2007; Dixon & Shore, 1997; Dixon & Smith, 2000; Morales, Mundy, Delgado, Yale, Neal, et al., 2000; Morales, Mundy, Delgado, Yale, Messinger, et al., 2000; Salley & Dixon, 2007; Slomkowski, Nelson, Dunn, & Plomin, 1992). For example, better attentional abilities have been found to be associated with better articulation (Locke & Goldstein, 1973) and language skills (e.g., Leve et al., 2013; Salley & Dixon, 2007) among infants, toddlers and preschool-age children. To the present author’s knowledge, there have been no reports of the relation between children’s attentional processes and *imbalanced* performance across standardized speech-language measures.⁴ Although such a relation could be inferred from the above findings (i.e., attentional processes are associated with speech-language development), empirical exploration of this topic appears warranted.

**Attention and Childhood Stuttering.** Regarding the association between attention and the diagnosis of childhood stuttering (i.e., CWS vs. CWNS), several researchers have compared the attentional processes of preschool-age CWS and CWNS using caregiver reports or various

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⁴ Millager, Conture, Walden, and Kelly (in press) correlated children’s attentional scores and *intratest* scatter, with “scatter” defined as imbalanced performance patterns (i.e., correctness of responses) *within* a standardized test.
experimental paradigms (Anderson, Pellowski, Conture, & Kelly, 2003; Eggers, De Nil, & van den Bergh, 2010; Eggers, De Nil, & Van den Bergh, 2012; Embrechts, Ebben, Franke, & van de Poel, 2000; Felsenfeld et al., 2010; Johnson, Conture & Walden, 2012; Kefalianos, Onslow, Block, Menzies, & Reilly, 2012; Schwenk, Conture, & Walden, 2007). As shown in Tables 1 and 2, there is at least some empirical evidence supporting an association between attention and childhood stuttering (e.g., Anderson et al., 2003). However, differing methodologies (i.e., varying parent questionnaires and experimental paradigms) make it difficult to directly compare studies and possibly account for equivocal findings. Thus, a better understanding of the nature of this association awaits further empirical study.
Table 1

Summary of empirical studies using caregiver reports to assess between-group (CWS vs. CWNS) differences in attention.

<table>
<thead>
<tr>
<th>Study</th>
<th>Caregiver Measure</th>
<th>Participants</th>
<th></th>
<th>Age Range (age;mos)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson, Pellowski, Conture, &amp; Kelly (2003)</td>
<td>BSQ</td>
<td>CWS 31</td>
<td>CWNS 31</td>
<td>3;0–5;4</td>
<td>• CWS exhibited significantly lower scores on the distractibility subscale.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Between-group differences approached significance, with CWS exhibiting higher scores on the attention span/persistence subscale.</td>
</tr>
<tr>
<td>Anderson &amp; Wagovich (2010)</td>
<td>CBQ-SF&lt;sup&gt;1&lt;/sup&gt;</td>
<td>9</td>
<td>14</td>
<td>3;6-5;2</td>
<td>• No group differences on the attention focusing subscale.</td>
</tr>
<tr>
<td>Eggers, De Nil, &amp; Van den Bergh (2010)</td>
<td>CBQ-D&lt;sup&gt;1&lt;/sup&gt;</td>
<td>58</td>
<td>58</td>
<td>3;4-8;11</td>
<td>• CWS exhibited significantly lower attention shifting scores than CWNS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• No group differences on the attention focusing subscale.</td>
</tr>
<tr>
<td>Embrechts, Ebben, Franke, &amp; van de Poel (2000)</td>
<td>CBQ&lt;sup&gt;2&lt;/sup&gt;</td>
<td>38</td>
<td>38</td>
<td>3;0–7;8</td>
<td>• CWS exhibited significantly lower attention focusing scores than CWNS.</td>
</tr>
<tr>
<td></td>
<td>Modified BSQ&lt;sup&gt;2&lt;/sup&gt;</td>
<td>65</td>
<td>56</td>
<td>3;0–5;11</td>
<td>• CWS exhibited significantly lower attention regulation scores than CWNS.</td>
</tr>
</tbody>
</table>

<sup>1</sup>Attention shifting and attention focusing are the attentional constructs/processes conceptualized by Rothbart (2011), which could be measured using various versions of the CBQ (see Note above). Specifically, attention focusing refers to the “tendency to maintain attentional focus upon task-related channels” (Rothbart, 2011, p. 52). Attention shifting refers the ability to transfer attentional focus from one activity/task to another.

<sup>2</sup> Karrass et al. (2006) used a modified version of the BSQ, from which a measure of attention regulation was derived. These authors reported that comparisons were made between the derived measures of attention regulation and another well-known measure of attention—the CBQ. Findings indicated that the "BSQ attention regulation was associated with CBQ attention shifting, r(34) = .67, p < .001" (p. 409). Therefore, this derived measure of attention regulation related to attention shifting.

Note. Children who stutter (CWS); Children who do not stutter (CWNS); Behavioral Style Questionnaire (BSQ; McDevitt & Carey, 1978); Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001); Dutch version of the Children’s Behavior Questionnaire (CBQ-D; Van den Bergh & Ackx, 2003); Children’s Behavior Questionnaire-Short Form (CBQ-SF; Putnam & Rothbart, 2006).
Table 2

Summary of empirical studies using experimental paradigms to assess between-group (CWS vs. CWNS) differences in attention.

<table>
<thead>
<tr>
<th>Study</th>
<th>Experimental Attention Tasks/Measures</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bush (2006)</td>
<td>• Frequency and latency of looks away from the computer monitor during narratives.</td>
<td>15 CWS, 17 CWNS</td>
<td>3;0–5;7 • CWS exhibited significantly slower and less frequent looks away from stimuli than CWNS.</td>
</tr>
<tr>
<td></td>
<td>• Frequency and latency of off-topic statements during narratives.</td>
<td></td>
<td>• No group differences in frequency of or latency to first off-topic statements.</td>
</tr>
<tr>
<td>Eggers, De Nil, &amp; Van den Bergh (2012)</td>
<td>Performance on a computerized Attention Network Test(^1)</td>
<td>41 CWS, 41 CWNS</td>
<td>4;0–9;0 • CWS exhibited significantly lower orienting network scores than CWNS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• No group differences were found for the alerting or executive control networks.</td>
</tr>
<tr>
<td>Johnson, Conture, &amp; Walden (2012)</td>
<td>Speed and accuracy of non-speech RT (i.e., button pushing) during Traditional and Affect cueing tasks.(^2)</td>
<td>12 CWS, 12 CWNS</td>
<td>3;0–5;11 No group differences.</td>
</tr>
<tr>
<td>Ntourou, Conture, &amp; Walden (2013)</td>
<td>Frequency of distraction behaviors.(^3)</td>
<td>18 CWS, 18 CWNS</td>
<td>3;0–5;11 No group differences.</td>
</tr>
<tr>
<td>Schwenk, Conture, &amp; Walden (2007)</td>
<td>• Frequency and duration of attention shifts from task to camera movements.</td>
<td>18 CWS, 18 CWNS</td>
<td>3;0–5;11 • CWS exhibited a significantly greater frequency of looks per camera movements.</td>
</tr>
<tr>
<td></td>
<td>• Latency of attention shifts (i.e., RT) between onset of camera movement to onset of attention shift to look at the camera.</td>
<td></td>
<td>• No group differences regarding duration of looks (attention shifts) at the camera following its movement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• CWS exhibited marginally significant slower RTs than CWNS.</td>
</tr>
</tbody>
</table>

Note: Children who stutter (CWS); Children who do not stutter (CWNS); Reaction time (RT).

\(^1\) The Attention Network Test (Fan, McCandliss, Sommer, Raz, & Posner, 2002) is a computerized instrument designed to measure the attentional networks of “alerting, orienting, and executive control in adults and in children” (Eggers et al., 2012, p. 947).

\(^2\) Both Traditional and Affect cueing tasks require “disengaging attention from focal point, shifting attention to [un]cued location, and [re]engaging attention to stimulus” (Johnson et al., 2012, p. 265). However, affect cueing tasks immediately follow instructions designed to influence participants’ emotionality. For further review, see Johnson et al. (2012).

\(^3\) Distraction behaviors were defined as “the diversion of attention to something other than the…[experimental] tasks” (Ntourou et al., 2013, p. 266).
Regarding the association between attention and stuttering behaviors (e.g., frequency of total, stuttered and non-stuttered disfluencies), it has been hypothesized that “the frequency of stuttering…tends to vary with the amount of attention that stutterers give to their speech, [or] the cues that evoke stuttering…[Specifically,] reduction in stuttering…appear[s] to be due to displacement of attention, or what has generally been called ‘distraction’” (Bloodstein & Bernstein Ratner, 2008, pp. 267-268). To the present author’s knowledge, only one study empirically assessed the relation between preschool-age children’s attention and their speech disfluencies (Ntouro, Conture, & Walden, 2013). Ntouro et al. reported that the longer CWS engaged in distraction behaviors—defined as “the diversion of attention to something other than the experimental tasks” (p. 266)—during emotionally eliciting conditions, “the less they stuttered during the [subsequent] narratives” (p.268). This finding was taken to suggest that CWS’s increased distractibility "facilitates their speech fluency...by diverting undue attention to or monitoring of their ongoing speech planning and production” (p.270).

**Present Study**

The above review provides empirical evidence for the possible associations between (1) stuttering and speech-language; (2) attention and speech-language; and (3) attention and stuttering. Given such evidence, a possible link among the three seems worthy of further empirical consideration. Based on the aforementioned findings and related theoretical accounts (e.g., Levelt’s [1989] model), the present author speculates that there is a relation among inefficient use of attentional resources, imbalanced speech-language abilities, and childhood

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5 For a more detailed discussion of the association between distraction and stuttering, see Bloodstein & Bernstein Ratner (2008, pp. 267-273).
6 Several investigators have studied the relation between attention and frequency of (non)stuttered disfluencies in adults who do and do not stutter (e.g., Arends, Povel, & Kolk, 1988; Bosshardt, 2002; Bosshardt, Ballmer, & De Nil, 2002; Oomen & Postma, 2001).
stuttering. Interactions among these variables seem reasonable given that preschool-age children are rapidly progressing through a period of speech-language and attentional development, that is, when these abilities are being established and made more automatic. To this writer’s knowledge, no such empirical investigation assessing the relation among stuttering, uneven language development, and attentional processes in preschool-age children has been reported.

It was, therefore, the purpose of the present study to investigate the relation among speech-language dissociations, one attentional process—distractibility—and childhood stuttering. This was accomplished by first addressing between-group differences in speech-language dissociations and distractibility (hypothesis 1 and 2, respectively), and then addressing the relation among attention, speech-language dissociations, and speech fluency (hypotheses 3 and 4). Table 3 provides a summary of the four hypotheses that were empirically tested in the present study, along with the related independent and dependent variables.
Table 3

The current study’s four hypotheses, as well as related independent/dependent variables and analytical methods.

<table>
<thead>
<tr>
<th>First research hypothesis</th>
<th>More preschool-age CWS exhibit speech-language dissociations than CWNS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td>Talker group (CWS vs. CWNS)</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Battery of standardized speech-language tests (i.e., GFTA-2, EVT, PPVT, TELD-3)</td>
</tr>
<tr>
<td>Analytical methods</td>
<td>(1) Correlation-based analysis (Bates et al., 2003) to detect dissociations.</td>
</tr>
<tr>
<td></td>
<td>(2) Chi-square analysis assessing between-group differences in the number of children exhibiting dissociations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second research hypothesis</th>
<th>Preschool-age CWS exhibit poorer distractibility than CWNS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td>Talker group (CWS vs. CWNS)</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Distractibility scores</td>
</tr>
<tr>
<td>Covariates</td>
<td>Gender</td>
</tr>
<tr>
<td>Analytical method</td>
<td>Analysis of variance (ANOVA)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third research hypothesis</th>
<th>Distractibility scores are associated with frequency of speech-language dissociations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td>Distractibility scores</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Measures of speech-language dissociations</td>
</tr>
<tr>
<td>Analytical methods</td>
<td>Separate Spearman’s rank correlations for: (1) CWS only and (2) CWNS only.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fourth research hypothesis</th>
<th>Interactions between distractibility and frequency of speech-language dissociations are predictive of fluency breakdowns.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variables</td>
<td>Distractibility scores</td>
</tr>
<tr>
<td></td>
<td>Frequency of speech-language dissociations.</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Frequency of stuttered, nonstuttered, and total disfluencies</td>
</tr>
<tr>
<td>Interaction term</td>
<td>Distractibility x Frequency of dissociations</td>
</tr>
<tr>
<td>Covariate</td>
<td>Gender</td>
</tr>
<tr>
<td>Analytical method</td>
<td>Generalized Linear Models (GLM)</td>
</tr>
</tbody>
</table>

Note: Children who stutter (CWS); Children who do not stutter (CWNS); Goldman-Fristoe Test of Articulation-2nd edition (GFTA-2; Goldman & Fristoe, 2000); Peabody Picture Vocabulary Test-Third Edition (PPVT-III; Dunn & Dunn, 1997); Expressive Vocabulary Test (EVT; Williams, 1997); Test of Early Language Development-3 (TELD-3; Hresko, Reid, & Hamill, 1999).

The first hypothesis predicted that more preschool-age CWS exhibit dissociations than CWNS. The second hypothesis predicted that preschool-age CWS exhibit poorer distractibility scores—as measured by the BSQ—than CWNS. The third hypothesis predicted that a relation exists between children’s distractibility scores and their frequency of speech-language dissociations. The fourth hypothesis predicted that preschool-age children’s distractibility moderates the relation between speech-language unevenness and speech fluency (i.e., frequency
of total [TD], stuttered [SD], and nonstuttered disfluencies [NSD]). Put differently, the fourth hypothesis posited that speech-language dissociations in the presence of poor (i.e., too much or too little) distractibility affect children’s frequency of speech disfluencies (Figure 2).

Figure 2. A moderation model accounting for the possible relation among attention, speech-language unevenness and speech fluency. This model suggests that the interaction between inefficient use of attentional resources and imbalanced speech-language abilities result in fluency breakdowns.
CHAPTER II

METHOD

Participants

Participants included 202 monolingual, English speaking preschool-age children (3;0–5;11 years of age), 82 of whom stutter (CWS; 65 males, $M=46.68$ months, $SD=9.04$) and 120 who do not stutter (CWNS; 59 males, $M=49.23$ months, $SD=9.0$). These participants’ data were previously collected as part of an ongoing series of empirical investigations of linguistic and emotional associates of childhood stuttering conducted by Vanderbilt University’s Developmental Stuttering Project ([DSP]; e.g., Arnold, Conture, Key, & Walden, 2011; Choi, Conture, Walden, Lambert, & Tumanova, 2014; Clark, Conture, Frankel, & Walden, 2012; Johnson, Walden, Conture, & Karrass, 2010; Jones, Buhr, Conture, Walden, Porges & Tumanova, in press; Millager et al., in press; Richels et al., 2010; Walden, Frankel, Buhr, Johnson, Conture, & Karrass, 2012). All were paid volunteers whose caregivers learned of the study from either (a) a free, monthly parent magazine circulated throughout Middle Tennessee, (b) a local health care provider, or (c) self/professional referral to the Vanderbilt Bill Wilkerson Hearing and Speech Center for an evaluation. Informed consent by parents and assent by children were obtained. The Institution Review Board (IRB) at Vanderbilt University (Nashville, Tennessee) approved the present study’s procedures.

Classification and Inclusion Criteria
Participants were classified as CWS if they (a) exhibited three or more stuttered disfluencies ([SD] i.e., sound/syllable repetitions, sound prolongations or single-syllable whole-word repetitions) per 100 words of conversational speech (Conture, 2001; Yaruss, 1998), and (b) scored 11 or greater (i.e., severity of at least “mild”) on the Stuttering Severity Instrument-3 (SSI-3; Riley, 1994). In contrast, participants were classified as CWNS if they (a) exhibited two or fewer SD per 100 words of conversational speech, and (b) scored 10 or lower on the SSI-3 (i.e., severity of less than “mild”). Children were categorized as unclassifiable if their talker group membership was ambiguous based on the following criteria (either [a] or [b]): (a) if the child exhibited two or fewer SDs per 100 words and scored 11 or greater on the SSI-3; OR (b) if the child exhibited three or more SD per 100 words and scored 10 or lower on the SSI-3.

Children were required to meet all of the criteria listed above to be considered a CWS, CWNS, or unclassifiable.

To be included in the present study, participants were required to be classified as either CWS or CWNS based on both their stuttering frequency and total SSI-3 scores (see criteria [a] and [b] above). Data from unclassifiable children (criteria [c] above) were excluded from the final data corpus (described below). All included CWS and CWNS were required to have no known or reported hearing, neurological, psychological, developmental, or behavioral disorders (e.g., ADHD). Furthermore, included participants were required to have complete data for all standardized speech-language tests as well as complete data for the distractibility subscales of the BSQ. Lastly, to minimize the possibility that present results may be confounded by clinically significant speech-language deficits, all included participants were required to score within

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7 It should be noted that the SSI-3 does not include a “no stuttering” category. Given that the lowest stuttering severity category on the SSI-3 is “very mild,” which corresponds with a total overall score of 10 or below, there could be some overlap between CWS and CWNS who fall under this category. To minimize such potential overlap, only children who scored 11 or above on the SSI-3 and exhibited 3 or more stuttered disfluencies (SD) per 100 words were classified as CWS. Similarly, only children who scored 10 or below on the SSI-3 and exhibited below 3 SDs per 100 words were classified as CWNS.
normal limits on the standardized speech-language measures (i.e., at or above the 16\textsuperscript{th} percentile).

\textit{Final Data Corpus}

The initial cohort consisted of 257 children, 9 of whom were removed from the study because they were unclassifiable (i.e., it was not possible to determine their talker group classification based on their frequency of SD and SSI-3 scores). Of the remaining 248 children, 13 were excluded because either one or more of their standardized speech or language data were missing, and an additional 23 children were excluded because of missing \textit{distractibility} data on the BSQ. Finally, of the remaining 212 children, 10 were excluded from further consideration because they exhibited below average speech-language scores (i.e., below the 16\textsuperscript{th} percentile or approximately 1 SD below the mean). The removal of the abovementioned 55 children resulted in the final 202 participants (82 CWS, 120 CWNS) who were analyzed in the present study.

\textbf{Standardized Measures of Speech and Language Abilities}

Four standardized speech-language tests were administered to assess participants’ articulation abilities, as well as their receptive and expressive vocabulary and language abilities. Each of these standardized speech-language measures are described in further detail below.

\textit{Measure of Speech Sound Articulation Abilities}

The norm-referenced “Sounds in Words” subtest of the Goldman-Fristoe Test of Articulation-Second Edition (GFTA-2; Goldman & Fristoe, 2000) assessed participants’ speech
sound articulation abilities. A greater standard score on this subtest suggests better articulation abilities. As described by Anderson et al. (2005):

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 2,350 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. (pp. 226-227)

Measures of Receptive and Expressive Vocabulary Skills

The Peabody Picture Vocabulary Test-Third Edition (PPVT-III; Dunn & Dunn, 1997) and the Expressive Vocabulary Test (EVT; Williams, 1997) measured participants’ receptive and expressive vocabulary skills, respectively. A greater standard score on the receptive and expressive vocabulary tests suggests better receptive and expressive vocabulary skills, respectively. These measures “were co-normed using a sample of 2,725 participants between the ages of 2.5 and 90 years” (Anderson et al., 2005, p. 226). The PPVT-III and EVT have median internal consistencies of .95 coefficient alpha, and “mean test–retest reliabilities of .92 and .84, respectively” (Anderson et al., 2005, p. 226).

Measures of Receptive and Expressive Language Abilities

The Test of Early Language Development-3 (TELD-3; Hresco, Reid, & Hamill, 1999)—comprised of the Receptive and Expressive subtests—measured participants’ receptive and expressive language development. Greater standard scores on the receptive and expressive subscales of the TELD-3 suggest better receptive and expressive language skills, respectively. As described by Anderson et al. (2005):
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 normed on] 2,217 children [between 2;0 and 7;11 years of age] and has a median coefficient alpha of .92 and test-retest reliability of .87 for both subtests combined. (p. 226)

Measurement of Speech Fluency

Participants’ speech fluency was measured with respect to frequency, type, and severity of stuttering, to be described in further detail below. These values were derived from a 300-word conversational speech sample—obtained through child-examiner free-play—using a disfluency count sheet (Conture, 2001) and the SSI-3.

Types of Disfluencies

Participants’ speech disfluencies were categorized as either stuttered or non-stuttered. Stuttered disfluencies include sound/syllable repetitions ([SSR] e.g., “s-s-s-sorry”), single-syllable whole-word repetitions ([WWR] e.g., “the-the-the”), and sound prolongations ([SP] e.g., “ssssssssorry”). Nonstuttered disfluencies include interjections ([INT] e.g., “um”), phrase repetitions ([PR] e.g., “I want to I want to”), and revisions ([REV] e.g., “I’m going to the store the restaurant”).

Frequency of Total, Stuttered and Non-stuttered Disfluencies

Frequency of total disfluencies (TD) was calculated by dividing the total number of all speech disfluencies (stuttered + non-stuttered) by the total number of words produced (i.e., TD/TW). Frequency of stuttered disfluencies (SD) was calculated by dividing the total number of stuttered disfluencies by the total number of words spoken (i.e., SD/TW). Frequency of non-
stuttered disfluencies (NSD) was calculated by dividing the total number of non-stuttered disfluencies per total words (NSD/TW).

Stuttering Severity

Participants’ stuttering severity was determined by their overall score on the SSI-3 (Riley, 1994)—a criterion-referenced measure assessing stuttering frequency, duration, and physical concomitants.

Behavioral Measure of Attention

The BSQ is a 100-item, parent questionnaire that assesses the temperamental characteristics of 3- to 7-years-old children along nine dimensions: activity level, adaptability, approach–withdrawal, mood, intensity, distractibility, attention span/persistence, sensory threshold, and rhythmicity (McDevitt & Carey, 1978). This instrument requires parents to rate their children’s temperamental characteristics on a 6-point scale, with 1 indicating that the behavior is “almost never” and 6 “almost always” observed in their child. The BSQ was normed on a relatively large sample of children (175 boys, 175 girls), and has excellent test–retest ($\alpha$.89) and split-half reliabilities ($\alpha$.84) based on samples of 53 and 350 children, respectively (McDevitt & Carey).

For the purposes of the present study, participants’ attention was measured using only the 10-item distractibility subscale of the BSQ,\(^8\) which has adequate test–retest reliability of $\alpha$.82, and split-half reliability of $\alpha$.70.\(^9\) Thomas and Chess (1977) define distractibility as “the

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\(^8\) The 10-item attention span/persistence subscale of the BSQ was not analyzed in the present study given its poor internal consistency, as reported by McDevitt and Carey (1978; $\alpha$.6) and consistent with present data ($\alpha$.53).

\(^9\) Comparable psychometric properties for the distractibility subscale have been reported elsewhere for both typical (Baydar, 1995; McDevitt & Carey, 1996) and atypical populations (Hepburn & Stone, 2006). It is recognized that
effectiveness of extraneous environmental stimuli in interfering with or in altering the direction of the [child’s] ongoing behavior” (p. 22). This definition is consistent with all 10 questions that comprise the BSQ’s *distractibility* subscale (e.g., “The child stops an activity because something else catches his/her attention”). As in Anderson et al. (2003), raw distractibility scores were converted to $z$-scores, with a score of 0=mean, +1=1 SD above the mean, and -1=1 SD below the mean. *Greater* or *positive* $z$-scores on the distractibility subscale suggest that the child is *more* easily distracted by external/irrelevant stimuli. In contrast, *lower* or negative distractibility $z$-scores suggest that the child is *less* easily distracted by external/irrelevant stimuli.

### Procedures and Measures of Speech-Language Dissociations

The present study replicated correlation-based analytical methods (Anderson et al., 2005; Bates et al., 2003; Coulter et al., 2009; Hollister et al., 2012) to identify the presence of speech-language dissociations among preschool-age CWS and CWNS. This particular procedure was chosen given its stringent criteria for assessing *true* dissociations. Such criteria reduce the risk of detecting false positives (i.e., detecting dissociations by chance) and false negatives (i.e., missing true dissociations). False positives are especially salient to the present study given that speech-language measures tend to be highly correlated (see Table 4), although not necessarily reflecting true dissociations. This four-step correlation-based procedure is described in detail below,
followed by a description of three measures resulting from this four-step procedure (i.e., *number of children exhibiting dissociations, number of dissociations, and magnitude/degree of linguistic dissociations*). See Figure 3 for a sample graphical illustration of this procedure—including a scatter-plot, density ellipsoid, and linear fit line—using data from the present study.
Table 4

Pearson product-moment correlations across speech-language domains for preschool-age children who do (82 CWS, 65 boys) and do not stutter (120 CWNS, 59 boys).

<table>
<thead>
<tr>
<th>Speech-language domains</th>
<th>CWS</th>
<th>CWNS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT-III vs. EVT</td>
<td>.54*</td>
<td>.604*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TELD-3 Receptive vs. TELD-3 Expressive</td>
<td>.430*</td>
<td>.427*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td><strong>Language &amp; Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TELD-3 Expressive vs. PPVT-III</td>
<td>.388*</td>
<td>.377*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td>TELD-3 Expressive vs. EVT</td>
<td>.476*</td>
<td>.488*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td>TELD-3 Receptive vs. PPVT-III</td>
<td>.388*</td>
<td>.339*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td>TELD-3 Receptive vs. EVT</td>
<td>.505*</td>
<td>.381*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td><strong>Articulation &amp; Vocabulary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. PPVT-III</td>
<td>.176</td>
<td>.251*</td>
</tr>
<tr>
<td></td>
<td>(.176)</td>
<td>(.006)</td>
</tr>
<tr>
<td>GFTA-2 vs. EVT</td>
<td>.122</td>
<td>.333*</td>
</tr>
<tr>
<td></td>
<td>(.272)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td><strong>Articulation &amp; Language</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. TELD-3 Receptive</td>
<td>.144</td>
<td>.327*</td>
</tr>
<tr>
<td></td>
<td>(.193)</td>
<td>(&lt;.001)</td>
</tr>
<tr>
<td>GFTA-2 vs. TELD-3 Expressive</td>
<td>.414*</td>
<td>.348*</td>
</tr>
<tr>
<td></td>
<td>(&lt;.001)</td>
<td>(&lt;.001)</td>
</tr>
</tbody>
</table>

*p ≤ .05
Figure 3. Sample relation between two speech-language measures (i.e., TELD-Rec and TELD-Exp) using Bates et al.’s (2003) correlation-based method. Scatter-plot and density ellipsoid are based on data from the present study. In this example there are 11 total outliers (9 CWS, 2 CWNS), which are those cases falling outside the larger density ellipse. Of these outliers, there are 8 true dissociations (7 CWS, 1 CWNS). According to the criteria defined in the text, truly dissociated cases are only those that (1) fall outside the larger density ellipse; and (2) exhibit at least “one standard deviation difference between the two measures” (Coulter et al., p 262). For the present study, outliers falling below the mean (i.e., <1 SD below the mean) on both measures were not considered dissociations (Bates et al., 2003). See Table 7 for a complete list of raw number of outliers and dissociations for each of the 10 comparisons across the five standardized speech-language (sub)tests.

Correlation-based Procedures

**Step one: Transform standard scores into z-scores.** Participants’ standard scores on each of the five speech-language (sub)tests (i.e., GFTA, PPVT, EVT, TELD-3 receptive subtest, TELD-3 expressive subtest) were first transformed into z-scores. Thus, each variable had a mean
score of zero, with individual z-scores representing the number of standard deviations from the mean. For example, children received a z-score of zero if they scored at the mean, exactly average for their age, on a standardized speech-language test. Those who scored 1 standard deviation above the mean on the standardized test received a z-score of +1. Those who scored 1 standard deviation below the mean on the standardized test received a z-score of -1.

**Step two: Run correlations and create scatter-plots.** Correlations were applied to participants’ z-scores “to examine relationships in [children’s] performances across the five speech-language measures” (Coulter et al., 2009, p. 261). Scatter-plots with linear fits were generated to illustrate the association among children’s speech-language scores. Separate correlations and scatter plots were conducted for the ten combinations/pairs of speech-language measures: (1) PPVT versus EVT; (2) PPVT versus GFTA; (3) PPVT versus TELD-Rec; (4) PPVT versus TELD-Exp; (5) TELD-Rec versus TELD-Exp; (6) EVT versus TELD-Rec; (7) EVT versus TELD-Exp; (8) GFTA versus EVT; (9) GFTA versus TELD-Rec; and (10) GFTA versus TELD-Exp.

**Step three: Superimpose density ellipses on the scatter-plots.** For each of the correlations, density ellipses were constructed and superimposed on the scatter-plots. Ellipses were first created for CWNS, using a confidence interval of 95%, and then applied to CWS’s data. Thus, the 95% of cases falling within the ellipses represent the “typical” population (i.e., based on CWNS exhibiting the typical relation between speech-language measures), and served
as the basis for comparing the presence of dissociations between CWS and CWNS. Visual inspection of the scatter plots with density ellipses helped identify the outliers. Outliers represent the 5% of participants who fall outside of the ellipses, exhibiting potential dissociations between two speech-language measures (Bates et al., 2003; Saygin, Dick, Wilson, Dronkers, & Bates, 2003).

It is important to note that not all outliers represented true dissociations. For example, participants classified as outliers based on low scores (i.e., below normal limits or <1 SD below the mean) in both domains were considered, perhaps, as having a clinical disorder for those abilities, but did not exhibit dissociations. Therefore, although a child who scores two standard deviations below the mean on two different speech-language measures would fall outside the density ellipse (i.e., would be considered an outlier), s/he would not exhibit a true dissociation (Anderson et al., 2005; Coulter et al., 2009).

**Step four: Identify true dissociations.** “The actual process of identifying genuine dissociations is more qualitative” in nature (e.g., visual inspection of the outliers; Saygin et al., 2003, p. 936,). To quantify true dissociations, participants were required to meet both of the following criteria (Anderson et al., 2005; Bates et al., 2003; Coulter et al., 2009): (1) fall outside the correlation ellipsoid [i.e., the 5% of outliers] and (2) perform at least “one standard deviation difference between the two measures” (Coulter et al., p 262). Thus, participants exhibiting what this study considered “true” dissociations represented extreme cases in which “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). As previously mentioned, individuals

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11 “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)” (Anderson et al., 2005, p. 221).
could exhibit dissociations even if they performed within or even above the normal limits on standardized speech-language measures.

**Measures of Speech-Language Dissociations**

The abovementioned correlation-based procedures produced three measures of linguistic dissociations—*number of children exhibiting dissociations, number of dissociations, and mean magnitude of dissociations*—to be described immediately below.

*Number of children* exhibiting dissociations served as a general index of the presence or absence of speech-language dissociations; that is, how many CWS and CWNS did and did not exhibit *true* dissociations across sub-components of their speech-language abilities. This measure was separated into three categories, indicating the number of children exhibiting specific *types* of dissociations: *Total, Language Only, and Speech-Language Dissociations*. *Total dissociations* refers to the total number of children who exhibited dissociations across all speech and/or language (sub)domains. *Language Only Dissociations* refers to the number of children who exhibited dissociations across the vocabulary and language (sub)tests (i.e., PPVT, EVT, TELD-3 receptive, and TELD-3 expressive). *Speech-Language Only Dissociations* refers to the number of children who exhibited dissociations across the articulation versus vocabulary and/or articulation versus language (sub)tests (i.e., GFTA versus PPVT, EVT, and TELD-3 receptive/expressive).

*Number of dissociations* served as an index measuring the *frequency* of dissociations or the number of data points that met the dissociation criteria. This measure, which is specific to *only* children with dissociations, was also categorized as *Total, Language Only, and Speech-Language Dissociations*. *Total Dissociations* refers to the total number of dissociations across all
speech-language (sub)domains. *Language Only Dissociations* refers to the number of dissociations across the vocabulary and language (sub)tests (i.e., PPVT, EVT, TELD-3 receptive, and TELD-3 expressive). *Speech-Language Only Dissociations* refers to the number of dissociations across the articulation versus vocabulary and articulation versus language (sub)tests (i.e., GFTA and PPVT, EVT, TELD-3 receptive/expressive).

*Mean magnitude* of dissociations served as an index of how largely dissociated children’s abilities are across several speech-language subtests/domains. This measure was derived as follows: After converting participants’ standard speech-language scores into *z*-scores, *difference scores* (henceforth referred to as *z*-score differences) were calculated by subtracting *z*-scores across each of the 10 combinations/pairs of standardized speech-language measure (e.g., PPVT vs. EVT; TELD-3.Rec vs. TELD-3.Exp). For example, a child with a *z*-score of +1 on the PPVT and -1 on the EVT received a *z*-score difference of 2 between these two speech-language measures. Thus, each child had a total of 10 *z*-score differences, one for each combination or pair of speech-language subtests, as described above. Participants’ mean *magnitude* of dissociations was calculated by averaging participants’ absolute *z*-score differences across all 10 combinations of speech-language measures (i.e., add the absolute values of *z*-score differences, and divide those absolute values by 10). For example, a child with a *z*-score difference between TELD-3.Rec—TELD.3.Exp = 2, PPVT—EVT = 1, GFTA—EVT = 5 (i.e., [2+1+5]/3) will have a mean *magnitude* of dissociations of 2.67 across these speech-language domains.

Procedures

*Parent Interview*
Parents were required to complete the BSQ prior to their interview at the Vanderbilt Developmental Stuttering Lab. During the parent interview, information was obtained regarding the family’s history of speech-language and fluency disorders, as well as caregivers’ concerns about their children’s speech-language abilities (see Conture [2001] for details pertaining to this interview process). Additionally, information regarding participants’ socioeconomic status (SES) was gathered.

SES data was classified using the Hollingshead Four-Factor Index of Social Position (Hollingshead, 1975), a measure based on the United States Census. This index takes into account both parents’ educational levels, occupation, gender, and marital status. Consistent with the manual (Adams & Weakliem, 2011; Hollingshead, 1975), computed SES scores range on a continuum from eight to 66,\(^{12}\) with a higher score indicating a higher socioeconomic status. Specifically, a score of eight reflects the lowest possible level of occupational status (e.g., dishwashers) and education (less than 7\(^{th}\) grade), whereas a score of 66 reflects the highest level of occupational status (e.g., aeronautical engineer) and educational level (graduate education).

**Child Testing**

Testing was conducted in a controlled laboratory environment. While one examiner conducted the parent interview, another examiner engaged the child in conversation during free-play, from which measures of speech fluency were obtained. Participants were then administered a series of standardized speech and language tests in the following, fixed order: the “Sounds in Words” subtest of the GFTA-2, PPVT-III, EVT, and TELD-3. As previously mentioned, these standardized tests assessed children’s articulation abilities, receptive and expressive vocabulary,

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\(^{12}\) Weighted Family SES scores are calculated by multiplying the occupation scale score by a weight of five and the education scale score by a weight of three, as per Hollingshead’s protocol.
as well as receptive and expressive language skills, respectively. Examiners adhered to the administrative procedures stipulated in the manuals of the abovementioned standardized speech-language measures.

Standardized testing was followed by the administration of bilateral, pure tone and tympanometric hearing screenings; all audiometric equipment was routinely calibrated. Although testing procedures might have introduced an element of fatigue to some of the later administered tests (e.g., TELD-3), this procedure was constant for all participants in both talker groups. Furthermore, the present authors have found that the above procedures maximize the chances that the greatest number of preschool-age children will successfully complete all standardized speech-language testing.

Data Analyses

Talker Group Characteristics

Speech fluency characteristics. Prior to testing the present study’s main hypotheses, generalized linear models (GLM; Nelder & Wedderburn, 1972) was performed to assess between-group differences (i.e., CWS vs. CWNS) in speech fluency (i.e., SSI scores, as well as frequency of stuttered, non-stuttered, and total disfluencies). GLM was chosen because speech

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13 “Generalized” linear models allow one to analyze dependent variables that follow various distributions (e.g., binary, Poisson, or negative binomial), including count data that are not normally distributed (Nelder & Wedderburn, 1972). “The GLM should not be confused with the general linear model [i.e., ANOVA] described by Cohen (1968)… The latter statistical model is a generalization of multivariate and univariate regression with normally distributed errors” (Gardner, Mulvey, & Shaw, 1995, p. 395).
disfluency data followed a negative binomial distribution\textsuperscript{14} (Clark et al., 2013; Tumanova et al., 2014). Interested readers are referred to Gardner, Mulvey, and Shaw (1995) for more detailed statistical illustrations/explanations of GLM and negative binomial distributions.

**Age, gender, SES, and speech-language characteristics.** A series of statistical analyses were performed to better describe/understand the age, gender, SES, and speech-language characteristics of our preschool-age CWS and CWNS samples. With the exception of gender, all of the sample characteristics followed normal distributions and allowed for parametric assessment.

A chi-square ($\chi^2$) assessed between-group gender differences given the non-normal categorical nature of the data. A series of analyses of variance (ANOVA) assessed between-group differences regarding other sample characteristics (i.e., age, SES, TELD-3, etc). Because multiple significance tests may yield false (i.e., “significant”) results by chance, a bootstrap re-sampling with replacement procedure (Efron, 1993) was employed for multiple tests with a family wise false discovery rate of $p < .05$ (Hochberg, 1988; Benjamini & Hochberg, 1995). Re-sampling makes no assumptions about normality or independence. This was done using SAS PROC MULTTEST (Westfall, Tobias et al. 1999). Characteristics that significantly differed between the talker groups were included as covariates in subsequent statistical models to account for competing explanations for present results.

**Hypotheses**

\textsuperscript{14} Non-normality of distribution were determined by graphical descriptive analysis of the data (i.e., histogram) as well as results of the Shapiro-Wilk test of normality ($p<.001$ for all disfluency measures). “Negative binomial” is a type of a Poisson regression with overdispersion (e.g., a long right-hand tail).
Table 3 provides a summary of the four hypotheses, to be described below, their related independent/dependent variables and statistical analyses.

**Hypothesis One: More preschool-age CWS exhibit speech-language dissociations than CWNS.** To test the first hypothesis, a chi-square analysis assessed between-group differences in the number of children exhibiting dissociations; that is, whether significantly more CWS, compared to CWNS, exhibited dissociations among subcomponents of their speech-language skills. Three ancillary analyses related to hypothesis one were performed for only children who exhibited one or more speech-language dissociations to assess: (1) age and gender differences relative to speech-language dissociations; (2) between-group differences in the number of dissociations; and (3) between-group differences in the mean magnitude of dissociations. Non-parametric procedures were used for the ancillary analyses given the non-normal distribution of the dependent variables (e.g., gender, as well as number and magnitude of dissociations), and to account for the relatively small samples of CWS and CWNS exhibiting dissociations. Specifically, chi-square analyses examined between-group gender differences; Mann-Whiney U assessed between-group differences regarding chronological age and magnitude of dissociations; and generalized linear models (GLM) for negative binomial distributions assessed between-group differences in number of dissociations.

**Hypothesis Two: CWS exhibit poorer distractibility than CWNS.** To test the present study’s second hypothesis, an ANOVA assessed between-group distractibility differences. Participants’ gender was included as a covariate given its potential relation to childhood
stuttering and attention (see Introduction). Thus, including this covariate controlled for possibly competing accounts of findings (e.g., the effect gender might have on distractibility).

**Hypothesis Three: Distractibility is associated with speech-language dissociations.** To test the present study’s *third* hypothesis, Spearman’s rank correlations were performed to determine whether participants’ distractibility scores are associated with measures of speech-language dissociations (i.e., magnitude of dissociations as well as frequency of total, speech-language only, and language only dissociations). Separate within-group correlations were conducted for: (1) only CWS who exhibited at least one dissociation, and (2) only CWNS who exhibited at least one dissociation. Between-group comparisons assessed whether the talker groups significantly differed in their respective correlations. These comparisons were done by employing Fisher’s r-to-z transformations (Preacher, 2002) and visual inspection of the standard error (SE) bars surrounding each of the correlations (Cumming & Finch, 2005). Between-group differences were considered significant—suggesting differences between the correlations of CWS and CWNS—if Fisher’s r-to-z transformation resulted in z-scores “greater than |1.96|” (Preacher), and if there was no overlap between the SE bars surrounding the correlations of the two groups (Cummings & Finch).

**Hypothesis Four: Distractibility moderates the relation between speech-language dissociations and speech fluency.** To test the present study’s *fourth* hypothesis, GLMs for

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15 See Cumming and Finch (2005) for detailed explanation of using “inference by eye” to interpret between-group differences in confidence intervals and standard error bars based on graphical illustrations.

16 “For a comparison of two independent [samples], p < .05 when the gap between the SE bars is at least about the size of the average SE, that is, when the proportion gap is about 1 or greater…In addition, p < .01 when the proportion gap is about 2 or more” (Cummings & Finch, 2005, p. 177).
negative binomial distributions assessed whether interactions between children’s distractibility and frequency of speech-language dissociations are predictive of their frequency of stuttered, nonstuttered, and/or total disfluencies. Given its relation to attention, speech-language development, and childhood stuttering (see Introduction), gender was included as covariate in the model to account for its possible effects on present results.

For the above analyses, estimates of effect size (ES) were expressed in partial eta squares ($\eta_p^2$), Spearman’s rho ($\rho$), beta weights ($\beta$), $d$ or $w$ (Cohen, 1988; 1992), depending on the statistical procedure employed. Traditional or recommended interpretations for these effect sizes were assumed (e.g., $d=.2/.5/.8 \sim$ small/medium/large; $\eta_p^2 = .01/.06/.14 \sim$ small/medium/large effects; $w =.1/.3/.5 \sim$ small/medium/large effects [Cohen, 1973, 1988; 1992; UCLA: Statistical Consulting Group; Ferguson, 2009; Volker, 2006]). Where possible, “a [95%] confidence interval for each effect size [was] reported to indicate the precision of estimation of the effect size” (Publication Manual, 2010, p. 34). All analyses were performed in JMP version 10 (Sall, Creighton, & Lehman, 2005) and SPSS version 21.0 (IBM Corp., 2012).

Statistical power

A Cohen-based power analysis (Cohen, 1988, 1992) was performed using PASS software (Hintze, 2008) for two-groups comparisons (i.e., hypotheses 1 and 2). Power was evaluated by estimating the minimum detectable effect size (MDES; Kraemer, Mintz, Noda, Tinklenberg, & Yesavage, 2006). Traditional criteria was assumed: $p < .05$ two-tailed, power=80%, and Cohen's effect size guidelines (e.g., $d=.2/.5/.8 \sim$ small/med/large effects).

Findings of the power analysis indicated that between-group analyses (i.e., hypotheses 1 and 2) with two groups (N=202; 82 CWS + 120 CWNS), using a standardized outcome (mean =
0, std = 1), could detect effects as small as Cohen’s $d = 0.4$ SDs with 80% power. Thus, the present study was sufficiently powered to detect small to medium effects (Cohen, 1992).

## Inter- and Intra-judge Reliability

Intra-class correlation coefficients (ICC; McGraw & Wong, 1996; Shrout & Fleiss, 1979) using the absolute agreement criterion was calculated to assess inter- and intra-judge reliability for the measurement of stuttered (SD), non-stuttered (NSD), and total disfluencies (TD). Four examiners, trained in assessing stuttering, measured participants’ disfluencies in real time while watching randomly selected, video-recorded speech samples (obtained during child-clinician conversations in free-play).

Assessment of inter-judge reliability was based on a random selection of approximately 16% ($n=32$; 14 CWNS and 18 CWS) of participants’ video-recorded, 300-word conversational speech samples. ICCs ranged from .95 to .97 (M=.96), with average measures of .989, $p<.001$, for identification of SD; from .82 to .89 (M=.86), with average measures of .955, $p<.001$, for identification of NSD; and from .94 to .97 (M=.96), with average measures of .987, $p<.001$, for identification of TD.

Assessment of intra-judge reliability was based on a random selection of approximately 5% ($n = 11$; M=6 CWS; M=5 CWNS) of participants’ video-recorded, 300-word conversational speech samples. At least 3 months passed between the first and second disfluency counts. ICCs ranged from .95 to .99 (M=.97) for identification of SD, from .88 to .96 (M=.93) for identification of NSD, and from .97 to .98 (M=.97) for identification of TD. The above reliability values exceed the popular criterion of .7 (Yoder & Symons, 2010).
CHAPTER III

RESULTS

Talker Group Characteristics

Prior to presenting findings related to this study’s main hypotheses, participants’ age, gender, SES, as well as speech fluency and speech-language characteristics (e.g., means [M] and standard deviations [SD]) are briefly described below (Table 5).
Table 5

Age, gender, social economic status (SES), speech, language, and fluency characteristics (e.g., M, SD) of preschool-age children who do (CWS, n = 82, 65 boys) and do not stutter (CWNS, n = 120, 59 boys).

<table>
<thead>
<tr>
<th></th>
<th>CWS (M, SD)</th>
<th>CWNS (M, SD)</th>
<th>F (df)</th>
<th>Wald $\chi^2$ (df)</th>
<th>$p$ (bootstrapped)</th>
<th>$\eta_p^2$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, Gender, and SES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronological Age in months</td>
<td>46.68 (9.04)</td>
<td>49.23 (9.01)</td>
<td>3.87 (1, 200)</td>
<td>N/A</td>
<td>.051</td>
<td>.019</td>
<td>N/A</td>
</tr>
<tr>
<td>Gender$^1$</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; .001*</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>SES$^2$</td>
<td>44.04 (12.38)</td>
<td>45.00 (11.46)</td>
<td>.309 (1, 192)</td>
<td>N/A</td>
<td>.579</td>
<td>.002</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Speech Fluency Measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Disfluencies (%TD)</td>
<td>13.1 (5.39)</td>
<td>4.37 (2.61)</td>
<td>N/A</td>
<td>56.18 (1, 200)</td>
<td>&lt; .001*</td>
<td>N/A</td>
<td>-1.098</td>
</tr>
<tr>
<td>Stuttered Disfluencies (%SD)</td>
<td>8.94 (1.24)</td>
<td>1.24 (.76)</td>
<td>N/A</td>
<td>167.97 (1, 200)</td>
<td>&lt; .001*</td>
<td>N/A</td>
<td>-1.975</td>
</tr>
<tr>
<td>Non-Stuttered Disfluencies (%NSD)</td>
<td>4.16 (2.35)</td>
<td>3.13 (2.35)</td>
<td>N/A</td>
<td>3.65 (1, 200)</td>
<td>.056</td>
<td>N/A</td>
<td>-.286</td>
</tr>
<tr>
<td>SSI-3 Total Score</td>
<td>18.94 (5.54)</td>
<td>6.86 (1.98)</td>
<td>N/A</td>
<td>46.09 (1, 200)</td>
<td>&lt; .001*</td>
<td>N/A</td>
<td>-1.016</td>
</tr>
<tr>
<td><strong>Speech-Language Measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFTA-2</td>
<td>109.35 (9.27)</td>
<td>110.43 (10.13)</td>
<td>.583 (1, 200)</td>
<td>N/A</td>
<td>.446</td>
<td>.003</td>
<td>N/A</td>
</tr>
<tr>
<td>PPVT-III</td>
<td>114.20 (12.42)</td>
<td>115.89 (12.33)</td>
<td>.917 (1, 200)</td>
<td>N/A</td>
<td>.340</td>
<td>.005</td>
<td>N/A</td>
</tr>
<tr>
<td>EVT</td>
<td>114.54 (13.58)</td>
<td>119.06 (11.6)</td>
<td>6.435 (1, 200)</td>
<td>N/A</td>
<td>.012</td>
<td>.031</td>
<td>N/A</td>
</tr>
<tr>
<td>TELD–3 Receptive</td>
<td>118.63 (14.46)</td>
<td>120.88 (11.4)</td>
<td>1.521 (1, 200)</td>
<td>N/A</td>
<td>.219</td>
<td>N/A</td>
<td>.008</td>
</tr>
<tr>
<td>TELD–3 Expressive</td>
<td>111.16 (15.17)</td>
<td>112.22 (11.78)</td>
<td>.310 (1, 200)</td>
<td>N/A</td>
<td>.578</td>
<td>.002</td>
<td>N/A</td>
</tr>
</tbody>
</table>

$N/A$ = Not applicable to a particular analytical procedure; $^* p \leq .05$
Note. As described in the Methods, ANOVAs assessed between-group differences in chronological age, SES and standardized measures of language (e.g., TELD-3, PPVT-III, EVT), a chi-square assessed between-group gender differences, and GLMs assessed between-group speech fluency differences (i.e., SSI-3 scores, as well as frequency of stuttered, non-stuttered, and total disfluencies). Therefore, Wald $\chi^2$ and $\beta$ values were only applicable to the speech fluency measures; $F$ and $\eta^2_p$ values are N/A.

1 A chi-square analysis assessed between-group gender differences, which provided frequencies of boys and girls per talker group, rather than M, SD, or F. As discussed in the Methods and Results, chi-square results indicated that the present sample consisted of more boys than girls who stutter (CWS=17 females and 65 males; CWNS=61 females and 59 males), $\chi^2$ (1)=18.621, $p<.001$, $w=.304$. Such findings are expected, given the gender differences in childhood stuttering (i.e., more boys than girls stutter).

2 SES information was available for 194 of the 202 total participants (114 CWNS, 80 CWS).

3 As described in the Methods, a bootstrap re-sampling procedure was employed when appropriate to control for false discovery rates.
Speech Fluency Characteristics

As would be expected based on talker group classification, preschool-age CWS, compared to CWNS, exhibited significantly more total disfluencies (TD), Wald $\chi^2(1, 200)=56.18$, $p < 0.001$, $\beta =-1.098$, and stuttered disfluencies (SD) per 100 words, Wald $\chi^2(1, 200)=167.97$, $p < 0.001$, $\beta =-1.975$. Consistent with these findings, CWS exhibited significantly higher mean scores on the SSI-3, Wald $\chi^2(1, 200)=46.09$, $p < 0.001$, $\beta =-1.016$. There was no significant group difference in non-stuttered disfluencies (NSD) per 100 words. All of the above $\beta$ values for speech disfluencies (i.e., an estimate of effect size) indicated strong effects, with the exception of NSD whose $\beta = -0.286$, which is “minimum [but] ‘practically’ significant…for social science data” (Ferguson, 2009, Table 1).

Age, Gender, and SES Characteristics

No between-group differences were found for chronological age ($p=.051, \eta^2_p=.019$; $p=.26$ bootstrapped) or SES ($p=.579, \eta^2_p=.002; ; p=.995$ bootstrapped). Thus, further consideration for these characteristics did no appear warranted. There was a moderate between-group gender effect, $\chi^2(1)=18.621$, $p<.001$, $w =.304$, indicating that the present sample consisted of more males than females who stutter (CWS=17 females and 65 males; CWNS=61 females and 59 males). Such gender differences are expected since more boys stutter than girls (Bloodstein & Bernstein Ratner, 2008, Table 3-1). Thus, gender was included as a covariate in subsequent statistical models to account for its possible effects on present results (i.e., children’s distractibility and speech-language dissociations).

Speech and Language Characteristics
Using the aforementioned bootstrap re-sampling with replacement procedure (Efron, 1993), none of the between-group speech and language differences reached significance \((p \text{ ranged from } .012 \text{ to } .578; \text{ bootstrapped } p \text{ ranged from } .071 \text{ to } .995)\). Additionally, the effect sizes (ES) were small, with \(\eta_p^2\) ranging from .002 to .031. Therefore, these between-group speech and language differences did not appear to warrant further consideration.

Hypotheses

**Hypothesis One: Between-group Differences in the Number of Participants Exhibiting Speech-Language Dissociations**

To test the first hypothesis—that is, significantly more preschool-age CWS, compared to CWNS, exhibit dissociations among subcomponents of their speech-language skills—a 2x2 chi-square analysis was conducted.\(^{17}\) Chi-square categories included CWS who do (n=23) and do not (n=59) exhibit dissociations, as well as CWNS who do (n=18) and do not (n=102) exhibit dissociations. Findings supported this hypothesis, with significantly more preschool-age CWS (n=23 out of 82; 28%) exhibiting total speech-language dissociations compared to their CWNS peers (n=18 out of 120; 15%), \(\chi^2(1) = 5.127, p = .024, w = .159, 95\% \text{ CI}=0.021, 0.291\). There were, however, no between-group differences in the number of participants exhibiting specific types of dissociations (i.e., *language only* or *speech-language only* dissociations; \(p=.238 \text{ and } .057\), respectively). Table 6 provides descriptive and statistical results relative to Hypothesis 1 (i.e., between-group differences in the *number of children* exhibiting dissociations across speech-language [sub]domains).

\(^{17}\) Readers are referred to the Method section detailing the four-step correlation-based analyses involved in the identification of speech-language dissociations.
Table 6

Number (percentage) of preschool-age children who do (CWS; n=82) and do not stutter (CWNS; n=120) who exhibited speech-language dissociations.

<table>
<thead>
<tr>
<th></th>
<th>Total Dissociations¹</th>
<th>Language Only Dissociations²</th>
<th>Speech-Language Only Dissociations³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>CWS</td>
<td>CWNS</td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>χ² (df)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Total Dissociations refers to the total number of children who exhibited dissociations across all speech and/or language (sub)domains. Note that some children exhibited multiple dissociations across domains. Thus, the same children may overlap in the language only and speech-language only dissociations.

² Language Only Dissociations refers to the number of children who exhibited dissociations across the vocabulary and language (sub)test (i.e., PPVT, EVT, TELD-3 receptive).

³ Speech-Language Only Dissociations refers to the number of children who exhibited dissociations across the articulation versus vocabulary and/or articulation versus language (sub)test (i.e., GFTA versus PPVT, EVT, and TELD-3 receptive/expressive).
Ancillary Findings Related to Hypothesis One: Age and Gender Differences, as well as Number and Magnitude of Dissociations

Three ancillary analyses related to hypothesis 1 were conducted for only children who exhibited one or more speech-language dissociations (23 CWS, 18 CWNS).\(^{18}\) The first analysis involved age and gender differences relative to speech-language dissociations. Findings indicated no significant differences in chronological age between preschool-age CWS (Mdn age = 44) and CWNS (Mdn age= 48.5) who exhibited at least one dissociation, \(U=150.50, p=.201, r=.2, 95\% \text{ CI}= -0.115, 0.478\).

Regarding gender differences relative to dissociations, 17.65\% (3 out of 17) CWS versus 13.11\% (8 out of 61) CWNS females exhibited dissociations, compared to 30.77\% (20 out of 65) CWS versus 16.95\% (10 out of 59) of CWNS males exhibited dissociations. When considering only participants who exhibited at least one dissociation (23 CWS, 18 CWNS), there was a medium to large gender effect, with significantly more males (20 CWS, 10 CWNS) than females (3 CWS, 8 CWNS) exhibiting dissociations, \(\chi^2(1)= 5.072, p=.024 (p=.036, \text{ Fisher’s Exact Test}), w=.352, 95\% \text{ CI}=0.050, 0.595\). Caveats related to findings of between-group gender differences will be considered throughout the Discussion section.

The second ancillary analysis involved between-group differences in the number of dissociations exhibited by only children who exhibited one or more speech-language dissociations (see Table 7 for raw number of outliers and dissociations). Gender was included as a covariate in the models to account for its possible effect on between-group differences relative to number of dissociations. For only children exhibiting dissociations, there were no significant between-group differences in the number of total dissociations \(p=.742, \beta=.137, 95\% \text{ CI}= -0.68,\)

\(^{18}\) Ancillary analyses were limited to this sample to better understand the characteristics of children who exhibited dissociations. Therefore, children who did not exhibit dissociations were excluded from these comparisons.
0.95), language only ($p=.754, \beta=.144, 95\% \text{ CI}= -0.76, 1.04$) or speech-language only
dissociations ($p=.831, \beta=.105, 95\% \text{ CI}= -0.86, 1.07$). Additionally, no gender effects were found
for total ($p=.644, \beta=-.217, 95\% \text{ CI}= -1.14, 0.70$), language only ($p=.338, \beta=-.521, 95\% \text{ CI}= -1.59, 0.55$) or speech-language only dissociations ($p=.841, \beta=.108, 95\% \text{ CI}= -0.95, 1.17$). Table
8 provides descriptive and statistical results pertaining to the number of dissociations exhibited by only children with dissociations.
Table 7

Number of outliers and dissociations across speech-language domains for preschool-age children who do (82 CWS, 65 boys) and do not stutter (120 CWNS, 59 boys).

<table>
<thead>
<tr>
<th>Speech-language domains</th>
<th>Number of outliers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Number of dissociations&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Type of dissociation (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CWS</td>
<td>CWNS</td>
<td>CWS</td>
</tr>
<tr>
<td><strong>Vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT-III vs. EVT</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>PPVT &gt; EVT (2)</td>
<td>PPVT &lt; EVT (2)</td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TELD-3 Rec vs. TELD-3 Exp</td>
<td>9</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>TELD R &gt; TELD E (3)</td>
<td>TELD R &lt; TELD E (4)</td>
<td></td>
</tr>
<tr>
<td><strong>Language &amp; Vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TELD-3 Exp vs. PPVT-III</td>
<td>7</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>TELD E &gt; PPVT (2)</td>
<td>TELD E &lt; PPVT (3)</td>
<td></td>
</tr>
<tr>
<td>TELD-3 Exp vs. EVT</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>TELD E &gt; EVT (3)</td>
<td>TELD E &lt; EVT (1)</td>
<td></td>
</tr>
<tr>
<td>TELD-3 Rec vs. PPVT-III</td>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>TELD R &gt; PPVT (3)</td>
<td>TELD R &lt; PPVT (4)</td>
<td></td>
</tr>
<tr>
<td>TELD-3 Rec vs. EVT</td>
<td>5</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>TELD R &gt; EVT (2)</td>
<td>TELD R &lt; EVT (4)</td>
<td></td>
</tr>
<tr>
<td><strong>Articulation &amp; Vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. PPVT-III</td>
<td>6</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>GFTA &lt; PPVT (5)</td>
<td>GFTA &lt; PPVT (6)</td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. EVT</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>GFTA &gt; EVT (1)</td>
<td>GFTA &gt; EV (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GFTA &lt; EV (3)</td>
<td>GFTA &lt; EV (3)</td>
<td></td>
</tr>
<tr>
<td><strong>Articulation &amp; Language</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. TELD-3 Rec</td>
<td>8</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>GFTA &gt; TELD R (3)</td>
<td>GFTA &gt; TELD R (1)</td>
<td></td>
</tr>
<tr>
<td>GFTA-2 vs. TELD-3 Exp</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>GFTA &lt; TELD R (5)</td>
<td>GFTA &lt; TELD R (4)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>64</td>
<td>57</td>
<td>48</td>
</tr>
</tbody>
</table>

<sup>1</sup> Outliers represent the 5% of participants who fall outside of the ellipses, exhibiting potential dissociations between two speech-language measures.

<sup>2</sup> Dissociated cases are those that (1) fall outside the density ellipse; and (2) exhibit at least “one standard deviation difference between the two measures” (Coulter et al., 2009; p 262).
Table 8

Number, M(SD), and range of speech-language dissociations\(^1\) exhibited by only preschool-age children with dissociations (23 CWS, 18 CWNS).

<table>
<thead>
<tr>
<th>Number of Dissociations</th>
<th>Total (^2)</th>
<th>Language Only (^3)</th>
<th>Speech-Language Only (^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>CWS</td>
<td>CWNS</td>
</tr>
<tr>
<td>Frequency</td>
<td>88</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>M</td>
<td>2.15</td>
<td>2.09</td>
<td>2.22</td>
</tr>
<tr>
<td>(SD)</td>
<td>(1.15)</td>
<td>(1.12)</td>
<td>(1.22)</td>
</tr>
<tr>
<td>Range</td>
<td>1-5</td>
<td>1-4</td>
<td>1-5</td>
</tr>
<tr>
<td>Wald (\chi^2)</td>
<td>.109</td>
<td>.098</td>
<td>.046</td>
</tr>
<tr>
<td>(df)</td>
<td>(1, 38)</td>
<td>(1, 38)</td>
<td>(1, 38)</td>
</tr>
<tr>
<td>(p)</td>
<td>.742</td>
<td>.754</td>
<td>.831</td>
</tr>
<tr>
<td>(\beta)</td>
<td>.137</td>
<td>.144</td>
<td>.105</td>
</tr>
</tbody>
</table>

\(^1\) Number of dissociations refers to the number of data points that met the dissociation criteria (i.e., fell outside the density ellipses and exhibited at least 1 SD difference between the speech-language measures). Children may exhibit one or more instances of dissociations across speech-language (sub)domains.

\(^2\) Total Dissociations refers to the total number of dissociations across speech-language (sub)domains.

\(^3\) Language Only Dissociations refers to the number of dissociations across the vocabulary and language (sub)tests (i.e., PPVT, EVT, TELD-3 receptive, and TELD-3 expressive).

\(^4\) Speech-Language Only Dissociations refers to the number of dissociations across the articulation versus vocabulary and articulation versus language (sub)tests (i.e., GFTA and PPVT, EVT, TELD-3 receptive/expressive).

The third ancillary analysis involved between-group differences in mean magnitude for only children exhibiting one or more speech-language dissociations. Results indicated no significant difference between the mean magnitude of preschool-age CWS with dissociations (n=23; M = .59 z-score difference; SD=.39, range: .04-2.11; Mdn=.71) and CWNS with dissociations (n=18; M=.51 z-score difference, SD=.53; range: .02-1.16; Mdn=.30), \(U=168, p=.306, r=.326, 95\% CI=0.020, 0.576\). There was, however, a small to moderate gender effect for magnitude, with girls (n=11) exhibiting a larger mean magnitude of dissociations (M=.83, SD=.58; range: .16-2.11Mdn=.76) compared to boys (n=30, M=.46, SD=.36; range: .02-1.16; Mdn=.42), \(U=94, p=.037, r=.138, 95\% CI=-0.177, 0.426\).
In summary, more preschool-age CWS exhibited overall dissociations than CWNS. For *only* children exhibiting at least one dissociation, there were no significant talker group differences in *number* or *magnitude* of dissociations. Gender effects indicated that this sample consisted of more boys than girls who exhibited dissociations, and that girls exhibited a greater mean magnitude of dissociations than boys.

**Hypothesis Two: Between-group Differences in Distractibility Scores**

To test the *second* hypothesis—that is, that preschool-age CWS, compared to CWNS, exhibit poorer distractibility scores on the BSQ—ANOVA was conducted. This model included gender as a covariate and a talker group x gender interaction to account for possible gender effects on between-group distractibility differences.

Findings did not confirm this hypothesis, indicating no significant differences between the BSQ distractibility scores of preschool-age CWS (M z-score=-.098, SD=1.02) and CWNS (M z-score=.065, SD=.99), F(1, 198)=1.945, p= .165, $\eta_p^2 = .010$, $d= .1998$, 95% CI=-.0817, 0.4813. There was, however, a significant gender effect for distractibility, F(1, 198)=6.548, p= .011, $\eta_p^2 = .032$, $d=.3698$, 95% CI=0.0843, 0.6553. Specifically, males scored significantly lower (M= -.123, SD=.961)—suggesting less distractibility—than females (M=.192, SD=1.042). Furthermore, there was a significant interaction effect for talker group x gender, F(1, 198)=4.012, p=.047, $\eta_p^2 = .020$, d=0.287, 95% CI=0.0048, 0.5692. Namely, CWS males scored significantly lower on the BSQ’s distractibility subscale (M= -.251, SD=.968) than both CWS females (M=.487, SD=1.028), p=.007, d=-0.7528, 95% CI=-1.299, -0.2066, and CWNS females (M=.109, SD=1.039), p=.046, d=-0.3589, 95% CI=-0.7111, -0.0067. No distractibility differences were found between CWNS males (M=.019, SD=.941) and CWNS females (p=.62, 51
d=-0.0907, 95% CI=-0.4488, 0.2674), CWS and CWNS males (p=.118, d=-0.2826, 95% CI=-
0.6368, 0.0715), nor between CWS and CWNS females (p=.188, d=0.3646, 95% CI=-0.176,
0.9052). Taken together, as shown in Figure 4, preschool-age CWS boys were found to be
significantly less distractible than CWS and CWNS girls.

![Figure 4](image)

Figure 4. Mean and standard error (in brackets) z-scores on the distractibility subscale of the Behavioral Style Questionnaire (McDevitt & Carey, 1978) for preschool-age children who do (CWS; n=82) and do not stutter (CWNS; n=120). Brackets and significant p-values represent comparisons between CWS boys and girls, and between CWS boys and CWNS girls.

**Hypothesis Three: Relation Between Speech-Language Dissociations and Distractibility**

To test the third hypothesis—that is, that there would be a significant relation between
children’s distractibility scores and measures of speech-language dissociations (i.e., magnitude
of dissociations as well as frequency of total, speech-language only, and language only dissociations)—separate Spearman’s rho correlations were conducted for only children who exhibited one or more dissociations (23 CWS, 18 CWNS).

Consistent with this hypothesis, for CWS exhibiting dissociations (n=23), there were significant inverse correlations between children’s distractibility scores and their frequency of total (rho= -0.433, p= .039, 95% CI= -.717, -.025) and speech-language only dissociations (rho= -0.417, p= .048, 95% CI= -.708, -.006). In other words, for preschool-age CWS exhibiting dissociations, less distractibility was associated with increased frequency of total and speech-language only dissociations. However, there were no significant correlations between CWS’s distractibility scores and the magnitude of their dissociations (rho= .241, p= .268, 95% CI= -.19, .594) and frequency of their language only dissociations (rho= -.063, p= .776, 95% CI= -.463, .359). Likewise, for CWNS exhibiting dissociations (n=18), there were no significant correlations between children’s distractibility scores and their measures of dissociations, with rho values ranging from -.12 to .172, associated p values from .496 to .77, and 95% CI from [-.321, .591] to [-.523, .407].

To test whether there were significant differences between CWS’s and CWNS’s correlations, we performed Fisher’s r-to-z transformations (Preacher, 2002) and visually inspected whether there was any overlap between the SE bars surrounding each of the talker group’s correlations (Cumming & Finch, 2005). As shown in Figure 5, although two of CWS’s correlations were significant (between distractibility and frequency of total and speech-language only dissociations), the error bars surrounding these correlations overlapped with those of CWNS. Similarly, there were overlapping error bars surrounding CWS’s and CWNS’s correlations between distractibility and frequency of language only dissociations, as well as

\footnote{It should be noted that negative or lower BSQ scores suggest less distractibility.}
between distractibility and magnitude of dissociations. Overlapping error bars suggest non-significant differences between CWS’s and CWNS’s correlations, which is consistent with Fisher’s $r$-to-$z$ transformation findings (z-scores ranged from -1.265 to .032, and associated $p$ values from .206 to .9742).
Figure 5. Between-group comparisons. Correlational (rho) values and standard error bars illustrating the association between distractibility z-scores and frequency of total, speech-language only, language only and magnitude of dissociations for preschool-age children who do (CWS; n=23) and do not stutter (CWNS; n=18) who exhibited at least one dissociation. Brackets indicate comparisons between the talker group’s correlations.
Hypothesis Four: Distractibility Moderates the Relation Between Speech-Language Dissociations and Speech Fluency

To assess the fourth hypothesis—that is, that interactions between children’s distractibility and speech-language dissociations predict fluency breakdowns (i.e., frequency of total, stuttered, and/or non-stuttered disfluencies)—separate GLMs were conducted for only children who exhibited at least one dissociation (CWS=23, CWNS=18). The dependent variables were frequency of total, stuttered, and non-stuttered disfluencies. The independent variables were children’s distractibility scores and frequency of total dissociations. Gender was included as a covariate in each of the models to account for its possible effect on results.

**Total Disfluencies (TD).** For both preschool-age CWS and CWNS who exhibited dissociations, TD was not significantly affected by the following variables and interaction: (a) distractibility (b) frequency of total dissociations, (c) gender, and (d) dissociation x distractibility. For CWS, p values ranged from .448 to .888, associated β values from -.106 to .087, and 95% CIs from [-.32, .50] and [-1.78, .79]. For CWNS, p values ranged from .353 to .996, associated β values from -.385 to 1.006, and 95% CIs from [-.50, .50] and [-1.12, 3.13].

**Stuttered Disfluencies (SD).** For both preschool-age CWS and CWNS who exhibited dissociations, SD was not significantly affected by the following variables and interaction: (a) distractibility (b) frequency of total dissociations, (c) gender, and (d) dissociation x distractibility. For CWS, p values ranged from .353 to .997, associated β values from -.614 to .158, and 95% CIs from [-.43, .43] to [-1.91, .68]. For CWNS, p values ranged from .688 to .984, associated β values from -.068 to .239, and 95% CIs from [-.41, .56] to [-.93, 1.4].
**Non-stuttered Disfluencies (NSD).** For both preschool-age CWS and CWNS who exhibited dissociations, NSD was not significantly affected by the following variables and interaction: (a) distractibility (b) frequency of total dissociations, (c) gender, and (d) dissociation x distractibility. For CWS, p values ranged from .227 to .745, associated β values from -.597 to .249, and 95% CIs from [-.16, .65] and [-1.54, 1.10]. For CWNS, p values ranged from .128 to .865, associated β values from -.717 to 1.821, and 95% CIs from [-.62, .50] and [-.53, 4.17].

In general, findings did not support hypothesis 4. Specifically, non-significant distractibility x dissociation interaction effects suggest that children’s distractibility did not moderate the relation between their speech-language dissociations and speech disfluencies (i.e., frequency of frequency of TD, SD, and/or NSD).
CHAPTER IV

DISCUSSION

Summary of Main Findings

The present study resulted in four main findings. First, more preschool-age CWS exhibited speech-language dissociations than CWNS. Second, CWS boys scored significantly lower on the BSQ’s distractibility subscale—suggesting they are less distractible—than CWS and CWNS girls. Third, for preschool-age CWS—but not CWNS—distractibility scores were associated with two out of four measures of speech-language dissociations (i.e., frequency of total and speech-language only dissociations). Fourth, neither CWS’s nor CWNS’s frequency of total, stuttered or non-stuttered disfluencies were predicted by their distractibility scores, frequency of speech-language dissociations, or distractibility x dissociation interactions. Implications of these findings are discussed immediately below.

*First Main Finding: Between-group Differences in Speech-Language Dissociations*

The first main finding indicated that more preschool-age CWS exhibited speech-language dissociations than CWNS.\(^{20}\) Specifically, 28% of preschool-age CWS exhibited speech-language dissociations compared to 15% of their fluent peers, a roughly 2:1 ratio consistent with Anderson et al. (2005; 35.6% CWS and 17.8% CWNS) and Coulter et al. (2009; 25% CWS and 12.5% CWNS). Although the present study assessed preschool-age CWS at one point in time—some of whom will later persist while others will recover from stuttering—it is interesting to observe that

\(^{20}\) Findings indicated that 20.3% (n=41) of the total sample (CWS+CWNS=202) exhibited speech-language dissociations. This suggests that only a subgroup of children from both talker groups—albeit more CWS than CWNS—exhibit dissociations.
the percentages of preschool-age CWS exhibiting dissociations are roughly similar to those of stuttering persistence (e.g., Yairi & Ambrose, 1999). Perhaps, there is an association between the continued presence of speech-language dissociations and stuttering persistence. Such speculations are consistent with Hall’s (1996) findings, which suggest a possible association between the continuation of speech-language unevenness—between preschool- and 9 years-of-age—and the continuation of fluency breakdowns exhibited by children with language disorders. Future longitudinal studies are warranted to assess typically developing CWS and CWNS, from preschool- through the school-age years. Findings of such studies should enhance our understanding of the possible role that speech-language dissociations play in the persistence of childhood stuttering.

Related to the first main finding, one ancillary result indicated that significantly more males (20 CWS, 10 CWNS) than females exhibited dissociations (3 CWS, 8 CWNS). When considering the total sample (124 males, 78 females) from which the dissociated sample (30 males, 11 females) was obtained, 24% males (30 out of 124) compared to 14% females (11 out of 78) exhibited dissociations. When considering each of the talker groups separately, 30.77% CWS males (20 out of 65) versus 17.65% CWS females (3 out of 17) exhibited dissociations, whereas only 16.95% CWNS males (10 out of 59) versus 13.11% CWNS females (8 out of 61) exhibited dissociations. It is possible that significant gender differences within the sample of children exhibiting dissociations could have resulted from the overall gender differences in the total sample from which they were taken (Table 5). With that caveat in mind, one might speculate that perhaps more boys than girls tend to exhibit speech-language dissociations. Such gender differences relative to speech-language dissociations might be associated with reports of girls generally exhibiting better developed language abilities than boys (e.g., Blair et al., 2005;
Bornstein et al., 2004; Leve et al., 2013). Perhaps better developed language reflects more congruence/evenness among speech-language (sub)domains, in that such congruence leaves less room for error in speech-language processing, planning, and/or production. Going forward, researchers may want to further investigate whether more preschool-age boys exhibit dissociations than girls.

Second Main Finding: Between-group Differences in Distractibility

The second main finding indicated that although there were no overall group differences in distractibility, there was a significant talker group x gender interaction, suggesting that preschool-age CWS boys are less distractible than CWNS and CWS girls. The non-significant overall group differences in distractibility scores are consistent with findings reported by some (e.g., Anderson & Wagovich, 2010; Eggers et al., 2010) but not others (e.g., Anderson et al., 2003; Karrass et al., 2006). Perhaps such equivocal findings relate, at least in part, to between-study differences in methodology (e.g., using caregiver reports vs. experimental paradigms). Ntourou et al. (2013) proposed that caregiver reports represent children’s overall abilities to effectively regulate their emotions, whereas direct observation and/or experimental procedures capture children’s regulatory attempts as they actually occur, at least during laboratory conditions. Similarly, Dixon and Shore (2000) suggest that parent questionnaires “tap into some aspects of temperament that are reflected by the children's own behavior…which are not necessarily reflected by laboratory-based observations of temperament” (p. 420). Thus, it seems likely that caregiver questionnaires, when compared to experimental paradigms, may be tapping into varying attentional constructs/processes (e.g., attention span/persistence, distractibility, attention shifting, attention focusing).
Despite the finding of no overall between-group differences in distractibility, there was a significant talker group x gender interaction, with preschool-age CWS boys exhibiting less distractibility than CWNS and CWS girls. Such findings are consisted with those reported by Anderson et al., (2003), indicating that a subset of preschool-age CWS were more likely to be rated by their parents as being less distractible compared to CWNS. Perhaps Anderson et al.’s sample of less distractible CWS comprised of mostly boys, however, gender information was not reported. Present findings are also consisted with meta-analytical results of 189 empirical studies (Else-Quest et al. 2006), which indicated that compared to boys, girls tend to exhibit “an overall better ability…to regulate or allocate their attention...[given that they] display a stronger ability to manage and regulate their attention” (p. 61).

Rothbart (2011) suggested that too much or too little self-regulation could be problematic, especially when it “is used to develop rigid and inflexible responses that protect the child from information or experience” (Rothbart, p. 234). Based on this suggestion, both “too much” and “too little” distractibility—but not necessarily disordered levels of distractibility—may be less effective forms of attention. However, it is presently unclear what constitutes as “too much” or “too little” distractibility, and what levels of distractibility/non-distractibility could be less than helpful in various situations. It is possible that subtle mean score differences in distractibility—as opposed to clinically significant attentional disorders associated with hyper- or hypo-distractibility—are especially problematic during rapidly changing situations, for example, during speech-language processing, planning, or production. Thus, such subtle, yet less effective forms of attention could relate or contribute to children’s speech fluency. Indeed, present findings suggest that preschool-age CWS boys exhibit subtle yet significantly less flexible/effective distractibility than girls, as indicated by their lower BSQ scores.
Perhaps less distractibility among preschool-age CWS boys plays a role in stuttering persistence, a speculation worthy of further investigation given that males are at greater risk for persistence (Clark, Ntourou, & Kelly, 2013; Yairi & Ambrose, 2005). Put differently, one might speculate that the more flexible distractibility of CWS girls—as suggested by their significantly greater BSQ scores—somehow aids or plays a role in their recovery. Additionally, CWS males’ less flexible distractibility might impact therapeutic outcome. For instance, “a child who is minimally distractible may be relatively impervious to environmental suggestions to change…from a speech-language pathologist, making it more difficult to successfully and quickly change his/her behavior” (Anderson et al., 2003, p. 1229). Specifically, rather than “letting go” and “moving on” to subsequent speech planning and production, some preschool-age CWS males may be more focused on and less able to shift their attention away from their speech errors/disfluencies. Such relatively sustained focus could exacerbate the length or physical tension associated with their instances of stuttering. Furthermore, according to Rothbart (2011), “Anxiety reflected in enhanced attention to threats…can also lead to rumination on problems that in turn can lead to further inhibition” (p. 180). Thus, future empirical study is needed to better understand whether less distractibility exhibited by preschool-age CWS males is associated with greater behavioral inhibition. The above speculations seem worthy of further empirical investigation given their theoretical and clinical salience.

Third Main Finding: Relation Between Speech-Language Dissociations and Distractibility

The third finding indicated that for CWS exhibiting dissociations, less distractibility was associated with increased frequency of total and speech-language only dissociations. Interestingly, although within-group correlations were significant for CWS but not for CWNS,
results of Fisher’s $r$-to-$z$ transformations and visual inspection indicated no significant differences between the talker groups’ correlations (see Results and Figure 5). These disparities regarding within- versus between-group correlations challenge a precise understanding of the relation between distractibility and speech-language dissociations. Nevertheless, present findings suggest an association between preschool-age CWS’s non-distractibility and increased speech-language dissociations, with one explanation for this association related to Levelt’s (1983; 1989) and Rispoli and Hadley’s (2001) models of speech-language production (see Introduction).

In brief, Rispoli and Hadley theorized that overt speech disfluencies are associated with “glitches” or “errors” that progress or propagate throughout the speech-language sub-processors (i.e., the conceptualizer, formulator, and articulator). These relatively subtle “glitches” may be associated with temporal misalignments or incongruities in speech-language information. According to Levelt (1983), a speaker’s monitoring system is alerted upon error detection (i.e., when glitches arise), which could result in new or adjusted instructions for error repair.

Applying the above theory to present findings, if speech-language dissociations are associated with more “glitches” and “errors,” then CWS’s monitoring/attentional systems may be more frequently alerted for repair. Receiving more frequent error-messages may require CWS to make greater use of their attentional resources. In other words, CWS may exert greater attentional vigilance (i.e., becoming less distractible) to detect and repair present errors, as well as anticipate or “be on the look-out” for possible future errors. Of course, “directionality of effect” (Conture, Kelly & Walden, 2013) among the various attentional, as well as speech and language processes will likely require more direct/controlled experimental procedures than those employed in the present study.
Fourth Main Finding: Relation Among Speech-Language Dissociations, Distractibility, and Speech Fluency

The fourth main findings indicated that for preschool-age CWS and CWNS, neither distractibility, speech-language dissociations, nor distractibility x dissociation interactions were predictive of children’s frequency of disfluencies. Non-significant distractibility x dissociation effects suggest that children’s distractibility does not moderate the relation between their speech-language dissociations and speech disfluencies. In contrast to these findings—that is, children’s distractibility, based on caregivers’ reports, were not predictive of their disfluencies—Ntourou et al. (2013) reported an association between CWS’s, but not CWNS’s, stuttering frequency and distractibility, the latter being based on behavioral observation. Likewise, in contrast to present findings—that is, children’s dissociations across standardized measures were not predictive of their disfluencies—others have reported that preschool-age CWS’s intratest scatter (i.e., imbalanced language performance within a standardized test)\(^{21}\) on the EVT-2 (Millager et al., in press) and TELD-Exp (Walden et al., 2012) was significantly associated with stuttering frequency. Perhaps these seemingly inconsistent findings relate to between-study differences in behavioral measures (e.g., caregiver report vs. behavioral observations; intratest scatter vs. speech-language dissociations across standardized tests) as well as statistical analyses (e.g., negative binomial GLM versus correlational analyses).

General Discussion of Main Findings

Overall, present findings were taken to suggest that at least some preschool-age CWS exhibit incongruent development of the various subcomponents of their speech-language abilities, and that such imbalances may be associated with less efficient usage of attentional

\(^{21}\) More specifically, intratest scatter was operationalized as inconsistent response patterns within a standardized test.
resources. Thus, present findings support the notion that a relation exists among speech-language dissociations, distractibility, and childhood stuttering—the diagnosis (i.e., CWS vs. CWNS). However, the precise nature of this relation remains unclear given that dissociations and distractibility did not predict children’s overt stuttering behaviors (e.g., frequency of stuttered disfluencies).

Aspects of Levelt’s model could be applied to the relation among speech-language dissociations, distractibility, and speech fluency. Specifically, speech-language imbalances and/or inefficient use of attentional resources (e.g., over- or under-monitoring input/output speech-language information) may contribute to glitches or errors in the incremental progression of speech-language information during speech-language planning and production (i.e., during conceptualization, formulation, and/or articulation). Based on this model, preschool-age children who exhibit speech-language dissociations and less flexible attentional processes produce more glitches disrupting the flow of information throughout the speech-language sub-processors. These glitches may contribute to temporal misalignment of speech-language information during such processing and, in turn, to speech disfluencies.

Present findings suggest that some preschool-age CWS—especially males—do exhibit speech-language dissociations and less flexible attentional processes (e.g., less distractible when new/salient stimuli are presented). However, contrary to the above speculation, present findings indicate that speech-language dissociations and inefficient distractibility—the putative sources of speech-language processing glitches—were not predictive of speech disfluencies (e.g., frequency of stuttered, nonstuttered, or total disfluencies). Of course, the present study did not directly measure “glitches.” Thus, the above theoretical speculation must await further empirical study.
Perhaps speech-language dissociations relate to other variables thought to be salient to speech fluency, namely *automaticity* or *timing* (see Bosshardt’s [2006] review of studies investigating the association among temporal, cognitive and linguistic variables—including processing and automaticity—exhibited by adults who do and do not stutter). As suggested in Levelt’s model, the speech-language planning and production system is largely automatic—particularly for those with well-established systems (e.g., older children and adults). Such automaticity results in precise temporal alignment of speech-language information, and, consequently, fluent speech. Based on this model, one would suspect that less automatic speech-language planning and production cause greater time delays and temporal misalignments of speech-language information, which, consequently, result in fluency breakdowns. Similarly, Leonard, Weismer, Miller, Francis, Tomblin, & Kail (2007) posited that “if the information is not processed quickly enough, it will be vulnerable to decay or interference from additional incoming information” (p. 409). Such “processing limitations may significantly affect the child’s ability to access language from the input and, once (finally) acquired, use it with facility” (Leonard et al., p. 408).

The above could be taken to suggest that speech-language dissociations, through mechanisms still poorly understood, affect the automaticity of some CWS’s speech-language planning and production processes. Specifically, it is possible that preschool-age CWS with dissociations experience relatively slowed/delayed processing of speech-language information, and therefore, have difficulties readily and quickly accessing speech and language information. Such challenges might lead these children to exert more attention in attempts to access and process the continuous stream of speech-language information, particularly during ongoing conversation. Future investigation would seem to benefit from assessing preschool-age CWS’s
versus CWNS’s automaticity/processing speed—for instance, by measuring their reaction times (RT)—particularly in relation to speech-language dissociations and attentional processes.

Caveats

One limitation of the present study is the possibility that speech-language dissociations may be an index/proxy for attention, particularly given the number of standardized speech-language tests that were conducted. Such standardized measures require test-takers to have the linguistic knowledge as well as adequately allocate their attentional processes to correctly respond to test items (Leonard et al., 2007; Millager et al., in press). Consistent with this notion, Millager et al. (in press) found a positive correlation between intratest scatter (i.e., imbalanced performance within standardized measures) and the number of test items on a standardized measure of expressive language, suggesting that intratest scatter might be affected by other testing-related variables (e.g., fluctuating levels of attention). Future studies should assess whether children’s imbalanced performance across standardized measures (i.e., speech-language dissociations) are associated with similar testing effects (e.g., relation between attention and number of test items).

A second limitation of the present study relates to the categorical means, which were used to assess children’s speech-language imbalances—that is, using specific criteria developed by Bates et al. (2003), children were categorized and analyzed on the basis of their presence versus absence of dissociations across speech-language domains. Future research of this topic might also consider more continuous means of assessing speech-language imbalances—that is, assessing children’s overall discrepancies across speech-language domains. Findings of such
studies should further our understanding of how speech-language *dissociations* versus *discrepancies* relate to speech fluency.

A third limitation of the present study is that children’s distractibility was only assessed by means of one parent reported questionnaire. Such methods are certainly salient to our understanding of children’s distractibility. As Bates et al. (1995) argued, “Parents have a far larger dataset than researchers or clinicians can ever hope to assemble; it is also far more representative of the child's ability, as it is based on the child's behavior in a wide range of situations” (p. 3). Likewise, Hederson and Wachs (2007) suggested that although “parent report measures do contain some subjective parental components, available evidence indicates that these measures also contain a substantial objective component that does accurately assess children’s individual characteristics.” (p. 402). Nevertheless, perhaps a multi-method approach assessing children’s attentional processes, by employing various measures (e.g., parent questions and experimental paradigms, such as the *Traditional* and *Affect* cueing tasks [Johnson et al., 2012], or the *Attention Network Test* [Eggers et al., 2012]), would provide a more comprehensive assessment of children’s attentional processes.

Finally, inferences and interpretations regarding gender effects should be made with caution, given the relatively small sample of female CWS in this study. Although the unequal ratio of males-to-females who stutter is inherent in the population (e.g., Yairi & Ambrose, 2013), further investigations employing larger samples of female CWS and/or more balanced gender ratios will need to be considered. Such investigations are warranted to better determine whether more preschool-age CWS males exhibit speech-language dissociations and less distractibility compared to preschool-age females.
CHAPTER V

CONCLUSION

The present investigation empirically studied the relation among speech-language dissociations, attention and childhood stuttering. Current findings indicated that more preschool-age CWS—particularly boys—exhibit speech-language dissociations than their normally fluent peers, and that for CWS there is a relation between greater attention (i.e., more non-distractibility) and speech-language dissociations. The latter results suggest that underlying variables—such as less flexible distractibility—are involved in speech-language dissociations for at least some preschool-age CWS. Such results emphasize the importance of studying associations and interactions among multiple variables (e.g., imbalances across several speech-language domains in addition to distractibility) and their possible relation to childhood stuttering.

Overall, findings suggest that for some preschool-age children, distractibility and speech-language dissociations are associated with childhood stuttering, the diagnosis (CWS vs. CWNS). However, it remains unclear how these variables contribute to overt stuttering behaviors (e.g., frequency of stuttered disfluencies), given that dissociations and distractibility did not predict children’s frequency of disfluencies. Thus, it seems likely that some “third-order” variable “ties together” attentional processes, speech-language dissociations, and the childhood stuttering. However, the precise number and nature of such variables must await future study.
## APPENDIX

Table A1

Summary of three studies using correlation-based procedures (Bates et al., 2003) to assess the percentage of preschool-age CWS who exhibit linguistic dissociations.

<table>
<thead>
<tr>
<th>Study</th>
<th>N CWS</th>
<th>Receptive versus Expressive Vocabulary</th>
<th>Receptive Vocabulary versus Receptive Language</th>
<th>Receptive Vocabulary versus Expressive Language</th>
<th>Expressive Vocabulary versus Receptive Language</th>
<th>Expressive Vocabulary versus Expressive Language</th>
<th>Receptive Language versus Expressive Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson et al. (2005)</td>
<td>45</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Coulter, Anderson, &amp; Conture (2009)</td>
<td>40</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Hollister (ASHA, 2012 poster)</td>
<td>45</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>7</td>
</tr>
<tr>
<td>Total CWS</td>
<td>130</td>
<td>6 out of 85</td>
<td>7 out of 85</td>
<td>4 out of 85</td>
<td>7 out of 85</td>
<td>6 out of 85</td>
<td>15 out of 130</td>
</tr>
</tbody>
</table>

Percentage of CWS exhibiting some form of dissociations across linguistic domains:

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.06%</td>
<td>8.24%</td>
<td>4.71%</td>
<td>8.24%</td>
<td>7.06%</td>
<td>11.54%</td>
</tr>
</tbody>
</table>

*Note.* The above three studies used slightly different inclusion criteria and standardized vocabulary/language tests.
### Table A2

*Summary of three studies using correlation-based procedures (Bates et al., 2003) to assess the percentage of preschool-age CWNS who exhibit linguistic dissociations.*

<table>
<thead>
<tr>
<th></th>
<th>N CWNS</th>
<th>Receptive versus Expressive Vocabulary</th>
<th>Receptive Vocabulary versus Receptive Language</th>
<th>Receptive Vocabulary versus Expressive Language</th>
<th>Expressive Vocabulary versus Receptive Language</th>
<th>Expressive Vocabulary versus Expressive Language</th>
<th>Receptive Language versus Expressive Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson et al.</td>
<td>45</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hollister (ASHA,</td>
<td>40</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2012 poster)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total CWNS</td>
<td>114</td>
<td>2 out of 85</td>
<td>5 out of 85</td>
<td>3 out of 85</td>
<td>2 out of 85</td>
<td>1 out of 85</td>
<td>1 out of 114</td>
</tr>
</tbody>
</table>

#### Percentage of CWNS exhibiting some form of disassociations across linguistic domains:

- Receptive vocabulary: 2.35%
- Expressive vocabulary: 5.88%
- Receptive language: 3.53%
- Expressive language: 2.35%
- Receptive vs. expressive: 1.18%
- Expressive vs. receptive: 0.88%

*Note.* The above three studies used slightly different inclusion criteria and standardized vocabulary/language tests.
Table A3

Summary of three studies using correlation-based procedures (Bates et al., 2003) to assess the percentage of preschool-age CWS and CWNS who exhibit dissociations across speech-language (sub)domains.

<table>
<thead>
<tr>
<th></th>
<th>Articulation versus Receptive Vocabulary</th>
<th>Articulation versus Expressive Vocabulary</th>
<th>Articulation versus Receptive Language</th>
<th>Articulation/Phonology (GFTA or HH10P) versus Expressive Language (T1-H13.exp or SPH11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CWS</td>
<td>CWNS</td>
<td>CWS</td>
<td>CWNS</td>
</tr>
<tr>
<td>Anderson et al.</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>(2005) Out of the</td>
<td>total 45 CWS</td>
<td>and</td>
<td>45 CWNS</td>
<td>total 45 CWS</td>
</tr>
<tr>
<td>Coulter, Anderson, &amp; Conture (2009)</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>out of the total</td>
<td>40 CWS</td>
<td>and 40</td>
<td>CWNS</td>
<td>total 40 CWS</td>
</tr>
<tr>
<td>Hollister (ASHA,</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>2012 poster) out</td>
<td>of the total</td>
<td>45 CWS</td>
<td>and 29 CWNS</td>
<td>total 45 CWS</td>
</tr>
<tr>
<td>in total</td>
<td>6 out of 85</td>
<td>2 out of 85</td>
<td>6 out of 85</td>
<td>2 out of 85</td>
</tr>
<tr>
<td>Percentage of</td>
<td>7.06%</td>
<td>2.35%</td>
<td>7.06%</td>
<td>2.35%</td>
</tr>
<tr>
<td>children</td>
<td>exhibiting</td>
<td>some form of</td>
<td>a</td>
<td>dissociation</td>
</tr>
<tr>
<td>some form of a</td>
<td>dissociation</td>
<td>across</td>
<td>speech-language</td>
<td>domains</td>
</tr>
</tbody>
</table>

Note. The above three studies used slightly different inclusion criteria and standardized speech-language tests.
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