Archives of Clinical Neuropsychology 21 (2006) 131–139

Archives of CLINICAL NEUROPSYCHOLOGY

Digit Span components as predictors of attention problems and executive functioning in children

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Accepted 10 August 2005

Abstract

This study examined the extent to which digits forward (DF) or digits backward (DB) account for variance in parent ratings of attention and executive function in children. The sample ($n = 90$) included children with no diagnosis and children with a range of clinical problems, including attention deficit hyperactivity disorder (ADHD). Clinical groups differed from the No Diagnosis group on cognitive ability as well as achievement. Once cognitive ability was controlled, no group differences emerged for Digit Span or digits forward; notably, the ADHD-Predominantly Inattentive group was able to recall significantly more digits backward than the ADHD-Combined Type group. Regression analyses indicated that Full Scale IQ explained significant variance in parent ratings of attention and executive function; DF emerged as a significant predictor only for one measure of attention. When only children with ADHD were considered, DF no longer was a significant predictor. Results support the notion that DF and DB are differing constructs, as well as highlighting the importance of controlling for cognitive ability in consideration of group differences on behavioral measures.

Keywords: ADHD; Digit Span; Attention; Executive function; Children

1. Introduction

The clinical assessment of intelligence has included tasks of memory since the advent of formal intelligence testing (e.g., Binet & Simon, 1905). The Digit Span (DS) subtest of the Wechsler scales (Wechsler, 1949, 1991) is comprised of digits forward (DF) and digits backward (DB) components that yield separate raw scores but are combined to yield a single scaled score. Some argue that the practice of combining DF and DB results in a loss of important information (Banken, 1985; Ramsey & Reynolds, 1995; Reynolds, 1997). Factor-analytic studies have found that the memory processes involved in forward recall of both digits and letters are distinctly different from those involved in backward recall (e.g., Reynolds, 1997). It has been suggested that DF is a task of short-term auditory memory, sequencing, and simple verbal expression (Hale, Hoeppner, & Fiorello, 2002), while DB is more sensitive to deficits in working memory. Group differences on DF or DB have emerged across studies with varying populations (e.g., Fossati, Amar, Raoux, Ergis, & Allilaire, 1999; Hale et al., 2002). Using DF as a baseline of auditory attention and examining the difference between DF and DB may facilitate the teasing out of attention from working memory.

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doi:10.1016/j.acn.2005.08.004

Working memory refers to an individual's ability to hold relevant information in mind for the purpose of completing a task; it is that functional system that provides for temporary storage and manipulation of information (Baddeley, 1990, 1992). Baddeley and Hitch (1974) proposed that working memory is made up of three subsystems: the phonological loop, visuospatial sketchpad, and central executive. The phonological loop is comprised of a temporary storage system and subvocal rehearsal system that preserves information in short-term auditory memory (Baddeley, 2003). The visuospatial sketchpad serves as a means of integrating visual and spatial information that may then be stored and manipulated temporarily (Baddeley, 2003); the attentional control of working memory is maintained by the central executive.

DF is frequently used as a measure of the phonological loop of Baddeley (1992) model of working memory; forward span tasks rely on either the articulatory loop or visual sketchpad with little need for a central executive system. In addition to relying on the subsidiary systems, backward-span tasks require some resources of the executive system due to the increase in attentional demands and control processes needed. Factor analysis resulted in three factors that would support Baddeley's model and the involvement of a central executive in backward-span tasks (Swanson, Mink, & Bocian, 1999).

Thus, different neuropsychological processes are involved in DF and DB; as such, DS may not be an adequate predictor of attention problems in children. Despite these concerns, DS often has been included as a task of working memory in assessment batteries and is frequently examined in the assessment of attention deficit hyperactivity disorder (ADHD). Children with ADHD present with a constellation of symptoms that include problems with attention, hyperactivity, or both. ADHD is believed to be characterized by an underlying deficit in executive functions, including the skills necessary for planning, organizing, monitoring, executing, maintaining, and evaluating behavior (Hale & Fiorello, 2001). Recent theories of ADHD also include deficits in working memory as contributing to difficulties with disinhibition (e.g., Barkley, 1997). Given the deficits presented by children with ADHD, it is not surprising that research has found children with ADHD to perform poorly on tasks of working memory (Karatekin & Asarnow, 1998). Although findings remain mixed, children with ADHD have been found to recall fewer digits than normal controls in most studies (e.g., Karatekin & Asarnow, 1998). Given theoretical concerns with combining DF and DB, additional research on the separate components that make up DS has been conducted.

1.1. Purpose of the study

In recent years, researchers have found ample empirical and theoretical support for analyzing DF and DB separately; however, research that analyzes DF and DB separately as predictors of attention and executive functioning in children remains limited. Hale et al. (2002) found that scores on DF and DB differentially predicted attention, executive functioning, and behavior rating measures. Further, their results supported the argument that DF primarily involves short-term auditory memory processes, whereas DB involves the additional components of attention and executive processes. One limitation of this study, however, was that the children were aggregated into a single, mixed, clinical group. The extent to which similar findings would emerge for a sample of children with ADHD is not known. The purpose of this study was to examine DF and DB separately as predictors of behavior ratings of attention and executive functioning. In addition, this investigation aimed to build on previous research by differentiating between children with ADHD by subtype, other psychiatric conditions, and no diagnosis controls in the examination of these relationships. Consistent with previous findings (Hale et al., 2002), it was hypothesized that DB would predict attention problems and executive functioning, but that DF would not predict these variables.

2. Method

2.1. Participants

Participants were 90 children and adolescents (aged 9–15 years) who were consecutive referrals to the Memory, Attention, and Planning Study (MAPS), a university based research study in the southwest for which DF and DB data were available. Children were recruited through the use of announcements distributed in the local community to pediatricians, local support groups for individuals with ADHD, a community-based counseling center, local bulletin boards, and the local newspaper. The announcement indicated that the research study focused on memory, attention and planning/problem-solving. Participation was voluntary with parental consent and child/adolescent assent was obtained.

Following the completion of the evaluation, parents or guardians received a comprehensive report of the results, along with recommendations if appropriate. For inclusion in this study, participants must have obtained an IQ greater than or equal to 80 and had to speak and read English; six children were excluded based on these criteria. An additional two children were excluded due to missing data. Prior to the start of the project, prior diagnosis of schizophrenia or history of severe head injury were established as additional exclusionary criteria.

The 90 children and adolescents who were included in this study had a mean age of 11.73 years (S.D. = 2.06). Of these, 60 (66.67%) were male and 30 (33.33%) were female. The ethnic composition of this sample was primarily white, non-Hispanic children and adolescents ($n = 71$, 78.89%). Additionally, 11 (12.22%) were African-American, 7 (7.78%) were Hispanic, and 1 (1.11%) was Asian-American. The mean Full Scale IQ of participants was 102.42 (S.D. = 12.58) and the mean total achievement was 98.93 (S.D. = 14.26). Mean parental educational level (highest of either parent) was 15.03 years of education (S.D. = 2.37). Based on diagnostic considerations, 40 (44.44%) met criteria for ADHD, 24 (26.67%) met criteria for some other disorder, but not ADHD (clinical control), and 26 (28.89%) did not meet criteria for any disorder (no diagnosis). Of those with ADHD, 12 (30.00%) met criteria for ADHD-PI and 28 (70.00%) met criteria for ADHD-CT. Of the children in the Clinical Control group, the diagnoses included oppositional defiant disorder, depressive disorders, anxiety disorders, alcohol abuse/dependence, learning disabilities, adjustment disorder, and schizoaffective disorder. Demographic information by group is provided in Table 1.

Analysis of variance (ANOVA) was performed in order to determine whether the groups of children with no diagnosis, ADHD-PI, ADHD-CT, and other clinical diagnosis (but not ADHD) differed significantly in age, Full

Table 1
Demographic characteristics of participants by group

	No diagnosis	ADHD-PI	ADHD-CT	Other clinical	Total
Frequencies					
Gender					
Males	12	12	22	14	60
Females	15	0	6	9	30
Ethnicity					
African-American	3	2	2	4	11
Asian	1	0	0	0	1
Hispanic	3	1	2	1	7
White, non-Hispanic	20	9	24	18	71
Currently on stimulant medication					
Adderall	0	1	5	0	6
Concerta	0	1	7	0	8
Ritalin	0	0	6	1	7
Paxil	0	0	0	1	1
Currently on other medication					
Albuterol/other asthma	2	0	0	1	3
Wellbutrin	0	0	1	0	1
Zyrtec	0	1	1	0	2
Strattera	0	0	1	0	1
Currently receiving special education services	0	1	3	2	6
Ever retained in grade	1	1	9	7	18
Mean (S.D.)					
Age (years)	11.49 (2.21)	12.44 (1.96)	11.44 (2.11)	11.99 (1.87)	11.73 (2.06)
Grade level	5.81 (2.39)	6.58 (1.98)	5.29 (2.11)	6.00 (2.11)	5.80 (2.18)
Parent educational level (years)	15.88 (2.34)	15.00 (2.17)	14.93 (2.29)	14.22 (2.43)	15.03 (2.37)
Full Scale IQ	109.52 (13.96)	95.75 (9.15)	102.00 (10.22)	98.09 (11.57)	102.42 (12.58)
Total achievement	107.77 (15.50)	91.67 (11.72)	96.18 (12.91)	96.09 (11.30)	98.93 (14.26)
Global assessment of functioning	78.63 (8.11)	65.58 (8.42)	63.57 (6.36)	58.87 (8.40)	67.16 (10.94)

Notes. ADHD-CT: attention deficit hyperactivity disorder–combined type; ADHD-PI: attention deficit hyperactivity disorder–predominantly inattentive; S.D.: standard deviation.

Scale IQ, parent educational level, total achievement, and global assessment of functioning (GAF). Results of this analysis revealed that these groups differed significantly regarding their Full Scale IQ [F (3, 89) = 5.69, $p = .001$], total achievement [F (3, 88) = 5.85, $p = .001$], and GAF [F (3, 89) = 30.86, $p < .001$]; however, the groups did not differ significantly on variables of age or parent educational level. Tukey HSD post hoc analyses and Scheffe post hoc analyses were performed in order to get both more conservative and less conservative estimates of these differences. As would be expected, Tukey HSD and Scheffe post hoc analyses indicated that children/adolescents from the No Diagnosis group had significantly higher GAF scores than children/adolescents from the ADHD-CT group, the ADHD-PI group, and the Other Clinical group.

Both Tukey HSD and Scheffe post hoc analyses indicated that children/adolescents from the No Diagnosis group had a significantly higher mean Full Scale IQ score than the ADHD-PI group and Other Clinical group. For total achievement, the Tukey HSD post hoc analysis indicated that children/adolescents from the No Diagnosis group had a significantly higher mean total achievement score than children/adolescents from the ADHD-CT group ($M = 96.77$, S.D. = 12.89, $p < .05$), the ADHD-PI group ($M = 91.67$, S.D. = 11.72, $p < .01$), and the Other Clinical group ($M = 95.48$, S.D. = 11.43, $p < .01$). The Scheffe post hoc analysis revealed that children/adolescents from the No Diagnosis group had a significantly higher mean total achievement score than children/adolescents from the ADHD-CT group, the ADHD-PI group, and the Other Clinical group. Thus, the No Diagnosis group evidenced both better achievement and higher cognitive ability than the clinical groups. Due to the significant differences in ability and achievement, some consideration of ability was deemed necessary, it was decided to include Full Scale IQ as a covariate in all other analyses.

2.2. Procedures

All individuals participated in a comprehensive evaluation including assessment of cognition, achievement, language, memory, executive function, attention, and behavioral/emotional status in a clinic setting. Every effort was made to obtain information from both parents and teachers (with parent consent) regarding behavioral/emotional status; however, this was not always possible. All measures were administered consistent with standardization by either a licensed psychologist or advanced doctoral students supervised by a licensed psychologist. Measures were administered in a random order; test sessions varied in length based on the individual being assessed. For those participants with a previous diagnosis of ADHD who were currently taking stimulant medication ($n = 24$), parents were asked to consult their physician regarding the possibility of omitting medication on those days the child was being evaluated; this was facilitated by conducting evaluations when the child or adolescent would not normally be taking the medication (e.g., school vacation, weekend). Those children or adolescents taking other types of medication continued on the medication as prescribed without interruption.

Diagnostic decision-making: Because this was a training program, at least two individuals (advanced doctoral students and at least one licensed psychologist) independently reviewed the results of the cognitive, achievement, and behavioral/emotional measures and provided diagnostic recommendations. Diagnosticians were blind to the dependent variables when making a diagnosis. Interdiagnostician agreement using the licensed psychologist and one doctoral student (i.e., case manager) was determined to be 90% (Cohen's kappa = 0.84). The interdiagnostician agreement for children and adolescents diagnosed with a subtype of ADHD was found to be 97% (Cohen's kappa = 0.93).

2.3. Instruments

Wechsler Intelligence Scale for children—Third Edition (WISC-III; Wechsler, 1991): The WISC-III is the most frequently used measure of cognitive ability for child populations. All subtests required for computation of the factor scores were administered. The Full Scale IQ was of interest for descriptive purposes. The DS scaled score, longest digits forward raw score, and longest digits backward raw score were of primary interest in this study. As noted earlier, raw scores are generated for DB and DF as well, but do not yield scaled scores. Means and standard deviations for DB and DF by age level were obtained, based on the standardization sample, from The Psychological Corporation (Zhiming Yang, personal communication, July 11, 2005) and raw scores were converted to z-scores.

Woodcock–Johnson Tests of Achievement—Third Edition (WJ-III; Woodcock, McGrew, & Mather, 2001): The WJ-III is a measure of achievement. For the purposes of this study, the standard battery was administered. For descriptive purposes only, the scale of total achievement was of interest for this study.

The Behavior Rating Inventory of executive function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 1996): The BRIEF is a questionnaire completed by parents or teachers to reflect the frequency with which a child exhibits specific behaviors associated with executive functions. Executive functions are described as a number of processes that are responsible for purposeful, goal-directed, problem-solving behavior (Gioia et al., 1996). The BRIEF parent-report and teacher-report forms yield eight clinical subscales, three global scales, and two validity scales. For this study, scores on the global scales (i.e., Behavioral Regulation Index, Metacognition Index, and Global Executive Function Index) of the parent-report form were of interest. Adequate reliability and validity has been established for the BRIEF (Gioia et al., 1996).

Conners Parent Rating Scale (CPRS; Conners, 1997): The CPRS is the parent-report scale of the *Conners' Rating Scales—Revised* (CRS-R; Conners, 1997). The CPRS is a multimodal approach to the assessment of behavior problems in children. There are three types of scales (parent, teacher, and self-report), and both short and long forms exist for each scale. The short form of the parent-report scale was employed in this study. The Inattention subscale was of primary interest. Adequate reliability and validity coefficients have been reported for the CPRS (Conners, 1997).

Behavior Assessment System for Children—Parent Rating Scale (BASC-PRS; Reynolds & Kamphaus, 1992): The BASC is a conceptually derived, multidimensional approach to assess the behaviors and emotions of children and adolescents between 4 and 18 years of age. There are multiple versions of the BASC, including a Parent-Report Scale (PRS), Teacher-Report Scale (TRS), and Self-Report Scale (SRP) with different forms based on the age of the child. Each form yields *T*-scores on a number of clinical and adaptive skills subscales, as well as behavioral composite scores. For the purposes of this study, scores on the Attention Problems subscale of the BASC-PRS were of interest. The validity of the BASC has been established based on the results of factor analyses and correlations between scores on the BASC and scores on other measures of behavioral and emotional problems in children (Reynolds & Kamphaus, 1992). Additional empirical support for the validity of the BASC has been obtained through an investigation of the ability to predict membership in diagnostic groups (e.g., no diagnosis, diagnosis of ADHD only, and diagnosis of ADHD and other comorbid behavior disorder) based on scores of the BASC-PRS (Doyle, Ostrander, Skare, Crosby, & August, 1997).

3. Results

3.1. Group comparisons

Multivariate analyses of covariance (MANCOVA) were performed in order to determine whether the groups (i.e., ADHD-CT, ADHD-PI, Other Clinical, No Diagnosis) differed in their DS, DF, or DB performance when accounting for their differences in Full Scale IQ. Results suggested that the groups differed significantly in their DB performance [$F(3, 86) = 4.83$, $p < .01$], but no differences were found with regards to their DF or overall DS performance. Multivariate results are displayed in Table 2. Post hoc analyses were performed to clarify differences among the groups. Results from the Tukey HSD test revealed that the ADHD-PI group demonstrated significantly greater DB performance than the ADHD-CT group; neither the ADHD-PI group nor the ADHD-CT group differed significantly from the No Diagnosis or Clinical Control group. In contrast, results from the Scheffe post hoc analysis were not significant ($p = .07$). In effect, the ADHD-PI group had the best performance (i.e., able to recall 4 to 5 digits backward on average) while the ADHD-CT group had the poorest performance (i.e., able to recall 3 to 4 digits backward on average).

Table 2
Multivariate analysis of variance for variables of interest

	Mean (S.D.)				*F*	Eta^2
	ADHD-CT	ADHD-PI	No diagnosis	Other clinical		
DS	8.46 (2.47)	9.75 (3.14)	9.67 (2.84)	9.65 (3.42)	2.14	0.06
DF	5.43 (1.14)	6.00 (1.91)	5.67 (1.21)	5.61 (1.37)	1.05	0.03
DB	3.50 (1.00)	4.67 (2.15)	4.22 (1.05)	4.35 (1.11)	4.83**	0.14**

Notes. ADHD-CT: attention deficit hyperactivity disorder–combined type; ADHD-PI: attention deficit hyperactivity disorder–predominantly inattentive; DS: Digit Span (scaled score); DF: longest digits forward (raw score); DB: longest digits backward (raw score).
** $p < .01$.

Table 3
Correlation matrix

	DS	DF	DB
BRIEF			
Behavioral Regulation Index	−.02	.04	−.02
Metacognition Index	<−.01	.16	.06
Global Executive Function Index	<−.01	.12	.04
BASC-PRS			
Attention problems	−.08	.01	−.08
CPRS			
Inattention	.01	.07	−.11

Notes. DS: Digit Span (scaled score); DF: longest digits forward (raw score); DB: longest digits backward (raw score). BRIEF: Behavior Rating Inventory of Executive Function; BASC-PRS: Behavior Assessment System for Children Parent Rating Scale; CPRS: Conners' Parent; Rating Scale–Revised.

Table 4
Regression analysis of DF and DB to Attention Problems Subscale on the BASC-PRS

Variable	*B*	SE *B*	*B*	Significance
Full Scale IQ	−0.41	0.10	−.41	<.001
DF	1.33	1.22	.12	.28
DB	−0.43	1.15	−.06	.61

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.172, $p = .001$.

3.2. Correlational analyses

A correlation matrix was constructed in order to identify significant correlations between scores on DS, DF, DB, and scores on the Attention Problems subscale of the BASC-PRS, the Inattention subscale of the CPRS, and the three Global Indices of the BRIEF-Parent Form. Results indicated no significant correlations between DS, DF, or DB performance and scores on any of the selected scales. The correlation matrix is presented in Table 3.

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3.3. Regression analyses

A series of multiple regression analyses were performed in order to examine the extent to which DF and DB performance could predict attention problems and executive functioning with Full Scale IQ included as a variable. For purposes of the regression analyses, the *z*-score transformations of raw scores for DF and DB, to account for age, were used. The first multiple regression analysis employed scores on the BASC-PRS Attention Problems subscale as the dependent variable (see Table 4). Results were significant [$F(3, 89) = 5.89$; $p = .001$; $R^2 = .17$] and indicated that 17.2% of the variance in BASC-PRS Attention Problems was explained by this model; however, Full Scale IQ was the only significant predictor in this model. The second multiple regression analysis employed scores on the CPRS Inattention subscale as the dependent variable (see Table 5). Scores on the CPRS Inattention subscale also were significantly

Table 5
Regression analysis of DF and DB to Inattention subscale on the CPRS

Variable	*B*	SE *B*	*B*	Significance
Full Scale IQ	−0.49	0.11	−.46	<.001
DF	2.64	1.28	.21	.04
DB	−.98	1.20	−.09	.42

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.222, $p < .001$.

Table 6
Regression analysis of DF and DB to Behavioral Regulation Index on the BRIEF

Variable	*B*	SE *B*	*Β*	Significance
Full Scale IQ	−0.38	0.13	−.30	.006
DF	1.30	1.47	.11	.38
DB	−0.09	1.53	−.01	.95

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.090, $p = .045$.

Table 7
Regression analysis of DF and DB to Metacognition Index on the BRIEF

Variable	*B*	SE *B*	*Β*	Significance
Full Scale IQ	−0.36	0.11	−.36	<.001
DF	2.18	1.25	.19	.08
DB	−0.43	1.17	−.04	.72

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.139, $p = .005$.

Table 8
Regression analysis of DF and DB to Global Executive Function Index on the BRIEF

Variable	*B*	SE *B*	*Β*	Significance
Full Scale IQ	−0.39	0.12	−.35	.001
DF	2.14	1.39	.17	.13
DB	−0.56	1.31	−.05	.67

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.129, $p = .008$.

predicted by this model [F (3, 89) = 8.11; $p < .001$; $R^2 = .22$]. This model accounted for 22.2% of the variance in CPRS Inattention with Full Scale IQ included; both Full Scale IQ and DF were significant predictors in this model.

The next set of multiple regression analyses were conducted to determine the extent to which DF and DB performance could predict parent ratings of executive functioning with Full Scale IQ included as a variable. The three global indices of the BRIEF were employed as dependent variables. The first analysis employed scores on the BRIEF Behavioral Regulation Index as the dependent variable. Results were significant [F (3, 89) = 2.80; $p = .045$; $R^2 = .09$]; however, Full Scale IQ was the only significant predictor in this model (see Table 6). Results also were significant for the second analysis with scores on the BRIEF Metacognition Index as the dependent variable [F (3, 89) = 4.57; $p = .005$; $R^2 = .14$]. Again, Full Scale IQ served as the only significant predictor in this model (see Table 7). The last multiple regression analysis employed scores on the BRIEF Global Executive Function Index as the dependent variable. Results were significant [F (3, 89) = 4.21; $p = .008$; $R^2 = .13$]; however, Full Scale IQ was the only variable to account for this effect (see Table 8).

In order to investigate whether or not the relationships found among DF and scores on the Inattention subscale of the CPRS were specific to ADHD, the multiple regression analyses were completed using only the ADHD sample ($n = 40$) using Inattention scores of the CPRS as the dependent variable and DF, DB, and Full Scale IQ as predictors (see Table 9). In children diagnosed with ADHD, results [F (2, 39) = 2.96; $p = .046$; $R^2 = .21$] again indicated that Full Scale IQ was the only significant predictor of the Inattention subscale for the ADHD sample.

Table 9
Regression analysis of DF to inattention on the CPRS in children with ADHD

Variable	*B*	SE *B*	*Β*	Significance
Full Scale IQ	−0.39	0.15	−.41	.02
DF	1.15	1.56	.12	.46
DB	−1.12	1.35	−.14	.41

Notes. DF: digits forward (age corrected *z*-score); DB: digits backward (age corrected *z*-score). R^2 (attention problems) = 0.207, $p = .046$.

4. Discussion

Previous research has demonstrated empirical and theoretical support for analyzing DF and DB separately, yet there has been limited research analyzing DF and DB separately as predictors of attention and executive functioning in children. Results indicated that the groups (i.e., ADHD-CT, ADHD-PI, other clinical diagnosis, no diagnosis) did not differ significantly in their DS or DF performance. Significant differences were obtained in their DB performance, with children diagnosed with ADHD-CT demonstrating significantly poorer performance on the longest Digit Span backward, compared to children diagnosed with ADHD-PI. These results lend support for the position that DF and DB should be analyzed separately. The significant difference between the ADHD-PI and ADHD-CT groups on DB would support Barkley's (1997) contention that the subtypes have different underlying deficits as well.

When using parent ratings of attention and executive function as is routinely done in clinical practice, DF and DB did not significantly predict problems in either of these domains. Rather, Full Scale IQ emerged as a significant predictor across the scales considered. Further, correlational analysis of DS, DF, and DB with behavior ratings of attention problems and executive functioning revealed no significant relationships. Findings such as this in relation to parent ratings of attention and executive function in comparison to laboratory measures (i.e., ecological validity) have been raised before (e.g., Matier-Sharma, Perachio, Newcorn, Sharma, & Newcorn, 1995; Price, Joschko, & Kerns, 2003; Vriezen & Pigott, 2002). Additionally, the lack of significant correlations suggests that DF and DB are measuring something other than inattention and executive functioning as measured by the rating scales. For instance, it may be that DF and DB are more reflective of sequencing ability. Previous research has proposed that a sense of temporal continuity results from a combination of the ability to retain a sequence of events in working memory, and the ability to compare the stimuli in this sequence (Michon & Jackson, 1984).

Taken together, results lend support for the analysis of DF and DB as separate components; however, further investigation into the constructs being measured is needed. This study failed to validate Hale et al. (2002) finding that DB would predict attention problems and executive functioning in youth as reported by parents. From Baddeley's model (1992), the lack of predictive contribution of DB may reflect the extent to which the central executive needs to be engaged to complete the backward-span task. Better predictive value as well as increased impairment may emerge if a dual-task paradigm is used (Karatekin, 2004). The addition of the Letter-Number-Sequence task to the Wechsler Scales (Wechsler, 2003) may provide additional information on the contribution of working memory to attention and executive functioning as rated by parents. Further investigations with larger samples and homogenous groups are needed.

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