CONVERSATIONAL DISFLUENCIES

CONVERSATIONAL DISFLUENCIES AS A PREDICTOR OF ATTENTION PROBLEMS IN PRESCHOOL CHILDREN

By

Elizabeth Hart, B.Sc.

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AUTHOR: Elizabeth Hart, B.Sc. (McMaster University)

SUPERVISOR: Karin R. Humphreys

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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is frequently comorbid with language impairment. There is currently no detailed linguistic profile of children with ADHD. A previous study (Redmond, 2004) found that in conversation, children with ADHD produced more words per maze than typically developing controls, but did not determine the specific disfluency driving the correlation. The present study examined the conversational language, and measures of attention deficits, executive functioning and spatial intelligence of a non-clinical community sample of 46 preschool-aged children. The results replicated Redmond's finding and further indicated that attention deficits and executive dysfunctioning were associated with the production of more long repairs and restarts. The number of pauses was positively correlated with spatial abilities. Findings suggest that a preschooler who produces many long repairs and restarts should be monitored for possible attention deficits.

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Conversational-based language measures are increasingly regarded as an important component of the diagnosis of language disorders in children. Conversational indices are useful for analyzing diverse aspects of language production (e.g. rate of speech, lexical diversity, length of utterances etc.) and have higher ecological validity than standardized language measures, which typically rely on simple tasks such as expressively or receptively labeling pictures (Miller, 1996). These indices are particularly functional in clinical evaluations of preschoolers who have varying abilities to attend during long structured assessments (Isquith, Gioia, & Espy, 2004). However, very little research has been conducted on the potential value of using conversational measures to develop language profiles for behavioural disorders such as Attention Deficit Hyperactivity Disorder (ADHD; Redmond, 2004). ADHD is a psychiatric disorder characterized by impaired attention, impulsivity and hyperactivity leading to deficits in social or academic functioning, with an age of onset before age seven (Barkley, 1991; Cohen, 2001). While there are several subtypes of ADHD, namely predominantly inattentive, predominantly hyperactive/impulsive and combined type, this paper's discussion of ADHD does not distinguish among the subtypes. High comorbidity between language impairments and ADHD has been frequently observed (e.g. Denckla, 1996; Purvis & Tannock, 1997; Vallance, Im & Cohen, 1999). Children with language impairments are diagnosed with ADHD more frequently than any other psychiatric disorder (Cohen et al., 2000). In a study of 7 to 14-year-old children, 46% of those found to be comorbid for language impairment and psychiatric disorders had been diagnosed with ADHD (Cohen et al, 1998). Early detection and initiation of treatment for ADHD is important for long term outcome (Rasmussen & Gillberg, 2000). Given the association between language impairment and ADHD, conversational language measures could serve as a useful predictive tool.

The current study used conversational language samples to analyze the relationships between linguistic disfluencies and attention deficits in preschool children. Extending a study by Redmond (2004), we investigated the association between the average number of words per maze (defined as filled pauses, repetitions, and revisions) and problems with attention. In particular, we examined the specific types of disfluencies included in the category of mazes to determine which were associated with attention deficits. We investigated the relationships among the different types of disfluencies and executive function and intelligence measures to better understand the underlying cognitive processes behind the speech errors.

It has been difficult to determine the association between language impairments and ADHD without studies that use carefully designed controls to dissociate the effects of the two conditions. Development of a better understanding of the causal factors behind these co-occurring disorders is essential to ensure proper diagnosis and treatment. A review by Tannock and Schachar (1996) posed important questions about the etiology of comorbid ADHD and language impairments: Do primary language impairments lead to frustration, manifesting in behavioural problems? Do fundamental impairments in executive functions lead to problems with communication? Or are language impairments and ADHD two unique disorders that should receive separate treatment? These questions are important to consider before addressing the potential role of conversational language samples in determining the specific language deficits of ADHD.

Language and ADHD

A significant focus of current ADHD research is to separate the symptoms of ADHD from those of commonly co-occurring disorders. In an earlier study designed to separate the effects of psychological disorders and language impairments on communication abilities, analyses of narrative discourses determined that children with psychological disorders had deficits in the flow of their discourse (Vallance et al., 1999). Specifically, the speech of children with psychological disorders was characterized by more repetitions, lower efficiency (a greater number of repairs/repetitions/unintelligible utterances per utterance), more unintelligible utterances and more semantic, pronominal and conjunction repairs (Vallance, et al., 1999). Over 45% of the children who participated in this study were also diagnosed with ADHD, indicating that the link between communication abilities and ADHD deserves further consideration (Vallance et al., 1999).

Cohen et al. (2000) conducted a study examining language impairment, ADHD, and cognitive processing in children with the goal of dissociating the effects of ADHD and language impairments. The experiment utilized four clinical samples: ADHD plus language impairment; ADHD-only; other psychiatric disorder plus language impairment; and other psychiatric disorder-only (Cohen et al., 2000). They reported a significant main effect for language impairment on the majority of structural language measures (i.e. morphosyntactic development) as well as pragmatics and narrative discourse measures

(Cohen et al., 2000). However, there was no significant main effect for ADHD on the pragmatics or narrative discourse measures. Deficits in phonological processing are frequently hypothesized to be an underlying factor in reading disorders, which are often comorbid with ADHD (Tannock & Schachar, 1996). To test if pragmatics and narrative discourse deficits are common to ADHD, regardless of comorbidity with language impairments or reading disability, Cohen et al. (2000) divided their ADHD participant groups further into : ADHD plus language impairment plus reading disability; ADHD plus language impairment; and ADHD alone. Pragmatic skills were the poorest for the ADHD plus language impairment plus reading disability group, while both ADHD/language impairment groups exhibited weaker narrative discourse ability than did the ADHD-only group (Cohen et al., 2000). These findings do not support the hypothesis that pragmatics and narrative discourse abilities are impaired in children with ADHD. Instead, these results suggest that communication problems in children with ADHD may be the result of a comorbid language impairment. Cohen et al. (2000) found that narrative discourse as a complete entity was not associated with ADHD, but rather with language impairment, the specific components of narrative discourse were not examined to determine their individual relationships with ADHD.

Associations among Executive functions, ADHD andLanguage

Children diagnosed with ADHD have consistently been found to have impaired executive functioning (Shallice et al., 2002). Executive functions can be defined as the processes that organize and control goal-directed behaviours, such as moving flexibly among activities or controlling emotional responses (Gioia, Espy, & Isquith, 2003). Some researchers argue that children with ADHD are not in fact clinically inattentive, but appear that way to teachers and parents because of the child's inability to inhibit responses (Barkley, 1997; Denckla, 1996). It has been suggested that working memory, namely the ability to maintain information (visual-spatial, verbal, or auditory) for the length of a task, may be one of the primary deficits of children with ADHD (Denckla, 1996). The proposed theory states that deficits in executive functioning experienced by those with ADHD could be the result of an impaired phonological subsystem (a.k.a. phonological loop) of working memory (Denkla, 1996). If the phonological loop is responsible for maintaining a verbal representation of rules, poor performance in tasks requiring working memory could be a result of underlying language impairments. Consistent with this theory, Cohen et al. (2000) found that working memory measures (both verbal and visual-spatial) were more linked with language impairments than with ADHD.

While working memory may only be associated with comorbid ADHD and language impairments, general executive dysfunction has been established as a component of ADHD. Pennington, Groisser and Welsh (1993) designed a study to help separate the symptoms of ADHD and reading disorders while also proposing an underlying language deficit for the comorbid condition. Results of this research found that children with ADHD-only had significant deficits in executive functioning, but not in phonological processing. Conversely, children with reading disorders had no impairments in executive functions but exhibited deficits in phonological processing (Pennington et al., 1993). It should be noted that executive functions in this study were examined as a group, rather than individually. The finding that impairments related to ADHD were different from those of reading disorders was significant. The authors suggested that comorbid ADHD plus reading disorder could originate from a fundamental language deficit, which when combined with negative socioeconomic factors, could lead to the behavioural problems that define ADHD (Pennington et al., 1993). While the study did not find phonological deficits in children with ADHD-only, conversational language measures that examined disfluencies were not included.

The role of executive functions and language in ADHD has also been incorporated into a model of the etiology of ADHD. Barkley's (1997) theoretical model of ADHD postulated that the symptoms of the disorder are caused by an overarching deficit in behavioural inhibition. The model suggests that impairment in behavioural inhibition weakens the abilities of the following four executive functions: working memory; self-regulation of affect/motivation/arousal; internalization of speech; and reconstitution. Barkley (1997) described reconstitution as the ability to creatively develop new, complex sequences of responses in the domains of language or behaviour. Language deficits in reconstitution would be reflected in poorer verbal fluency or weaker narrative abilities. Furthermore, Barkley's model proposed that proficient internalized speech, in conjunction with working memory, is necessary to conduct rule-governed behavior (Barkley, 1997). This tenet is particularly relevant in the discussion of a possible underlying language impairment in children with ADHD and language impairments since this core deficit may lead to problems with internalized speech, possibly resulting in externalizing behavior due to a decreased ability to maintain verbal representations of rules. The model's principle that children with ADHD have impairments in reconstitution is particularly germane to the current study given that verbal fluency is proposed as an area that would be deficient in children with ADHD (Barkley, 1997). The potential link between verbal fluency and ADHD warrants further research, as verbal fluency can be measured using conversational language samples.

Spatial Intelligence and its Links with ADHD, Executive Functioning and Language

Spatial working memory is one of the most studied concepts in the category of executive functions (Goldman-Rakic, 1987). The ability to maintain a spatial representation in order to perform a task can be observed in children as young as four, making it an appropriate measure for preschoolers (Luciana & Nelson, 1998). A study examining the spatial task abilities of 6 to 12-year-old children with ADHD found that spatial working memory was impaired in children with ADHD compared to typically developing controls (Barnett et al., 2001). The analyses indicated that children with ADHD have greater difficulty holding multiple spatial representations in memory, but perform comparable to controls in their ability to manipulate spatial information (Barnett et al., 2001). An earlier study by Beitchman, Tuckett and Bath (1987) examined intelligence, visual-motor skills and language abilities in preschoolers with either hyperactivity plus delayed expressive language development, hyperactivity alone, or typical development. The purpose of the experiment was to determine whether there existed a distinct subgroup of preschoolers with comorbid hyperactivity and expressive language delays, and if so, to determine how they were different from the hyperactive-only group. Preschoolers with comorbid hyperactivity and language delays were found to have weaker scores on the Beery-Buktenica Test of Visual-Motor Integration (VMI; Beery & Buktenica, 1967) and had significantly lower IQ scores (Beitchman et al., 1987). A study comparing children with psychiatric disorders, language impairments and psychiatric disorders plus language impairments found that all three groups had lower Performance IQ compared to controls (Vallance et al., 1999). Results from this and previous studies suggest that the spatial abilities of children with ADHD is an area of research warranting further investigation.

Current Study

Although ADHD is a well-researched childhood disorder, empirical studies have typically used laboratory-based measures to assess symptoms (Barkley, 1991). A review by Barkley (1991) examined the ecological validity of more frequently used standardized measures, including continuous performance tasks and reaction time tasks. Results of this review found that while most of these measures were able to differentiate ADHD groups from controls, the tests were inconsistent in discriminating ADHD from other clinical groups (Barkley, 1991). To ensure high ecological validity, Barkley (1991) proposed that observational (or analogue) measures taken in a naturalistic environment would be more useful and valid in assessing those with ADHD.

Measures such as conversational based indices that simulate behaviours which occur in the natural environment are likely to have higher ecological validity (Barkley, 1991). To date, there have been few studies measuring the ability of conversational samples to differentiate the language production of children with ADHD from typically developing children, with a few notable exceptions (Barkley, Cunningham, & Karlsson, 1983; Zentall, 1988). Barkley et al. (1983) did not find significant differences in the number of utterances and average number of syllables between 9-year-old children with ADHD and controls. Zentall (1988) measured the total number of words, sentences, grammatical errors, repetitions and revisions in the conversational samples of twenty-two 9-year-olds with ADHD and age matched controls. Results revealed that there were no significant differences between the groups in the number of disfluencies (repetitions and fillers) produced (Zentall, 1988).

In 2004, Redmond examined differences in performance on conversational indices between 6 year-old children with ADHD but no language impairment (N = 10), with specific language impairment (SLI, N = 10) and typical age-matched controls (N = 13). The study sought to determine if children with ADHD have deficiencies "in empirically validated conversational indices of language impairment" (Redmond, 2004, p.112). One of the conversational indices used to analyze group differences was the category of mazes, a term taken from the language analysis software, Systematic Analysis of Language Transcripts (SALT), which is widely used in both research and clinical settings. A maze is typically defined as any utterance containing a false start, filler, repetition or revision (Redmond, 2004). SALT lists three categories of mazes: filled pauses, repetitions, and revisions. The conversational measures used to assess group differences were: words per minute, utterance formulation measures (percentage of maze words out of the total number of words and average number of words per maze), number of different words per 100 utterances, composite tense (e.g. use of past tense marker " –ed", irregular past tense) as well as the more widely-known mean length of utterance (MLU) (Redmond, 2004).

Results indicated that utterance formulation measures were the only conversational measures that showed significant group differences between the ADHD group and controls (Redmond, 2004). A standardized language test, the Test of Language Development Primary-Third edition (TOLDP-3; Newcomer and Hammil, 1997) was administered to the ADHD group. The group's mean score on the overall TOLDP-3 was comfortably within the normal range for the test (M = 95, SD = 13; test norm M = 100, SD = 15; Redmond, 2004). Children with ADHD produced more average words per maze and had greater percentages of maze words (out of the total number of words) compared to the typically developing, age-matched controls, but the groups did not differ on any of the other measures (Redmond, 2004).

While Redmond examined the relationship between mazes and ADHD, the category of maze contains only a small subset of the types of linguistic disfluencies. Maze measures (as defined by SALT) are not considered distinct from other linguistic disfluencies in the psycholinguistic literature (Goldman-Eisler, 1972). There is currently no empirical justification for why these additional disfluencies should not be included when determining linguistic profiles for psychopathologies. Another complication is that a maze, even as a subset of the larger category of disfluencies, consists of a fairly heterogeneous group. The underlying cognitive processes behind filled pauses, repetitions and revisions are not necessarily the same, and may not all reflect language formulation problems that point to larger language processing issues. Treating mazes as a uniform measure does not take into account the fact that different types of mazes could be serving different functions. Taking the approach that all mazes serve the same function would result in a child who produced 10 filled pauses per utterance and a child who produced 10 repetitions or revisions per utterance appearing the same in the analysis of their maze measures. Although these two children's percentages of mazes per utterance would be the same, a more detailed analysis of their linguistic profiles would indicate that their speech patterns are very different. Critically, a more detailed linguistic analysis of disfluencies might yield greater predictive power when looking for warning signs of attention problems, and may also help to better understand the cognitive nature of the attentional and linguistic deficits observed.

Objectives of current study.

The present study examined relationships among conversational language, attention, executive function and intelligence measures collected on preschoolers. These data were part of a larger, longitudinal study of behavioural and language measures on toddlers. An important difference between the current study and Redmond's is that the participants of the current study were young preschoolers rather than school-aged children. ADHD is usually not formally diagnosed until the child enters school, though symptoms may be observed in earlier years (Isquith et al., 2004). The measures used in this study to evaluate attention deficits and attention deficit/hyperactivity symptoms can be treated as predictors of ADHD.

The first objective of the present study was to attempt to replicate Redmond's (2004) findings that the average number of words per maze and the percentage of maze words (per total words) are associated with ADHD, but in a preschool population. The second objective was to examine the associations among the specific types of disfluencies and the attention measures, as well as other behavioral and intelligence measures, including abilities in executive functions and spatial ability. The ultimate goal is to develop a linguistic profile of preschoolers that may help to predict a risk for future diagnosis of ADHD and to provide a more thorough understanding of the relevant cognitive processes.

Method

Recruitment and Participants

Conversational language samples were acquired from 46 children (24 girls and 22 boys, mean age = 38.5 months, SD = 6.0 months) for this study; these children were also participants of a larger longitudinal study examining language development, executive function and behavior among preschool children. Participants were recruited from childcare centers in Hamilton, Ontario, Canada. The only inclusion criterion for participation in the study was age; the children were required to be between 3 and 5 years old. Parents of preschoolers in the centers were approached and asked to participate in a longitudinal research study that would examine executive functioning abilities and language development in preschool children and how these skills relate to other behaviours such as aggression. When informed consent was obtained from the parent, the child's teacher was asked to participate in the study. The WPPSI-III (Weschler, 2002) measure was collected in a quiet part of each classroom by trained research assistants. Most of the teachers completed the BRIEF-P (Goia, Espy,. & Isquith, 2003) and the C-

TRF (Achenbach & Rescorla, 2000a) at the childcare centres and immediately returned them to research assistants. Some teachers took the forms home to complete.

Standardized Measures

The teacher reports were used for analysis in the current study. In a previous longitudinal study, teacher reports (C-TRF) were found to be more predictive of future behavioural problems than parent reports (Verhulst, Koot, & Van der Ende, 1994). Hinshaw, Han, Erdhardt, and Huber (1994) found that only teacher reports predicted non-compliance and aggression. A study by Stanger and Lewis (1993) found teacher reports of externalizing problems to be a better predictor of referral to mental health services than self-reports or parent ratings. The evidence suggested that teacher ratings capture aspects of the child's behavior which are particularly useful in clinical assessments. While it is important to use multiple informants to comprehensively analyze a child's functioning and behavior, teacher reports appear to be the most effective ratings to consult when studying any externalizing behavior, such as attention problems.

Caregiver-Teacher Report Form 1½-5 (C-TRF 1½-5; Achenbach & Rescorla, 2000a).

The C-TRF 1½ -5 measures preschool children's behaviour, emotions and language development. The instrument was administered to each child's preschool teacher. The instrument consists of 99 statements, which are rated by the teacher as being: 0 (not true), 1 (somewhat or sometimes true), and 2 (very true or often true), when considering the child's behavior and abilities over the last 2 months. As one of the objectives of this study was to define the relationship between conversational language measures (specifically, disfluencies) and ADHD, the C-TRF 1½-5 was used primarily for its ability to measure problems with attention in young children which could indicate a possible future diagnosis of ADHD. The C-TRF 1½-5 provides information about the child's levels of attention problems through two subscales, the Attention problems syndrome and the Attention Deficit Hyperactivity problems DSM-oriented subscale (Diagnostic and Statistical Manual of Mental Disorders, 4th ed., [DSM–IV], American Psychiatric Association, 1994). Attention problems is one of seven syndromes included in the C-TRF 1 ½-5 (e.g. Anxious/Depressed and Aggressive Behaviour). The DSM-oriented scales were created by asking psychologists and psychiatrists from ten different cultures to rate which items were reflective of DSM categories (including affective problems, pervasive developmental problems etc.; Achenbach & Rescorla 2000b). The syndromes were derived by factor analytic methods (Achenbach, Dumenci & Rescorla, 2003) The Attention problems syndrome has a test-retest reliability of 0.84; the Attention Deficit Hyperactivity (ADH) problems scale has similarly high reliability with an r of 0.79 (Achenbach & Rescorla, 2000b). Because the two scales were created using different approaches (theory-driven and empirical), they provide an integrated assessment of the child's attention deficits (Achenbach et al., 2003).

Behaviour Ratings Inventory of Executive Functioning - Preschool Version (BRIEF-P; Goia, Espy,. & Isquith, 2003.)

The BRIEF-P is a measure of executive functioning used for children aged 2 years, 5 months to 5 years, 11 months. Preschool teachers evaluated 63 statements as being true either never (1), sometimes (2), or often (3). The BRIEF-P consists of five clinical scales which construct three indices and a global composite score, summarized in Table 1. High scores on BRIEF-P scales or indices reflect executive dysfunction. Test-retest reliability for the 5 scales ranges from r = 0.65 (Shift) to r = 0.94 (Inhibit) with a total score reliability of r=0.88 (Isquith et al., 2004). Mean scores for the teacher normative sample for the BRIEF-P scales range from 13.72 (Emotional Control, SD = 3.93) to 23.17 (Working Memory, SD = 6.06) for 2 to 3- year- old boys. For girls of the same age, the normative sample's mean scores range from 13.3 (Plan/Organize, SD = 3.26) to 21.41 (Working Memory, SD = 5.54; Goia et al., 2003).

Block Design subtest of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III; Wechsler, 2002).

Block Design is a subtest of the WPPSI-III, which measures intelligence in children ages 2 years 6 months to 7 years 3 months. The Block Design test was chosen for use in this study as it measures non-verbal abstract conceptualization and spatial visualization (Shah & Frith, 1993). The Block Design subtest undertaken by the preschoolers was designed for children ages 2 years 6 months to 3 years 11 months. In this test, the preschoolers must watch the experimenter create a model out of blocks and are then required to recreate it within a time limit, or create a structure out of blocks from looking at a picture of the model. Test retest reliability for the performance subtests of the WPPSI-III is r = 0.86 (Lichtenberger, 2005). Average scores for the population fall between 90 to 109 for the total Performance IQ score (Smith, 2003).

Conversational language samples

Sampling procedures.

Conversational language measures were administered at time 2 of the larger longitudinal study, when the children's language development was more advanced. The conversational samples were recorded at the childcare centres, in each child's classroom. Language samples were collected during conversations about a book between the examiner (student assistants) and the preschooler. These conversations were tape recorded using a Marantz CD recorder CDR300. The children were given the option of talking about a Dora the Explorer book or a Bob the Builder book. The examiners were instructed to use open-ended language to encourage further conversation. Examiners used the book the child had chosen as a guide, asking questions such as, "What do you like to do at a fair?" "Tell me more." "What's happening in this picture?" The discussion continued for a minimum of three minutes.

Transcription.

Each language sample (approximately three minutes in length) was transcribed by linguistically trained researchers into Systematic Analysis of Language Transcripts program files (SALT Version 8.0.4, Miller, 2004). SALT provides standard analyses of language transcripts and can compare samples with a reference database of age-matched peers. Initial transcriptions were performed by several different researchers, followed by a single researcher checking all of the transcriptions. The samples were transcribed according to detailed coding instructions. Although the current study focuses on disfluencies, the transcriptions were also coded for pragmatic errors, intelligibility, morphemic overregularizations etc. These other types of errors will not be discussed in this paper.

Coding.

Each sentence was counted as one utterance, and unlike SALT conventions, was not split at conjunctions ("and", "or", "because," "unless"). Mean Length of Utterance (MLU) was calculated using the number of words, rather than number of morphemes. Mazes were coded according to SALT conventions and included the following: whole word repetitions; revisions or repairs/restarts; and filled pauses. All conversational maze measures (as specified by SALT) were included in the analyses, which included: utterances with mazes; average number of mazes per utterance; total maze words; percentage of maze words out of the total number of words; average number of words per maze; and the total number of mazes (filled pauses, repetitions, revisions). When transcribing, mazes were placed in parentheses while other disfluencies were coded by indicating the actual production in curly brackets and recording the correct production. See Table 2 for a list of all disfluencies coded with examples.

Other conversational language measures of interest in this study were the number of complete words and utterances. To determine the mean length of utterance (MLU) in words, coders had to determine the number of complete words produced by each participant. Any speech that was difficult to interpret was coded. Instances of cluttering (speaking in short, quick bursts and slurring) were listed in comments after the utterance or at the bottom of the transcription in a comment line. Unintelligible utterances were coded with X's , with best guesses as to the intended production placed in curly brackets.

A word that was partially intelligible was written as it sounded, with Xs indicating the unintelligible portion (ex. raXX). If an utterance was intelligible but hard to understand, the best guess of the transcriber was recorded and the utterance was coded as [DD], or difficult to distinguish.

Table 3 provides an example of a SALT transcription file. The letter E denoted experimenter, while C indicated that the child was speaking.

Results

Participant data

Block Design data were collected for 42 of the children (21 girls and 21 boys) for which conversational language measures were obtained. Teachers filled out the C-TRF for 34 of the preschoolers (15 girls and 19 boys) and completed the BRIEF-P for 33 children (15 girls and 18 boys).

Descriptive Statistics

The descriptive statistics for the conversational language measures and disfluencies (Table 4) generally showed that numbers of any specific disfluency type by the preschoolers appeared to be relatively low (e.g. filled pause – M = 0.26, SD = 0.65). The mean number of maze words produced was 11.72 (SD = 10.44), while the mean number of mazes was 7.54 (SD = 5.18). Within-word repetitions were not produced by any of the participants; the measure was removed from further analyses. The number of utterances and the number of complete words produced had large ranges. The number of utterances ranged from 15 to 55 with a mean of 27.26 (SD = 8.55). The number of complete words ranged from 29 to 239, with a mean of 114.76 (SD = 51.84). These wide ranges in the number of total words and utterances produced had to be taken into consideration for subsequent analyses. A child who produced a low number of disfluencies but spoke few words overall would have a very different conversational profile from a child who produced the same number of disfluencies but who spoke a great deal.

The specific disfluency measure of repair/restart was examined. SALT automatically categorizes these disfluencies by number of words of the repaired element (repair/restarts of each of one to seven words). Due to the low occurrence of these measures individually, the seven repair/restart measures were reorganized into two categories. The two new categories were repair/restart short, which consisted of all such disfluencies containing anywhere from one to three words, and repair/restart long, which contained all repair/restarts of four to seven word length. We propose that short repair/restarts are mediated by a different cognitive function than long repair/restarts. For similar reasons, the number of repetition without corrections, which was individually divided by length of the disfluency (one to five words), was reorganized into one category containing all repetition without corrections.

Table 5 contains the descriptive statistics for the intelligence, attention and executive function measures. All analyses involving the C-TRF, and the BRIEF-P used standardized scores scaled for gender and age; the Block Design standardized scores were scaled for age only. Higher scores indicate greater levels of dysfunction on the C-TRF and the BRIEF-P and greater levels of functioning on the Block Design test. The Block Design test scores had a mean of 8.48 (SD=2.7), while the C-TRF scales had very similar distributions, with mean scores of approximately 58 (SD~9). Standardized scores under 65 are considered normal for both the Attention problems syndrome and the ADH problems scale (Rescorla, 2005). The BRIEF-P scales and indices were also very similar in their distributions, with mean scores hovering around 60 (SD~14). The scale furthest from this consensus was Shift, which had a mean of 55.9. Standardized scores for the BRIEF-P scales have a mean of 50 and a standard deviation of 10 (Gioia et al., 2003). The scores for the three instruments were normally distributed.

Intercorrelation analyses

We will be examining the relationship between disfluencies and ADHD; however, there are many different types of disfluencies. We aimed to better understand these specific disfluencies by looking at their associations with behavioural and intelligence measures. To develop meaningful linguistic profiles of psychopathologies, a thorough comprehension of the nature of the various disfluencies is necessary. By comparing the disfluency measures with other better-understood, conversational indices (e.g. MLU and total number of words), a clearer definition of the characteristics of the disfluencies could be determined. Disfluency measures concerning the category of maze as a whole were referred to as the "overall disfluency measures". Table 6 lists the intercorrelations among the various conversational language measures, including the overall disfluency measures: number of utterances with mazes; number of mazes; number of maze words; percentage of maze words (out of the total number of words); and average words per maze. Most of the overall disfluency measures correlated positively and significantly with each other; average words per maze did not correlate significantly with the number of utterances with mazes ($r = .21$, $p = .16$). The number of average words per maze correlated strongly with the number of complete words, but not with the number of utterances. The number of mazes and the number of maze words did not correlate significantly with the number of utterances, but did correlate positively and significantly with the number of complete words. This finding suggested that the number of mazes and maze words increased with the number of complete words spoken, but not with the number of utterances.

The mean length of utterance (MLU) in words was determined for each participant. MLU is often used as a marker of linguistic proficiency (Bishop & Adams, 1990). MLU was positively correlated with both the average number of words per maze ($r = .35$, $p < .05$) and the number of maze words ($r = .44$, $p < .01$). These associations suggest that as the length of the utterance increased, so did the length of the mazes.

The measures hereafter referred to as "specific disfluency types" were analyzed to determine the associations both between the disfluencies themselves and their relationships with MLU (See Table 7). The specific disfluency types incorporated those conventionally known as mazes as well as other disfluencies including: pause; intra-syllable pause; emphasis lengthening; end of word lengthening; within word disfluency-lengthening; within word disfluency-silence; repair/restart short; repair/restart long; and repetition without correction total. Examining the associations between these specific disfluencies with MLU provided more information about their characteristics. The number of pauses was strongly correlated with MLU ($r = .61$, $p < .01$). MLU significantly correlated with the number of filled pauses ($r = .30$, $p < .05$), as well as with the number of short repair/restarts ($r = .31$, $p < .05$). Children with higher MLU also paused more and produced more short repair/restarts.

Correlations with Block Design and Attention Deficit Measures

The correlations between the Block Design subtest and the attention deficit measures approached significance the with ADH problems subscale ($r = -.35$, $p = .058$), but did not reach significance with Attention problems ($r = -.30$, $p = .10$). These results indicate a marginal trend associating increased levels of attention deficits with poorer spatial abilities. The relationship between spatial abilities (as measured by the Block Design subtest) and the overall disfluency measures was examined using correlation analyses. The bivariate correlations between the overall disfluency measures and the Canadian-standardized Block Design scores (scaled; mean = 10, SD = 3) are found in Table 8. Block Design scores correlated positively with all of the overall disfluency measures, with the exception of the average number of words per maze. Significant, positive correlations were found for the Block Design scores with the number of utterances with mazes, the total number of mazes, the number of maze words and the percentage of maze words out of the total number of words. The correlation between the number of average words per maze and Block Design was found to be non-significant and negative ($r = -.16$). Generally, higher scores on the Block Design test (i.e. better performance) were associated with producing more mazes and more overall maze words, and were also linked with producing shorter mazes.

The Attention problems and Attention Deficit Hyperactivity (ADH) problems subscales of the C-TRF were used to analyze attention deficits; collectively, the two subscales are hereafter referred to as the "attention deficit measures". The two subscales were highly correlated ($r = .92, p < .01$). The associations between the overall disfluency measures and the attention deficit measures were examined through correlation analyses. Correlations between the attention deficit measures and the overall disfluency measures were non-significant with the exception of the average number of words per maze (See Table 9). Significant positive correlations were found between the average number of words per maze and both Attention problems ($r = 0.46, p < .01$) and ADH problems ($r = 0.53, p < .01$) subscales. Longer mazes tended to be associated with higher scores on the attention deficit measures.

As previously discussed, preschoolers who spoke more words in total also produced more total maze words and more average words per maze. To control for this association, partial correlation analyses were run on the average number of words per maze, the Block Design task and the attention deficit measures, controlling for the number of utterances and the number of complete words (Table 10). These analyses examined the relationships between the average number of words per maze, Block Design, and the attention deficit measures when the effects of total number of utterances and words were removed. The average number of words per maze was significantly, negatively correlated with the Block Design scores ($r = -0.50, p < .01$). Preschoolers with high scores on the Block Design test were more likely to produce shorter mazes. Partial correlations for the total number of mazes and the total number of maze words, controlling for the number of utterances and the number of complete words, revealed that when these effects were removed, the total number of mazes correlated with Block

Design ($r = .39$, $p < .05$). Block Design did not correlate significantly with the total number of maze ($r = .23$, $p = .15$), in contrast to previous analyses. When the total number of utterances and words were controlled for, the average number of words per maze was strongly correlated with the Attention measure and with the ADH problems measure. Preschoolers who produced a higher average number of words within each maze were also more likely to generate higher scores on attention deficit measures.

To determine the linguistic profile of children with attention deficits, the correlation relationships between the specific disfluency categories and Block Design as well as the attention deficit measures were examined (Table 11). Generally, these associations were non-significant; the exception was the number of long repair/restarts which were strongly correlated with Attention problems ($r = .64$, $p < .01$) and ADH problems ($r = .66$, $p < .01$). The correlation between pauses and Block Design scores approached significance ($r = .29$, $p < .10$). Long repair/ restarts were negatively associated with Block Design, though the correlation did not reach statistical significance ($r = -.231$, $p = .14$). These results indicate that children who produced more long repairs and restarts were more likely to have problems with attention.

Linguistic disfluencies are a heterogeneous set. Even the category of maze, consisting of filled pauses, repetitions and repairs/restarts, is a complex measure. By breaking the category of maze down into the specific disfluencies, the specific relationships between each disfluency and the behavioral and intelligence measures could be analyzed. For example, we suggest that a filled pause reflects a different cognitive process or function than a repetition without correction. Evidence for this hypothesis appeared in a study examining linguistic profiles of children who stutter, which found that the percentage of stuttering-like disfluencies (e.g. part-word repetition) differed between children who stuttered and those who did not, but that there was no significant difference between the groups in other disfluencies (e.g. revision-incomplete phrase; Pellowski & Conture, 2002). The goal of the current study was to determine the specific class of errors that was driving the correlations between the maze category and the various behavioural and intelligence measures. To accomplish this, the specific disfluencies were theoretically reorganized into new categories (hereafter referred to as the reorganized disfluency categories). The six reorganized disfluency categories were: pause, filled pause, within word disfluency total (consisting of emphasis lengthening, end-of-word lengthening, within word disfluency-silence, intra-syllable pause and within word disfluency-lengthening), repetition without correction total, repair/restart short (1-3 words) and repair/restart long (4-7 words). Scores in these categories were converted into percentages per complete word. The category of total within word disfluencies contained all the specific disfluency types that occur within a word (See Table 2 for examples). The number of pauses, though not a conventional maze measure according to SALT, continued to be included in the subsequent analyses involving the reorganized disfluency measures. The decision was partially based on the fact that measures similar to pauses are considered to be mazes in previous research, such as an intrasyllable pause and a within-word disfluency-silence. These reorganized disfluency categories represented more psycholinguistically motivated distinctions, with an objective to better understand the relationship between attention deficits and disfluencies seen in Redmond (2004).

The reorganized disfluency categories were correlated with the Block Design subtest and the attention deficit measures (Table 12). The number of pauses per complete word was significantly correlated with Block Design ($r = 0.35$, $p < .05$). The number of long repair/restarts per complete word correlated strongly with the Attention ($r = 0.62$, $p < .01$) and ADH problems subscales ($r = 0.67$, $p < .01$). The number of pauses produced by the preschoolers tended to be higher for those with better scores on a spatial task; more long repairs and restarts were associated with higher levels of attention problems. Controlling for the total number of words and utterances increased the strength of these correlations compared to when they were calculated without removing these effects, as listed in Table 11.

Regression Analyses

Multiple linear regression analyses were used to determine the largest contributors of the reorganized disfluency measures to the prediction of scores on the Block Design test and also on the attention deficit measures. Using a forward regression, the number of pauses per complete word was the only significant predictor of Block Design scores (11.9% of the variance, $p < .05$). The number of long repair/restarts (per complete word) was the only predictor of both the attention deficit subscales. The number of long repair/restarts accounted for 38.1% of the variance of the Attention scores ($p < 0.01$). The number of long repair/restarts accounted for 44.7% of the variance of scores on the Attention Deficit/Hyperactivity problems subscale ($p < 0.01$). These regression analyses asserted that the number of long repairs and restarts was the specific disfluency driving the correlations between the average number of words per maze and the attention deficit measures. The regressions also confirmed that the preschoolers' levels of pauses were the greatest contributor to scores on the Block Design task.

Correlation Analyses with the BRIEF-P

The preschoolers' levels of executive dysfunction were measured using the BRIEF-P. The BRIEF-P consists of five scales measuring different executive functions : Inhibit, Shift, Emotional Control, Working Memory, and Plan/Organize. The BRIEF-P also uses three indices that contain various combinations of the scales. These indices measure more general constructs: inhibitory self-control, flexibility and emergent metacognition. The Global Executive Composite is a summary score consisting of all 5 scales. See Table 1 for full descriptions of the constructs measured in these scales and indices. As previously discussed, executive dysfunctioning is believed to be a factor in ADHD. By examining the relationships between the various disfluencies (overall, specific, and reorganized categories) and the BRIEF-P measures, it was possible to identify linguistic errors that were more commonly associated with higher levels of executive dysfunctions. Table 13 lists the correlations between the BRIEF-P measures and the attention deficit measures. As was found in previous studies, the associations between these executive function measures and the attention deficit measures were strongly correlated ($p < .01$ for all correlations).

Correlation analyses were conducted on the BRIEF-P measures and the Block Design subtest to determine the relationship between the executive functions and spatial intelligence (Table 14). The associations between the BRIEF-P measures and Block Design were all negative and non-significant, except for the correlation involving the

Shift scale, which was strongly correlated ($r = -.59$, $p < .01$). These findings indicate that increasing scores on a performance IQ task were associated with greater abilities to move easily between activities and frames of mind.

To investigate the relationships between the executive functions and the disfluency measures, the same correlation analyses performed on the attention deficit and Block Design measures were conducted on the BRIEF-P measures. Table 15 gives the correlations between the BRIEF-P measures and the overall disfluency measures. Generally, these measures were not strongly correlated. A non-significant negative trend was observed between the number of utterances with mazes and the number of mazes with the Shift, Working Memory, and Plan/Organize scales. This indicates that there is a very slight trend for more mazes to be associated with less executive dysfunctioning. The total number of maze words had a general non-significant positive association with executive dysfunctions, except for the Shift scale, which was slightly negatively correlated. The average number of words/maze correlated positively and significantly with the Working Memory and Plan/Organize scales as well as with the index of Emergent Metacognition and the Global Executive Composite. Preschoolers who produced more average words per maze were also more likely to have higher executive dysfunction scores in working memory and in the ability to plan and organize.

To control for the effects of the total number of utterances and complete words, partial correlations between the BRIEF-P measures and the average number of words per maze were analyzed (Table 16). The average number of words per maze achieved moderate but significant correlations with the scales of Shift, Emotional Control, with the

Flexibility index and with the Global Executive Composite. The scales of Working Memory, Plan/Organize, and the Emergent Metacognition index were strongly, significantly correlated with the average number of words per maze ($p < .01$). For example, the correlation between the Working Memory scale and the average number of words per maze was significantly, positively correlated ($r = .50$, $p < .01$). These associations suggest that preschoolers who produced longer mazes (filled pauses, repetitions, repair/restarts) also had higher levels of executive dysfunctioning, particularly in the areas of working memory and planning/organizing.

To determine the type of error that was driving the association between the average number of words per maze and executive dysfunctioning, the correlations between the specific disfluency types and the BRIEF-P measures were examined (Table 17). Generally, the specific disfluency types did not correlate significantly with the BRIEF-P measures. However, the number of pauses correlated significantly with the Shift scale ($r = -.36$, $p < .01$) and with the Flexibility index ($r = -.36$, $p < .01$). This negative association suggests that children who produced more pauses were scored by their teachers as being better at transitioning between activities and emotions. The correlations between the number of long repair/restarts and the Shift scale and Flexibility index were moderately, significantly correlated ($r = .38$; $r = .36$, respectively, $p < .05$). The number of long repair restarts was also strongly correlated with the scales of Working Memory, Plan/Organize as well as the Emergent Metacognition Index and the Global Executive composite ($p < .01$ for the four correlations). These findings showed that children who were scored as possessing weaker abilities in working memory, planning/organizing, and transitioning also tended to produce more long repairs and restarts in conversational speech.

To control for the effect of total number of words, the reorganized disfluency categories (per complete word) were correlated with the BRIEF-P measures (Table 18). The number of pauses per word approached significance with the Shift scale ($r = -.34$, $p = .05$). The number of long repair restarts (per total number of words) correlated strongly with the Shift, Emotional Control and Working Memory scales, the Flexibility and Emergent Metacognition Indices and the Global Executive Composite ($p < .01$ for all correlations). The scales of Emotional Control and Plan/Organize as well as the Inhibitory Self-Control index were also significantly correlated with the number of long repairs and restarts ($p < .05$ for all correlations). The production of more long repairs and restarts in preschoolers was associated with general executive dysfunctioning.

The results from the correlations between the BRIEF-P measures and the overall disfluency categories suggested that producing higher numbers of pauses is associated with stronger executive functioning when shifting from one activity or frame of reference to another. Significant, positive correlations between the number of long repair/restarts and all of the BRIEF-P measures except the Inhibit scale indicated that the production of longer repair/ restarts was associated with higher levels of executive dysfunction.

Discussion

Results of the correlation analyses provide more detail regarding the relationship between linguistic disfluencies and ADHD (or ADHD risk) than seen in previous studies. By examining the relationships between the specific disfluency types and the attention, intelligence, and executive function measures, we were able to illustrate the diverse nature of the group of disfluencies that have previously been grouped together in the category of mazes. Our study extends Redmond's (2004) work by corroborating his finding regarding the average number of words per maze and by piecing apart that relationship to determine the specific disfluency type associated with attention problems. The average number of words per maze was moderately correlated with the attention deficit measures, as seen in Redmond's 2004 study. Contrary to Redmond's results, however, the current study did not show a positive association between the percentage of maze words (out of the total number of words) and attention deficits. The association between the average number of words per maze and attention deficits was strongly positive when the number of complete words was controlled for. A partial correlation analysis which controlled for the total numbers of words and utterances revealed a moderate, negative correlation between the Block Design subtest and the average number of words per maze. The Block Design task was also negatively correlated and approached significance with the Attention Deficit/Hyperactivity problems subscale. This result indicates that there may be a marginal trend for children with attention related problems to produce lower scores on a visual-spatial task providing some, although not strong support for previous research linking ADHD and spatial task deficits (Barnett et al., 2001; Beitchman et al, 1987). Children with greater average numbers of words per maze tended to have higher levels of attention deficits and weaker spatial abilities. It is important to note that participants of the present study were approximately three years younger than those in Redmond's study (2004). Replicating Redmond's finding regarding the average number of words per maze and ADHD in a younger sample provides more evidence that this disfluency measure could have utility in predicting a future diagnosis of ADHD.

The main goal of the current study was to determine which of the specific disfluency types was driving the correlations between the average number of words per maze and attention deficits, given the cognitively heterogeneous category of "maze." Examining the nature of the relationships of the reorganized disfluency categories with respect to attention problems and the Block Design task provided more information on the specific nature of these associations. The Attention problems and Attention Deficits subscales were strongly and positively correlated with the number of long repairs and restarts. The forward regression analyses with the reorganized disfluency measures and the attention deficits measures revealed that the number of long repair/restarts was the only significant predictor of scores on both the Attention and the ADH problems subscales. These robust results associating greater numbers of long repairs/restarts and problems with attention suggest that this conversational measure could be a useful addition to the battery of screening measures used to identify preschoolers who are at risk for a later diagnosis of ADHD. The disparate relationships observed between the reorganized disfluency categories and the attention measures indicate that these linguistic measures cannot be treated as a single, homogeneous category. The specific disfluency types of repetitions without correction and filled pauses, which were treated as mazes in Redmond's (2004) study was not associated with attention deficit problems. The only positive association between a specific disfluency type and the attention deficit measures occurred with the number of long repairs and restarts, which were also included in the category of mazes used in Redmond's study (2004). Associating the overall category of maze with attention deficits implies that all disfluencies in this category are associated with such behavioural problems, which we have shown is not necessarily the case. The number of short repairs and restarts showed no association with attention deficit problems, suggesting that different cognitive processes may be responsible for producing long and short revisions. The number of short repairs and restarts was even moderately, positively correlated with MLU, suggesting this disfluency may be associated with higher levels of functioning. We propose that repairs and restarts may reflect a speech-monitoring process that catches and corrects speech errors. It is possible that short repairs and restarts reflect a more efficient monitoring process, as the speaker quickly recognizes an error and revises their utterance, while long repairs and restarts occur when the disfluency is not recognized as quickly. This impaired speech monitoring system could be among the cognitive processes that are associated with problems with attention. Crucially, this account would suggest that children with attentional problems do not necessarily have any more problems with initial language formulation issues than other children. This monitoring and editing account also fits well with the idea that inhibitory processes are particularly relevant to ADHD.

Further evidence of the diverse nature of the specific types of disfluencies was observed by examining the category of pauses. The Block Design subtest, a measure of performance IQ, correlated positively with the number of pauses (per complete word). The regression analyses revealed that the number of pauses was the only significant predictor (out of the reorganized disfluency categories) of scores on the Block Design test. The analyses also showed that not only was the number of pauses positively associated with Block Design, but none of the other reorganized disfluency categories, such as within-word disfluency total, were negatively associated with Block Design. This analysis further suggests that disfluencies are not inherently problematic. None of the disfluency categories were linked with poorer performance on the Block Design subtest and the production of more pauses was associated with greater scores on the task. The production of a pause could allow time for sentence planning. A pause provides the speaker time to organize an utterance. Filled pauses were not positively correlated with Block Design, indicating that the cognitive processes behind a pause and a filled pause may be different. These findings show that disfluencies are a very mixed group of linguistic measures, with different underlying cognitive processes which do not necessarily reflect particular cognitive or linguistic problems.

Examining the relationships between the executive function measures (the BRIEF-P scales and indices) and the reorganized disfluency categories was a useful way to further investigate the underlying processes of the disfluency types. The executive dysfunction measures showed similar patterns as the attention deficit measures in their correlation analyses with the disfluency categories. In the analyses of our preschool participants, all of the BRIEF-P scales and indices were positively and strongly correlated with the attention deficit measures. The association between problems in executive functioning and ADHD has also been found in previous studies (Denckla, 1996; Pennington, Groisser, & Welsh, 1993). A negative and strong correlation was observed between the Block Design subtest and the Shift scale of the BRIEF-P, which measures the ability to transition between activities and frames of mind. Higher scores on the BRIEF-P scales indicate greater problems in functioning, therefore, higher scores on the spatial abilities task were associated with a better ability to shift easily and think creatively.

We examined the relationships between the overall disfluency measures and the executive function measures. Of particular interest was the average number of words per maze, found by Redmond (2004) to associate with ADHD. Given its relationship with ADHD, determining the association between the average number of words per maze and executive dysfunctions was of interest. The majority of the overall disfluency measures (e.g. number of mazes) did not correlate with any of the executive function measures. The exception to this was the average number of words per maze, which, when controlling for the effects of words and utterances, correlated positively with all scales except for Inhibit. The disfluency measure also correlated with the indices of Emergent Metacognition and Flexibility and the Global Executive Composite. The average number of words per maze was associated not only with attention deficit measures, but also with an impairment consistently found in children with ADHD, executive dysfunction, thus showing a robust relationship to a range of different measures of attention problems.

Producing more long repairs and restarts was not only correlated with problems with attention, but also associated with an overall increase in executive dysfunction. No other disfluency category was correlated with any BRIEF-P scale or index, indicating that most disfluency types are not associated with any impairment in executive functioning. Of the disfluency types, only the number of long repairs and restarts was found to be associated with negative behavioural characteristics.

The number of pauses (per word) was negatively correlated and approached significance with the Shift scale. The trend indicates that the number of pauses may be associated with a better ability to move easily between activities and divide attention. This correlation is marginal; however, it provides some support for the proposal that pauses are underscored by positive cognitive mechanisms, as seen in the earlier, related finding associating the number of pauses with improved spatial abilities. It is interesting to note that both the number of pauses and the Block design subtest were negatively associated with the Shift scale, though marginally with respect to the number of pauses. This could suggest that the cognitive processes behind the production of pauses and spatial abilities are both associated with the ability to transition between activities and to problem-solve creatively.

This study had several limitations. First, the small sample size used makes it more difficult to generalize the clinical implications. The participants did not constitute a clinical sample. The participants had varying levels of attention deficits, but were not specifically diagnosed with ADHD. It is also important to note that the preschoolers were not placed into groups comparing children with ADHD and typically developing controls. The Attention problems syndrome and ADH problems subscale of the C-TRF were used to identify levels of attention deficits, but were not used as diagnostic criteria. Despite these limitations, we suggest that conversational language samples of preschoolers could still be used to identify children who produce a large number of long repairs and restarts. At this point, clinicians may decide to conduct ADHD assessments on these children immediately to ensure they are monitored for the potential development of the disorder.

Our study shows that the average number of words per maze (using standardized SALT terminology) is a linguistic measure that could be used in early assessments of preschoolers. Considering the maze category as a unit, however, does not reflect the diversity of disfluency types contained within it. We have shown that the disfluency type linking the maze category with attention deficits is the number of long repairs and restarts. The implication for teachers and parents looking to keep watch for possible attention problems in their preschoolers is that they should not be listening for a general category of disfluencies labeled as mazes, which could include several types of speech errors, but specifically for long repairs and restarts. Redmond's (2004) finding regarding the average number of words per maze and attention deficits was accurate. More specifically, we have found that the number of long repairs and restarts is the conversational measure responsible for the correlation between the average number of words per maze and attention deficits. Our examination of specific types of disfluencies has shown that disfluencies make up a heterogeneous group. Some disfluencies, such as the number of pauses appear to be associated with better cognitive processing. Conversational language measures, particularly utilizing the analyses of disfluency types, could prove a useful tool in identifying preschool children who could be at risk for behavioural disorders with a language component such as ADHD.

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Table 1

Descriptions of Executive Functions Measured in BRIEF-P (Scales, Indices and Composite)

BRIEF-P measure	Description
Inhibit Scale	Measures the ability to inhibit behaviour, control impulsivity and stop behaviours when necessary. Children with ADHD typically have deficits in this executive function.
Shift Scale	Measures the ability to move easily between activities/frames of mind. The process involves being able to make transitions, change or divide focus of attention, and think creatively when problem solving. This scale contains items that tap into inattention and impulsivity.
Emotional Control Scale	Measures the ability to control emotional displays, and to produce appropriate emotional reactions. Deficits in this executive function would manifest as frequent mood changes and inappropriate outbursts.
Working Memory Scale	Measures the ability to hold information in memory for immediate use. This process is necessary for anything with multiple steps such as instructions or directions. Dysfunction in this process usually results in the child being perceived as forgetful. An example of an item in this scale is "Cannot stay on the same topic when talking".

Plan/Organize Scale	Measures the ability to handle current and upcoming tasks Children with deficits in this process appear disorganized and have difficulty managing problems with multiple steps.
Inhibitory Self-Control Index (ISCI)	This index comprises the scales of Inhibit and Emotional Control. ISCI measures the child's ability to control how they act and how they express their emotions using suitable inhibitory control.
Flexibility Index (FI)	This index consists of the scales of Shift and Emotional Control. FI measures the child's ability to easily transition among all aspects of their functioning including actions and emotions.
Emergent Metacognition Index (EMI)	This index comprises the scales of Working Memory and Plan/Organize. EMI measures the child's ability to instigate, design, coordinate, put into action and maintain future-oriented problem solving.
Global Executive Composite (GEC)	This composite consists of all 5 scales and is a general summary measures. The GEC is only appropriate for clinical use if scores on all or most of the BRIEF scales are similar. Otherwise, using the GEC can mask specific executive function deficits by looking at the category of functions as a whole.

Table 2

Coding of disfluencies

Type of disfluency	Example
Filled pause[a]	"And (um) then he came (ah) home."
Intra-syllable pause [b]	"I wanted to go down the elevator {e (:03) levator}."
Pause [b]	"I went (0:05) to the store."
Repair/Restart	"I went to go (upstairs) downstairs."-repair/restart short (1 word) "Sarah was walking and then she (walk home to go) had to run to the store." – repair/restart long (4 words)
Repetition without Correction	"This is (the) the bed." (1 word)
Emphasis Lengthening	No! {NNNo!}
End of Word Lengthening	Alligator {Alligatorrr}.
Within word disfluency-lengthening	Alligator {Alligaaator}.
Within word disfluency-silence	Hello {He (0:01) llo} .
Within word repetition (sound or syllable)	duck {du* duck} or hello {hel*hello}

Note. [a] Typically non-words, with the exception of "like". The word "like" was transcribed as a word unless the transcriber was confident it was being used as a filled pause similar to "um". [b] The length of the disfluency is indicated by recording the length in number of seconds in parentheses. Pauses less than 1 second in length were coded as [P].

Table 3
SALT transcription file

E What can we make with them?

C (Th*) They clean {keen} [DD].

E They clean?

C They clean stuff.

E And what else do they do?

C (Th* they) They do some things {fings} with different {w'different} jobs.

E Which one's your favourite one to play with?

C (The {duh}) This {dis} one.

E Yeah?

E And what's his name?

C (uh) Muck {mook}.

Note: All numbers were rounded to 2 decimal places.

Table 4
Descriptive Statistics for Conversational Language Measures and Disfluencies

Conversational measures	Minimum	Maximum	Mean	Std. Deviation
# Utterances	15	55	27.26	8.55
# Complete words	29	239	114.76	51.84
# Utterances w/mazes	0	16	6.41	4.05
# Mazes	0	20	7.54	5.18
# Maze words	0	53	11.72	10.44
% Maze words/total number of words	0	0.33	.10	.07
Average words/maze	0	3	1.43	.60
Pause	0	10.00	3.28	2.74
Filled pause	0	3.00	.26	.65
Intra-syllable pause	0	2.00	.30	.51
MLU[a] in Words Total	1	9	3.90	1.64
Repair/restart - short word (1-3 words)	0	2.00	.28	.58
Repair/restart –long (4-7 words)	0	1.00	0.11.	.31
Repetition without correction total (1-5 words)	0	5.00	1.30	1.36
emphasis lengthening	0	6.00	.50	1.28
end of word lengthening	0	3.00	.28	.72

Conversational measures	Minimum	Maximum	Mean	Std. Deviation
within word disfluency - lengthening	0	6.00	.20	.93
within word disfluency - silence	0	1.00	.04	.21
within word repetition	0	0	0	0

Note. N=46
[a] MLU=mean length of utterance

Table 5
Descriptive Statistics for Scaled scores of Intelligence, Attention and Executive Function Measures

	Minimum	Maximum	Mean	Std. Deviation	N
Canadian-standardized Block Design subtest - WPPSI[a]	3	15	8.48	2.70	42
Attention Deficit/Hyperactivity Problems -C-TRF[b]	50	91	58.32	10.49	34
Attention Problems -C-TRF	50	76	57.12	8.03	34
Behaviour Rating Inventory of Executive Function-Preschool Version measures[c]					
Inhibit	43	84	61.21	13.76	33
Shift	41	91	55.94	14.04	33
Emotional Control	41	88	59.03	13.64	33
Working Memory	42	89	60.79	14.11	33
Plan/Organize	40	96	60.94	14.47	33
Inhibitory Self-Control Index	41	90	61.39	14.19	33
Flexibility Index	40	94	58.85	14.09	33
Emergent Metacognition Index	41	93	61.03	14.40	33
Global Executive Composite	41	94	62.27	14.78	33

[a] WPPSI= Weschler Preschool and Primary School of Intelligence
[b]C-TRF=Caregiver-Teacher Report Form
[c]Teacher Reports

Table 6
Intercorrelations Between Conversational and Overall Disfluency Measures

Conversational/Disfluency Measures	1	2	3	4	5	6	7	8
1 #of Utterances	_	.59**	.37*	.28	.25	-.06	.18	-.14
2. # Complete words		_	.47**	.54**	.64**	.09	.48**	.68**
3. # of Utterances with mazes			_	.93**	.71**	.71**	.21	.13
4. # of Mazes				_	.88**	.78**	.32*	.29
5. # of Maze words					_	.75**	.59**	.44**
6. % of Maze words (of total words)						_	.40**	.003
7. Average words/maze							_	.35*
8. MLU[a] in Words								_

Note. N=46
[a]MLU= Mean length of utterance
*p< .05. **p< .01.

Table 7

Intercorrelations Among Specific Disfluency Categories and MLU

	1	2	3	4	5	6	7	8	9	10	11
1. Pause	_	.40**	-.14	-.06	.08	-.12	-.06	.09	-.09	.13	.61**
2. Filled pause		_	.02	-.08	-.07	-.09	-.09	.15	-.14	-.14	.30*
3. Intra-syllable pause			_	.34*	.003	-.03	.08	.15	-.07	.02	-.01
4. Emphasis lengthening				_	.09	.14	-.08	.31*	.14	-.15	.02
5. End of word lengthening					_	.35*	-.09	.34*	.16	.02	.12
6. Within word disfluency - lengthening						_	-.05	.06	.08	-.15	-.20
7. Within word disfluency - silence							_	-.10	-.07	.03	-.06
8. Repair restart short								_	.07	-.14	.31*
9. Repair restart long									_	-.13	.10
10. Repetition without correction total										_	.14
11. MLU[a] in Words Total											_

[a]MLU= Mean Length of Utterance *p < .05. **p < .01

Table 8
Correlations Between Overall Disfluency Measures and Block Design

Overall disfluency measure	CAN[a] Block Design (Scaled Scores) WPPSI[b]
# Utterances with mazes	.38*
# Mazes	.42**
# Maze words	.32*
% Maze words/total # of words	.37*
Average words per maze	-.16

Note. N=42.
[a]CAN=Canadian-standardized
[b] WPPSI= Weschler Preschool and Primary School of Intelligence
$^{*}p < .05$. $^{**}p < .01$

Table 9

Correlations Between Overall Disfluency Measures and Attention Deficit Measures

	Attention Problems[a]	Attention Deficit/Hyperactivity Problems[a]
# Utterances with mazes	-.17	-.13
# Mazes	-.12	-.05
# Maze words	.05	.14
% Maze words	-.10	-.02
Average words/maze	.46**	.53**

Note. N=34.

[a] From Caregiver-Teacher Report Form 1 1/2-5, Standardized Scores
**p < .01

Table 10

Partial Correlations Between Average Words/Maze, Attention Deficit and Spatial Intelligence Measures

Control Variables	Standardized measures	Average words/maze
# utts & # comp wds	CANBlock Design - WPPSI[a]	-.33*
	Attention Problems[b]	.49**
	Attention Deficit/Hyperactivity Problems[b]	.56**

[a] Canadian-standardized, scaled scores from the Weschler Preschool and Primary Scale of Intelligence. N=42

[b]From Caregiver-Teacher Report Form 1 1/2-5, standardized scores. N=34.

*$p < .05$. **$p < .01$.

Table 11

Correlations Among Specific Disfluency Types, Attention Deficit and Spatial Intelligence Measures

Specific Disfluency Type	CAN Block Design WPPSI [b]	Attention Deficit/Hyperactivity Problems [a]	Attention Problems [a]
Pause	.287	-.189	.007
Filled pause	.017	-.216	-.196
Intra-syllable pause	.049	.248	.186
Repair restart short	-.078	.234	.159
Repair restart long	-.231	.660**	.641**
Repetition without correction total	.215	-.193	-.176
Emphasis lengthening	.000	.152	.254
End of word lengthening	-.075	.139	.217
Within word disfluency - lengthening	-.105	-.028	-.010
Within word disfluency - silence	-.028	-.044	-.051

[a]. From Caregiver-Teacher Report Form 1 1/2-5, standardized scores. N=34

[b] Canadian-standardized, scaled scores from the Weschler Preschool and Primary Scale of Intelligence. N=42

~marginal significance, $p < .10$. $^{**}p < .01$

Table 12

Correlations Between Reorganized Disfluency Categories, Attention Deficit and Spatial Intelligence Measures

Disfluency measure (per complete word)	Attention Problems [a]	Attention Deficit/Hyperactivity Problems [a]	CAN Block Design - WPPSI [b]
Pause	-.02	-.21	.35*
Filled pause	-.21	-.22	.02
Within word disfluency total	-.06	-.04	-.07
Repetition without correction total	-.23	-.26	.16
Repair/restart short (1-3 words)	.17	.23	-.09
Repair/restart long (4-7 words)	.62**	.67**	-.22

[a]. From Caregiver-Teacher Report Form 1 1/2-5, standardized scores. N=34.
[b] Canadian-standardized, scaled scores from the Weschler Preschool and Primary Scale of Intelligence. N=42

Table 13

Correlations between BRIEF-P[a] Teacher Report Scales and Indices and Attention Deficit Measures

BRIEF-P measures	Attention Problems[b]	Attention Deficit/Hyperactivity Problems[b]
Inhibitory Self Control index	.67**	.74**
Flexibility index	.56**	.66**
Emergent Metacognition index	.88**	.82**
Global Executive composite	.83**	.85**
Inhibit scale	.63**	.69**
Shift scale	.50**	.60**
Emotional Control scale	.56**	.64**
Working Memory scale	.87**	.78**
Plan/Organize scale	.86**	.83**

[a] BRIEF-P= Behaviour Rating Inventory of Executive Function-Preschool Version. T scores. N=33

[b] From Caregiver-Teacher Report Form 1 1/2-5, standardized scores.

$^{**}p < .01$

Table 14

Correlations between BRIEF-P [a] Teacher Report Scales/Indices and Block Design Measure

BRIEF-P measures	CAN Block Design WPPSI[b]
Inhibit scale	-.08
Shift scale	-.59**
Emotional Control scale	-.18
Working Memory scale	-.28
Plan/Organize scale	-.35
Inhibitory Self Control index	-.10
Flexibility index	-.36
Emergent Metacognition index	-.30
Global Executive composite	-.30

[a] BRIEF-P= Behaviour Rating Inventory of Executive Function- Preschool Version. T scores. N=33
[b] Canadian-standardized, scaled scores from the Weschler Preschool and Primary Scale of Intelligence.
** $p < .01$

Table 15

Correlations between BRIEF-P Teacher Report Scales and Indices and Overall Disfluency Measures

BRIEF-P measures	# Utterances with mazes	# Mazes	# Maze wds	% Maze wds	Average words per maze
Inhibit scale	-.003	.15	.27	.06	.24
Shift scale	-.06	-.11	-.09	-.12	.20
Emotional Control scale	.08	.14	.20	.20	.30
Working Memory scale	-.16	-.10	.04	.06	.38*
Plan/Organize scale	-.16	-.09	.06	.04	.38*
Inhibitory Self Control index	.01	.14	.27	.12	.278
Flexibility index	-.03	-.02	.03	.01	.22
Emergent Metacognition index	-.16	-.10	.05	.06	.37*
Global Executive composite	-.09	-.01	.13	.05	.35*

[a] BRIEF-P= Behaviour Rating Inventory of Executive Function- Preschool Version. T scores. N=33
*$p < .05$

Table 16

Partial Correlations between BRIEF-P[a] Measures and Average words per maze

Control Variables	BRIEF-P measures	Average words/maze
# Utterances & # complete words	Inhibit scale	.23
	Shift scale	.40*
	Emotional Control scale	.36*
	Working Memory scale	.50**
	Plan/Organize scale	.49**
	Inhibitory Self Control index	.30
	Flexibility index	.35*
	Emergent Metacognition index	.51**
	Global Executive composite	.45*

[a] BRIEF-P= Behaviour Rating Inventory of Executive Function- Preschool Version.
T scores. N=33.
*p < .05. **p < .01

Table 17
Correlations Between Specific Disfluency Types and BRIEF-P[a] Measures

Specific Disfluency Types	Inhibit (S)	Shift (S)	Emotional Control (S)	Working Memory (S)	Plan/ Organize (S)	Inhibitory Self Control (I)	Flexibility (I)	Emergent Meta-cognition (I)	Global Executive (C)
Pause	-0.12	-0.36*	-0.28	-0.07	-0.1	-0.20	-.36*	-0.10	-0.20
Filled pause	-0.21	-0.22	-0.30	-0.30	-0.21	-0.26	-0.29	-0.27	-0.29
Intra-syllable pause	0.28	-0.02	0.07	0.19	0.23	0.24	0.06	0.22	0.21
Emphasis lengthening	0.32	-0.03	0.16	0.22	0.29	0.26	0.07	0.25	0.25
End of word lengthening	-0.07	-0.03	-0.04	0.11	0.04	-0.05	-0.05	0.05	0.01
Within word disfluency - lengthening	0.07	-0.1	-0.11	0.11	0.11	0.01	-0.11	0.10	0.042
Within word disfluency - silence	-0.2	0.167	-0.06	-0.13	-0.21	-0.17	0.06	-0.16	-0.137
Repair restart 1-3 words	-0.01	-0.01	-0.07	0.07	0.07	-0.03	-0.06	0.06	0.02
Repair restart 4-7 words	0.27	.38*	0.30	.58**	.50**	0.32	.36*	.53**	.49**
Repetition without correction total	0.1	-0.18	0.06	-0.19	-0.18	0.04	-0.09	-0.19	-0.12

Note. (S) = scale. (I)= index. (C) = composite. a BRIEF-P= Behaviour Rating Inventory of Executive Function- Preschool Version. T scores. N=33*p < .05. **p < .01

Table 18

Correlations Between BRIEF-P[a] Measures and Reorganized Disfluency Categories[b]

BRIEF-P Measures	Pause	Filled pause	Within word disfluency total	Repetition without correction total	Repair/restart long	Repair restart short
Inhibit scale	-.19	-.19	.14	-.08	.32	.03
Shift scale	-.34~	-.22	-.07	-.14	.48**	-.01
Emotional Control scale	-.19	-.30	-.09	.01	.39*	-.09
Working Memory scale	.003	-.30	.06	-.17	.46**	.09
Plan/Organize scale	-.09	-.22	.11	-.20	.43*	.08
Inhibitory Self Control index	-.22	-.25	.06	-.11	.39*	-.01
Flexibility index	-.29	-.30	-.08	-.09	.47**	-.07
Emergent Metacognition index	-.04	-.27	.08	-.19	.44**	.08
Global Executive composite	-.18	-.29	.06	-.17	.50**	.04

[a] BRIEF-P= Behaviour Rating Inventory of Executive Function- Preschool Version. T scores. N=33.
[b] Disfluency categories calculated per complete word.
~marginally significant, $p < .06$. *$p < .05$. **$p < .01$