PROCESSING SPEED IN CHILDREN WITH CLINICAL DISORDERS

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The Processing Speed Index (PSI) was first introduced on the Wechsler Intelligence Scale, Third Edition (WISC-III; D. Wechsler, 1991), and little is known about its clinical significance. In a referred sample ($N = 980$), children with neurological disorders (ADHD, autism, bipolar disorder, and LD) had mean PSI and Freedom from Distractibility Index (FDI) scores that were below the group mean IQ and lower than Verbal Comprehension (VCI) and Perceptual Organization (POI). For these groups, Coding was lower than Symbol Search. The majority of these children had learning, attention, writing, and processing speed weaknesses. This pattern was not found in the other clinical groups. For children with depression, only PSI was low. Children with anxiety disorders, oppositional-defiant disorder, and mental retardation had no PSI weakness. PSI and POI were both low in children with traumatic brain injury and spina bifida. Implications for a revision of the WISC-III (WISC-IV; D. Wechsler, 2003) are discussed. © 2005 Wiley Periodicals, Inc.

Assessment of intellectual abilities in children with mental disorders using the Wechsler scales has become part of the diagnostic routine in many clinical and school settings. Because the Wechsler Intelligence Scale-Third Edition (WISC-III; Wechsler, 1991) surveys a broad range of cognitive functions, it is frequently used to help target specific areas that may be problematic for a child and to identify a child's cognitive strengths and weaknesses that might help to guide educational intervention. There is much debate over the validity of profile analysis. Some have argued that only Full Scale IQ is valid (Bray, Kehle, & Hintze, 1998). Others have supported the interpretation of the WISC-III factor or index scores, but not the less reliable subtest scores (Donders, 1996; Glutting, McDermott, Prifitera, & McGrath, 1994; McDermott, Fantuzzo, & Glutting, 1990; Oh, Glutting, & McDermott, 1999); however, proponents of subtest analysis have argued that subtests provide unique and meaningful information that is lost if only factors are analyzed (Kaufman, 1994; Kramer, 1993; Nyden, Billstedt, Hjelmquist, & Gillberg, 2001; Sattler, 2002). WISC-III studies have demonstrated consistent profiles for some clinical groups. For example, group mean scores for children with attention deficit hyperactivity disorder (ADHD), learning disability (LD), and autism were low on Freedom from Distractibility and Processing Speed relative to Verbal Comprehension and Perceptual Organization and low on Coding relative to Symbol Search (Mayes & Calhoun, 2003a; Mayes, Calhoun, & Crowell, 1998a; Mealer, Morgan, & Luscomb, 1996; Nyden et al., 2001; Prifitera & Dersh, 1993; Schwean, Saklofske, Yackulic, & Quinn, 1993).

The WISC-III comprises four factors: Verbal Comprehension Index (VCI), Perceptual Organization Index (POI), Freedom from Distractibility Index (FDI), and Processing Speed Index (PSI). PSI is a new factor not found in previous versions of the WISC. In the WISC-III standardization sample (Wechsler, 1991), PSI had the lowest correlation with Full Scale IQ (.58) in comparison to the other factors (VCI .90, POI .88, and FDI .68). PSI also had the lowest factor loading on general intelligence or g (.62), in contrast to loadings of .86 for VCI, .85 for POI, and .90 for FDI (Keith & Witta, 1997). Further, the two PSI subtests (Coding and Symbol Search) were among the four subtests with the lowest g loadings (Kaufman, 1994). These data all indicate that PSI is more independent of IQ than the other factors. Because PSI is relatively unique, this factor

may have clinical significance for individual children and diagnostic groups; however, PSI also had lower reliability ($M = .85$) than the other index coefficients of .87 to .94 (Wechsler, 1991).

Our study analyzed PSI and its respective subtests (Coding and Symbol Search) relative to other WISC-III scores in a large sample ($N = 980$) of children with various clinical disorders [e.g., ADHD, LD, autism, bipolar disorder, anxiety, depression, oppositional-defiant disorder (ODD), spina bifida, traumatic brain injury, and mental retardation]. Our purpose was to determine profile similarities and differences between groups that may be clinically, diagnostically, and educationally meaningful.

Method

Sample and Procedure

The sample was composed of children with clinical disorders ($N = 980$) who were evaluated in our psychiatry diagnostic clinic. Children were referred for learning, attention, and/or behavior problems. Only children with Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994) diagnoses agreed upon by both a child psychologist and a child psychiatrist were included in the sample. The psychological evaluation included (a) IQ, achievement, and neuropsychological tests, (b) teacher and parent questionnaires and rating scales, (c) a child interview and self-report scale, (d) clinical observations of the child, and (e) review of the child's developmental history, school transcripts from kindergarten to the present, and previous evaluations. The psychiatric evaluation entailed semistructured interviews with the child and parents, review of records, clinical observations of the child, and analysis of the questionnaire and rating scale data obtained from the parents and teachers. Clinical diagnoses and subsample sizes are listed in Table 1.

Children ranged in age from 6 to 16 years, with a mean of 9 years and an *SD* of 3. The mean IQ was 97 (*SD* = 19), with a range of 48 to 150. Twenty-seven percent of the children were

Table 1
Sample Diagnoses (N = 980)

n	Clinical Diagnosis
431	ADHD (attention deficit hyperactivity disorder, combined type) with or without a comorbid diagnosis
134	ADD (attention deficit hyperactivity disorder, predominantly inattentive type) with or without a comorbid diagnosis
91	Autism
64	Bipolar disorder[a]
29	Brain injury (traumatic injury such as closed head injury or anoxic brain injury)
19	Spina bifida with hydrocephalus
17	Anxiety disorder (generalized anxiety disorder, separation anxiety disorder, obsessive-compulsive disorder, or social phobia)
11	Depression (dysthymic disorder or major depression) with or without anxiety or oppositional-defiant disorder
9	Oppositional-defiant disorder with or without anxiety
7	Adjustment disorder
6	Psychotic disorder
162	Mental retardation (children with clinical disorders and an IQ below 80)

Note. Seventy-three percent of the children with an IQ $\geq$ 80 also had a learning disability in addition to their clinical diagnosis.
[a]Bipolar disorder and bipolar disorder-NOS (National Institute of Mental Health Research Roundtable, 2001).

female, 91% were White, and 9% were Black, Hispanic, or Asian. For 37% of the children, one or both parents had a professional or managerial occupation.

Instruments and Learning Disability Definition

Children were administered the 12 WISC-III subtests comprising the four Indexes (VCI, POI, FDI, and PSI) and the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992) reading, math, and writing subtests. All children in the study 8 years of age and older who had normal IQs ($\geq$80) were categorized as having or not having a learning disability (LD) in reading (either reading decoding or reading comprehension), math, or written expression. A cutoff age of 8 years was used because the WIAT Written Expression subtest cannot be administered to younger children. An IQ cutpoint of 80 was chosen because the WISC-III manual defines normal to above-normal intelligence as an IQ $\geq$ 80 (Wechsler, 1991) and because this is the cutoff used in most LD research studies (Anderson, Kutash, & Duchnowski, 2001; Casey, Rourke, & Del Dotto, 1996; Fletcher et al., 1998; Hall, Halperin, Schwartz, & Newcorn, 1997; Jimenez et al., 2003; Mayes et al., 1998a; Mayes, Calhoun, & Crowell, 2000). The WISC-III and the WIAT were used to compare IQ and achievement because these tests have a co-normed linking sample allowing for direct comparison of standard scores on the two tests (vs. comparing IQ and achievement test scores on different tests normed on different samples at different times). The WISC-III and WIAT regression equation controls for the correlation between tests, regression to the mean, and measurement error (Glutting et al., 1994). A learning disability was defined as a WIAT reading, math, or written expression subtest score significantly lower ($p < .05$) than predicted based on the child's WISC-III Full Scale IQ using the predicted achievement method specified in the WIAT manual (Wechsler, 1992). The predicted achievement method (vs. simple discrepancy) was employed so that children with high IQs would not be overidentified as having LD. All children classified with LD had one or more WIAT standard score below age level (<100). The ability–achievement discrepancy definition used in this study is consistent with the Individuals with Disabilities Education Act (Federal Register, 1999) and is the most conventional way to define LD (American Psychiatric Association, 1994; Fletcher, Shaywitz, & Shaywitz, 1999; Glassberg, Hooper, & Mattison, 1999; Gresham, MacMillan, & Bocian, 1996; Hoskyn & Swanson, 2000; Sattler, 2002; Tannock & Brown, 2000; Ward, Ward, Glutting, & Hatt, 1999). Seventy-three percent of the children were classified with LD.

Data Analyses

Three discrepancy scores were calculated to represent each child's Processing Speed performance relative to other WISC-III scores: (a) Full Scale IQ minus Processing Speed Index (IQ-PSI), (b) IQ minus Coding (IQ-Coding), and (c) IQ minus Symbol Search (IQ-Symbol Search). Coding and Symbol Search scores were converted into standard scores with a mean of 100 and an *SD* of 15 so that all test scores were comparable.

The significance of differences between obtained standard scores and the normal mean of 100 was determined with *z* scores. Analysis of variance (ANOVA) and post hoc Bonferroni *t* tests (to control for the number of comparisons made) were used to ascertain the degree of differences in scores between diagnostic groups. Dependent *t* tests were calculated to compare pairs of scores (e.g., PSI and FDI), and independent *t* tests were used to contrast scores obtained by two different groups. The effect size statistic, Cohen's *d* (Cohen, 1988), was calculated to indicate the practical significance of differences in mean scores between groups, and the binomial test was applied to ascertain the significance of score patterns. All tests of significance were two-tailed.

The accuracy of Processing Speed score patterns in predicting group membership was determined by calculating sensitivity (percentage of children correctly identified as having a specific

disorder), specificity (percentage correctly classified as not having the disorder), positive predictive power (PPP; percentage of children with the disorder among total number of children with an abnormal score), and negative predictive power (NPP; percentage without the disorder among the total number without the abnormal score).

<div align="center">RESULTS</div>

Index Score Patterns

For the total sample, mean PSI and FDI were significantly below the normal mean of 100 (PSI $z = 14.6$, FDI $z = 20.9$, $p < .0001$), and PSI was significantly higher than FDI, $t(979) = 5.5$, $d = .2$, $p < .0001$. Mean VCI was above the norm, and POI was not significantly below the norm ($z = 2.1$, $p > .01$). Mean IQ and Index scores for each diagnostic group are reported in Table 2.

Table 3 presents (a) mean Index scores that were lower than the mean IQ for each diagnostic group and lower than the normal population mean of 100, and (b) mean Index scores that were above both the diagnostic group mean IQ and normal population mean. Children with LD, autism, bipolar disorder, ADHD, and ADD had low scores on PSI and FDI. Children with spina bifida and brain injury had low scores on PSI and POI. Children with depression had a weakness only on PSI. Last, children with anxiety, ODD, and mental retardation had no relative weaknesses on PSI. Children with autism and children with ADD had a greater weakness in processing speed (IQ-PSI discrepancy score) than children with ADHD, $F(9,773) = 3.8$, $p < .0001$, Bonferroni $p = .002$, $d = .5$ and $p = .02$, $d = .4$.

Relationship Between Coding and Symbol Search

For the total sample, both Coding ($M = 90$) and Symbol Search ($M = 95$) were significantly lower than the normal mean of 100 ($z = 20.9$ and 10.4, $p < .0001$), and Coding was significantly lower than Symbol Search, $t(979) = 9.9$, $d = .3$, $d = .3$, $p < .0001$. Coding was less than Symbol

Table 2
Mean Full Scale IQ and Index Scores (N = 980)

Diagnosis	IQ	VCI	POI	FDI	PSI
Total sample	97	102	99	90	93
Mental retardation	68	76	73	69	69
IQ ≥ 80	103	107	104	94	97
Depression	102	104	104	106	93
Autism	103	106	105	95	92
ADD	106	111	106	93	98
Bipolar	99	102	103	91	92
Brain injury	96	101	95	99	91
Spina bifida	93	105	86	89	88
ADHD	104	107	105	94	100
Anxiety	109	111	106	106	109
Oppositional-defiant	102	109	97	105	103
Learning disability (LD)	103	107	105	92	96

Note. All children with LD also have a clinical diagnosis in addition to LD and are included in the other diagnostic groups as well. VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; FDI = Freedom from Distractibility Index; PSI = Processing Speed Index.

Table 3
Mean Index Scores Relative to the Diagnostic Group Mean IQ and the Normal Mean of 100

Diagnosis	Below Group IQ and 100			Above Group IQ and 100		
Learning disability	FDI*	PSI*		VCI	POI	
Autism	FDI*	PSI*		VCI	POI	
Bipolar	FDI*	PSI*		VCI	POI	
ADD	FDI*	PSI		VCI	POI	
ADHD	FDI*	PSI		VCI	POI	
Spina bifida	FDI*	PSI*	POI*	VCI		
Brain injury		PSI*	POI	VCI		
Depression		PSI		VCI	POI	FDI
Anxiety				VCI		PSI
Oppositional-defiant			POI	VCI	FDI	PSI
Mental retardation						

*Significantly below the normal mean of 100 ($z = 3.2 - 11.4$, $p < .01$). FDI = Freedom from Distractibility Index; PSI = Processing Speed Index; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index.

Search for all of the 11 diagnostic subgroups (binomial test $p = .001$). Symbol Search was significantly above the norm for children with an anxiety disorder ($z = 2.6$, $p = .009$).

Group Prediction

Each diagnostic group was dichotomized according to whether the mean PSI score was above or below the group mean IQ. Mean PSI scores for children with depression or a neurological disorder (ADHD, ADD, LD, autism, bipolar disorder, brain injury, and spina bifida) were below IQ. Mean PSI was not below IQ for children with an anxiety disorder or ODD without LD. The mean IQ-PSI difference score for children with neurological disorders or depression was 6.0, in contrast to a mean of −2.5 for children with anxiety or ODD without LD, $t(799) = 2.7$, $p = .008$, $d = .6$.

The extent to which IQ-PSI differentiated the neurological/depressed and anxious/ODD groups is presented in Table 4. If PSI was less than IQ, children were assigned to the neurological/depressed group. The criterion for assignment to the anxious/ODD group was PSI ≥ IQ. Using these criteria, children were identified with 65% accuracy. When FDI was considered with PSI,

Table 4
Differentiation of Children with Neurological Disorders or Depression (n = 783) from Children with Anxiety and/or Oppositional-Defiant Disorder (n = 18)

	PSI < IQ	(FDI + PSI) ÷ 2 < IQ
Positive predictive power	98%	99%
Negative predictive power	4%	6%
Sensitivity	66%	79%
Specificity	56%	56%
Total accuracy	65%	79%

PSI = Processing Speed Index; FDI = Freedom from Distractibility Index.

Table 5
*Percentage of Children with Weaknesses in Processing Speed and
Freedom From Distractibility*

Diagnosis	PSI < IQ	FDI < IQ	(FDI + PSI) ÷ 2 < IQ
Autism	79%*	75%*	80%*
ADD	74%*	87%*	84%*
Learning disability	70%*	83%*	86%*
Bipolar	67%*	75%*	78%*
ADHD	60%*	82%*	80%*
Depression	82%	36%	55%
Spina bifida	68%	74%	68%
Brain injury	62%	38%	52%
Anxiety	53%	47%	65%
Oppositional-defiant	44%	56%	33%

*Significantly greater than expectancy based on chance (binomial test $p < .01$). PSI = Processing Speed Index; FDI = Freedom from Distractibility Index.

differentiation between the neurological/depressed and anxious/ODD groups improved to 79%. Mean IQ − [(FDI + PSI) ÷ 2] was 7.8 for the neurological/depressed group and −0.8 for the anxious/ODD group, $t(799) = 3.8$, $p < .0001$, $d = 1.0$.

Subgroups Within Diagnostic Groups

Though group mean scores showed significant processing-speed problems in the clinical sample, there was much individual variation, even within diagnostic groups. For example, among children with normal intelligence, 74% of children with ADD had a weakness in processing speed (PSI < IQ), but 26% did not. Many children with ADHD were slow in processing speed, but a large subgroup (40%) was not. The percentage of children in each diagnostic group who had weaknesses in PSI and in PSI and FDI combined are reported in Table 5.

Discussion

Profile Analysis

Children with neurological disorders (ADHD, ADD, autism, bipolar disorder, and LD) have similar mean WISC-III profiles characterized by lower PSI and FDI than VCI and POI scores. This suggests processing speed, attention, and writing weaknesses. In contrast, children with anxiety disorder, ODD, depression, and mental retardation do not have this particular cluster of weaknesses. Learning problems also are more common in the neurological groups. Children with ADHD, ADD, autism, and bipolar disorder in our study had a high incidence of LD (75%) versus children with anxiety, depression, and ODD (20%).

The majority of children with ADHD, ADD, autism, and bipolar disorder have LD *and* processing speed, attention, and writing weaknesses (i.e., PSI + FDI < VCI + POI). Therefore, these neurological weaknesses are interrelated and often occur together. Psychologists need to be aware of the likely coexistence of such problems and insure that referred children are properly assessed in these areas. If problems are identified, educational interventions can address these problems. Unfortunately, an evaluation of written expression is often neglected in LD research (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002) and in school psychological evaluations, even though this is the most common type of LD (Mayes & Calhoun, 2003b; Mayes et al., 2000). Many

effective interventions are available for students who have writing problems (Danoff, Harris, & Graham, 1993; Graham, Harris, & Larsen, 2001; Lane & Lewandowski, 1994; MacArthur, 1996, 2000; McNaughton, Hughes, & Ofiesh, 1997; Sawyer, Graham, & Harris, 1992; Vaughn, Gersten, & Chard, 2000).

Processing Speed

Students with slow processing speed may have problems with rate of learning, comprehension of new information, speed of performance, and mental fatigue (Prifitera, Weiss, & Saklofske, 1998). According to Kaufman (1994), the PSI is "related to clinical, personality, behavioral, and neurological variables" (p. 209). Our findings certainly support this contention. Our results and those from previous studies show that children with ADHD, LD, and autism score low on both PSI and FDI relative to VCI and POI whereas typical children and children with mild mental retardation do not (Mealer et al., 1996; Naglieri, Goldstein, Iseman, & Schwebach, 2003; Newby, Recht, Caldwell, & Schaefer, 1993; Nyden et al., 2001; Prifitera & Dersh, 1993; Saklofske, Schwean, Yackulic, & Quinn, 1994; Schwean et al., 1993; Snow & Sapp, 2000; Wechsler, 1991). ADHD, LD, and autism have a neurological basis (Fiedorowicz et al., 2001; Hooper & Tramontana, 1997; Learning Disabilities Roundtable, 2002; Raskind, 2001; Seidman et al., 1995; Tramontana, Hooper, Curley, & Nardolillo, 1990), which supports Kaufman's position that PSI is negatively impacted by neurological variables.

Kaufman (1994) also noted that PSI is adversely affected by fine-motor problems. For all diagnostic groups in our study, scores on Coding (writing speed) were lower than on Symbol Search (visual mental speed). This is most likely a consequence of the specific writing weakness that many children with clinical disorders have.

Kaufman (1994) also hypothesized that PSI can be affected by motivation and anxiety. Our analyses yielded some interesting results in this respect. As expected, children with depression performed poorly on PSI relative to other scores, which probably reflects their depressive symptomatology (i.e., underarousal, apathy, low energy, and poor motivation). Children with ODD also might be expected to have low scores on PSI because of opposition, resistance, and low motivation, but they did not. This suggests that even children with ODD can be motivated during psychological testing.

Surprisingly, children with anxiety disorders performed well on PSI, which was the second highest of their mean index scores. Little research is available on anxiety and neuropsychological performance, and most studies focus on the disruptive effect of test anxiety on performance (Hooper & Tramontana, 1997); however, in our study of children with anxiety disorders (most of whom had generalized anxiety disorder), anxiety may have had a motivating (vs. paralyzing) effect. Interestingly, when an anxiety disorder was added to other clinical disorders (e.g., ADHD, ADD, and depression), processing speed improved. Other studies have shown that anxiety may have positive effects. For example, a large multisite study (MTA Cooperative Group, 1999) found that children with ADHD plus an anxiety disorder had a significantly better response to counseling and behavior therapy than children with ADHD and no anxiety disorder.

Our results also show significant processing speed differences between children with ADHD and ADD. Though both groups scored low on PSI relative to IQ, the PSI deficit was greatest for children with ADD. Therefore, when hyperactivity is added to ADD (making ADHD), PSI improves. This finding provides external validity for the DSM-IV distinction between ADHD combined type and predominantly inattentive type (commonly referred to as ADD). The finding also supports the position held by many (Barkley, DuPaul, & McMurray, 1990; Cantwell & Baker, 1992; Carlson & Mann, 2002; Goodyear & Hynd, 1992; McBurnett, Pfiffner, & Frick, 2001) that there is an ADHD inattentive subtype not simply characterized by inattention (as described in the DSM-IV) but also

by slow performance speed, sluggish cognitive tempo, underarousal, low energy, and lethargy (i.e., hypoactivity). Performance on PSI may be helpful in distinguishing between different ADHD/ ADD subtypes.

Implications for the WISC-IV

On the WISC-IV, PSI consists of Coding and Symbol Search (as on the WISC-III), but the other Indexes are modified. Arithmetic is replaced with Letter–Number Sequencing on FDI (now called Working Memory Index or WMI). Therefore, WMI is not confounded by math ability (as is FDI) and may be a more accurate measure of attention than FDI. VCI now has one less subtest and is composed of Similarities, Vocabulary, and Comprehension. POI (now called Perceptual Reasoning Index or PRI) also has only three subtests, two of which are new. Block Design is retained, and Picture Completion, Picture Arrangement, and Object Assembly are replaced with two untimed, motor-free, visual reasoning tests (Picture Concepts and Matrix Reasoning). Therefore, PRI has only one timed visual-motor test (Block Design), in contrast to three on the WISC-III POI. Now that a child's performance speed and fine-motor coordination will have less of an impact on PRI, this factor may be even more distinct from PSI than was POI. Preliminary WISC-IV data (Wechsler, 2003) are consistent with our WISC-III findings. For children with ADHD, autism, and LD, the lowest mean WISC-IV Index scores are WMI and PSI, and Coding is lower than Symbol Search in these groups.

Another potentially significant WISC-IV change is that all four of the WMI and PSI subtests are included in the calculation of Full Scale IQ, as opposed to only two of the four FDI and PSI subtests on the WISC-III. Therefore, children with low WMI and PSI scores relative to the other index scores may have a lower IQ on the WISC-IV than on the WISC-III. This would include most children with ADHD, ADD, LD, autism, and bipolar disorder. This is unfortunate because FDI/ WMI and PSI scores can be affected by a number of variables unrelated to intelligence (Kaufman, 1994), as shown in our study. When there is significant factor or subtest scatter (as for many clinical groups), Full Scale IQ is an unreliable measure of intelligence (Hale, Fiorello, Kavanagh, Hoeppner, & Gaither, 2001). Therefore, for children with neurological disorders and depression, VCI and PRI may be better indicators of overall IQ than the WISC-IV Full Scale IQ.

Future Research

Limitations of our study are the unequal subgroup sizes and the small sizes for some of the diagnostic groups. Further, though significant mean PSI and FDI differences were found between clinical groups, there was much individual variation, even within diagnostic subgroups. As a result, the diagnostic validity of PSI and FDI alone is poor. While low PSI and FDI scores by themselves do not predict clinical diagnoses, the identification of weaknesses in these areas is helpful in understanding the neuropsychological profiles of these children and may have important implications for educational intervention (i.e., selecting instructional methods that teach to the child's verbal and nonverbal strengths while remediating, compensating for, and circumventing the attention, writing, and performance speed weaknesses). Research is needed using additional ability test scores and multivariate analyses to determine if unique and clinically meaningful profiles can be identified that differentiate clinical groups and have diagnostic utility.

Conclusion Regarding Profile Analysis

Our results support the position that profile analysis provides reliable and useful information about the strengths and weaknesses of children with various clinical disorders. Many studies, including ours, consistently demonstrate a weakness in Processing Speed and Freedom from Distractibility relative to Verbal Comprehension and Perceptual Organization for children with ADHD,

LD, and autism (Mayes et al., 1998a; Mayes, Calhoun, & Crowell, 1998b; Mayes & Calhoun, 2003a; Mealer et al., 1996; Naglieri et al., 2003; Newby et al., 1993; Nyden et al., 2001; Prifitera & Dersh, 1993; Saklofske et al., 1994; Schwean et al., 1993; Snow & Sapp, 2000; Wechsler, 1991). Consistent with our study, other research has shown that children with traumatic brain injury perform more poorly on Processing Speed and Perceptual Organization than on the verbal factors (Donders & Warschausky, 1997; Hoffman, Donders, & Thompson, 2000; Kay & Warschausky, 1999). For our study and all published clinical studies reporting subtest scores, Coding is lower than Symbol Search. These reliable and distinctive findings support profile analysis at both the subtest and factor levels. If only PSI had been analyzed in these studies, the consistent and clinically meaningful finding of low Coding (writing speed) relative to Symbol Search (visual mental speed) would have been lost.

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