

A cross-etiology comparison of the socio-emotional behavioral profiles associated with attention-deficit/hyperactivity disorder and specific language impairment

SEAN M. REDMOND & ANDREA C. ASH

Department of Communication Sciences and Disorders, University of Utah, Salt Lake City, UT, USA

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Abstract

Cross-etiology comparisons provide important information that can help practitioners establish criteria for differential diagnosis and tailor interventions towards the source of children's difficulties. This study examined the extent to which parent rating scales of socioemotional behavioral difficulties differentiate cases of attention-deficit/hyperactivity disorder (ADHD) from cases of specific language impairment (SLI), and typical development (TD). Parents of 60 children (7–8 years) completed the Child Behavior Checklist (Achenbach & Rescorla, 2001) and the Conners Parent Rating Scale-Revised (Conners, 2004). Significant differences were observed between ratings provided for the children with ADHD and the children with SLI and TD across several scales which assessed behavioral and emotional difficulties. Most of the observed differences between ratings provided for the SLI and TD groups were not significant when nonverbal IQ was treated as a covariate or when syndrome scales were adjusted for the presence of language and academic items. In contrast, these adjustments had little impact on observed differences between the children with ADHD and the other groups. These results highlight important and clinically useful differences between the scope and the scale of socioemotional behavior difficulties associated with ADHD and SLI.

Keywords: ADHD, assessment, differential diagnosis, specific language impairment

Introduction

Comparisons between children with neurodevelopmental disorders and children with typical development provide helpful but incomplete information regarding the nature of affected children's difficulties. Cross-etiology comparisons are necessary in order to establish whether a particular pattern of strengths and weaknesses is characteristic of and unique to a particular group. Such comparisons not only help efforts to refine taxonomic classifications and establish criteria for differential diagnosis but also they are necessary to the successful identification of genetic and environmental mechanisms (Mervis, 2004). Comparisons between different atypical groups are particularly helpful in situations where clinical designations involve potentially overlapping symptoms or when these designations frequently display comorbidity in therapeutic settings.

In this study, we compared the socioemotional behavioral profiles of two common and commonly co-occurring neurodevelopmental disorders: specific language impairment (SLI) and attention-deficit/hyperactivity disorder (ADHD).

SLI is the term presently used to refer to those cases of developmental language disorder which occurs in the absence of significant limitations in hearing acuity, cognitive development, or social development. It represents the most common form of language disorder affecting approximately 5–7% of the school-age population (Johnson et al., 1999; Tomblin et al., 1997). Individuals affected with SLI represent a fairly heterogeneous group both in terms of the severity of their primary expressive and receptive language symptoms as well as in the extent to which additional areas (academics, peer relations) are affected (cf. Schwartz, 2009). As a group, however, children with SLI have long been characterized as being at risk for ADHD (Baker & Cantwell, 1983, 1987a, 1987b; Beitchman, Hood, & Inglis, 1990; Beitchman, Hood, Rochon, & Peterson, 1989; Benasich, Curtiss, & Tallal, 1993; Chess & Rosenberg, 1974; Cohen, Davine, & Meloche-Kelly, 1989; Lindsay, Dockrell & Strand, 2007; Love & Thompson, 1988).

ADHD applies to a profile of behavioral difficulties that include developmentally inappropriate levels of inattention, hyperactivity, and impulsivity. Historically, the prevalence of ADHD had been estimated at approximately 3–5% of the student population (e.g. American Psychiatric Association, 2004; Scahill & Schwab-Stone, 2000). However, recent reports now document a sharp increase over the last decade in the rate of ADHD diagnoses, raising concerns of over-treatment. For example, data from the National Survey of Children's Health indicate that for the 2011–2012 academic year 15% of school-age boys and 7% of girls (11% overall) had a diagnosis of ADHD (Center for Disease Control and Prevention, March 2013), making ADHD the most commonly diagnosed disorder in childhood. From this perspective, it is not surprising that ADHD has frequently been found within study samples of SLI.

There is some evidence that ADHD may be co-occurring with SLI at levels that exceed expectations (cf. Mueller & Tomblin, 2012). Unfortunately, the nature of this co-occurrence is unclear and several obstacles make it difficult to synthesize across existing reports. For example, many investigations did not include control groups into their designs (Baker & Cantwell, 1982, 1983, 1987a, 1987b; Cantwell & Baker, 1985; Chess & Rosenberg, 1974; Elbro, Dalby, & Maarbjerg, 2011; Lindsay & Dockrell, 2008; Lindsay et al., 2007; Love & Thompson, 1988; St. Clair, Pickles, Durkin, & Conti-Ramsden, 2011; Tirosh & Cohen, 1998). The absence of typically developing comparison groups is especially problematic for tracking disorders like ADHD that have experienced dramatic increases in diagnosis rates. Most studies have utilized clinical convenience samples of affected children (e.g. Baker & Cantwell, 1982, 1983, 1987a, 1987b; Benasich et al., 1993; Cantwell & Baker, 1985; Chess & Rosenberg, 1974; Cohen et al., 1998; Lindsay & Dockrell, 2008; Lindsay et al., 2007; Love & Thompson, 1988; Redmond & Rice, 1998, 2002; Snowling, Bishop, Stothard, Chipchase, & Kaplan, 2006; St. Clair et al., 2011; Tirosh & Cohen, 1998; Willinger et al., 2003). A smaller number of studies have been based on epidemiologically ascertained groups (Beitchman et al., 1989, 1990; Tomblin, Zhang, Buckwalter, & Catts, 2000; Whitehouse, Robinson, & Zubrick, 2011). On one hand, clinical samples provide important information because they reflect the kinds of cases practitioners are likely to have referred to them. On the other hand, clinical samples are known to be biased towards more severe and complex cases, which artificially elevate co-occurrence rates (cf. Berkson, 1946). Surprisingly, this distinction accounts for very little of the variability in reported rates of ADHD and SLI co-occurrence (clinical sample range: 3–54.5%; epidemiological sample range: 17.7–59%).

Another problematic feature is the extent to which studies have separated cases of SLI from cases of language impairment with co-occurring cognitive and other limitations (i.e. “non-specific language impairment”). Some investigations have made this distinction

(Benasich et al., 1993; Clegg, Hollis, Mawhood, & Rutter, 2005; Elbro et al., 2011; Law, Rush, Schoon, & Parsons, 2009; Redmond & Rice, 1998, 2002; Snowling et al., 2006). Other investigations have used combined samples representing a variety of language impairments (e.g. Beitchman, Peterson, & Clegg, 1988; Gualiteri, Ursala, Van Bourgondien, & Saleeby, 1983; Willinger et al., 2003). Distinctions between SLI and other language impairments are important because developmental factors besides verbal proficiency may have been responsible for the observed links between language impairments and ADHD. Some studies provide evidence that nonverbal IQ represents an important independent predictor of children's behavioral symptoms (Benasich et al., 1993; Elbro et al., 2011; Gualtieri et al., 1983; Law et al., 2009; Silva, Justin, McGee, & Williams, 1984). Other investigations reported that nonverbal IQ was not a significant contributor (Botting & Conti-Ramsden, 2000; St. Clair et al., 2011; Tirosch & Cohen, 1998; Wadman, Botting, Durkin, & Conti-Ramsden, 2011). Other factors besides nonverbal IQ introduce confounds. One widely cited study combined children learning English as a second language with monolingual children in their cases of language impairment (Love & Thompson, 1998).

Synthesizing across investigations is complicated further by other considerations. For example, a large variety of procedures have been used to evaluate the socioemotional behavior problems of children with SLI preventing direct comparisons. In some cases, ADHD symptoms can be separated from overall problem composite scores (Beitchman et al., 1989; Redmond & Rice, 2002; Rescorla, Ross, & McClure, 2007; Snowling et al., 2006; Stanton-Chapman, Justice, Skibbe, & Grant, 2007; Tomblin et al., 2000; Willinger et al., 2003). In other reports, ADHD symptoms contributed to a general estimate of socioemotional behavioral risk (Beitchman et al., 2001; Schoon, Parsons, Rush, & Law, 2010; Whitehouse et al., 2011). Information regarding the extent to which the specific ADHD symptom clusters of inattention, hyperactivity, and distractibility are selectively affected in children with SLI has been extremely limited (Love & Thompson, 1988; Mueller & Tomblin, 2012).

Direct comparisons of the socioemotional profiles associated with ADHD and SLI have also been in short supply. Helland, Helland, and Heiman (in press) found significantly more clinical symptoms within their group of 10-year-old children with ADHD across a broader range of difficulty areas than in their group of 8-year-old children with SLI. After controlling for potential age effects, these investigators reported moderate-to-large effect sizes for parental ratings of emotional problems, peer problems, conduct problems and hyperactivity-inattention symptoms. However, a significant portion of children in the SLI group had scored within the clinical range suggesting potential overlap between the groups. Because hyperactivity and inattention symptoms were combined within the rating scale used it was unclear whether inattention, hyperactivity, or both were responsible for the elevation of symptoms within the SLI group. More comprehensive comparisons between these two clinical designations are warranted to further determine if the difficulties associated with SLI are similar in scope and scale to the difficulties associated with ADHD.

Several aspects of ADHD and its diagnosis make a comparison between ADHD and SLI particularly informative. ADHD is a highly comorbid condition associated with a complex profile of socioemotional and behavioral difficulties, and there are a variety of conditions that have symptoms similar to ADHD. Co-occurring anxiety, depression, and externalizing disorders have been common in epidemiological samples of children with ADHD and disorders like post-traumatic stress disorder and sleep disturbances may present in ways that mimic ADHD (see Barkley, 2006 for a review). This creates a situation where differential diagnosis and the identification of comorbidity are regarded as paramount to effective case management (Brock, Jimerson, & Hansen, 2009; Brown, 2000). Unfortunately, these issues have not been taken up in studies on SLI.

There are no diagnostically validated behavioral measures of inattention, hyperactivity, or impulsivity (Barkley, 2006). Efforts to establish behavioral metrics of ADHD have yielded mixed results. Although significant weaknesses across various performance measures of response inhibition, vigilance, working memory, and planning have been consistently reported in study samples of ADHD, effect sizes have also consistently been in the medium range, compromising both positive and negative predictive powers (Nigg, Willcutt, Doyle, & Sounga-Barke, 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Furthermore, weaknesses in these areas have proven to be poorly suited for differential diagnosis in that they appear with regularity in non-ADHD study samples of children with various neurodevelopmental conditions including intellectual disability, reading disability, conduct disorder, schizophrenia, sleep disorders, and SLI (cf. Archibald & Joanisse, 2009; Cardy, Tannock, Johnson, & Johnson, 2010; Riccio, Reynolds, & Lowe, 2001; Willcutt et al., 2005).

Standardized rating scales documenting levels of informant concern for inattention, hyperactivity, and impulsivity feature prominently in current evaluations of ADHD and its differential diagnosis. Parental rating scales represent a particularly effective method of collecting information because parents are in a unique position to observe their children under a variety of circumstances and for extensive periods of time relative to other informants. Biederman, Keenan, & Faraone (1990) reported that when parent rating scales were positive for ADHD, there was a 90% probability that teacher reports would also be positive and suggested that for this reason parent rating scales were sufficient in most cases for confirming ADHD status. The predictive relationship between parent and teacher ratings appears to work in only one direction. Very low levels of concordance ($r < 0.30$) between teacher ratings and parent ratings have been common across study samples (cf. Barkley, 2006), suggesting that teacher identified ADHD symptoms are often elevated relative to parent identified symptoms.

Under some contexts, linguistic proficiency might be conflated by teacher informants with the core symptoms of ADHD. For example, inattention or distractibility during classroom activities that are due to a student's primary difficulties with the semantic content or syntactic form of instruction might be misattributed to ADHD. There is some direct evidence that children with language and reading disabilities are at risk for over-identification when teacher ratings are used. Charach, Chen, Hogg-Johnson, and Schachar (2009) compared teacher ratings of ADHD symptoms using the Conners' Teacher Rating Scale-Revised (CTRS-R) against a reference standard of blinded DSM-IV psychiatric interviews and found that teacher ratings of children with language impairments provided twice as many false positives as true positives (19.0% versus 9.5%). Elevated levels of false positives were also reported among children with reading disabilities (35.2% versus 21.6%). In contrast, children with low IQ levels were identified at comparable rates by the two methods (18.3% versus 18.0%), suggesting that over-identification of ADHD symptoms relative to the standard of psychiatric interview was not necessarily a general property of the CTRS-R protocol but rather teacher ratings were particularly vulnerable to misattribution when applied to cases of language impairment and reading disability. Teacher rating scales have figured prominently in reports of elevated co-occurrence of ADHD in study samples of SLI (e.g. Baker & Cantwell, 1987a, 1987b; Beitchman et al., 1989; Lindsay et al., 2007; Mueller & Tomblin, 2012; St. Clair et al., 2011; Tomblin et al., 2000).

Overlapping symptoms represents a long-standing issue in the identification of ADHD that has been primarily addressed by examining the consequences of modifying clinical criteria to account for the overlap (see Milberger, Biederman, Faraone, Murphy, & Tsuang, 1995 for an example of criteria adjustments that successfully differentiated pediatric ADHD symptoms from depression, anxiety, and bipolar disorder symptoms). Unfortunately, the issue of overlapping symptoms between ADHD and SLI has received very little attention. Redmond and Rice (1998) examined the impact of removing language and academic symptoms from parent and teacher ratings

collected on children with SLI and typically developing controls and found that observed differences between the groups became non-significant across most of the syndrome scales. Redmond (2002) reviewed several widely used behavioral rating scales and found that all of them contained items that could be construed as primary symptoms of language impairment or academic difficulties. These items typically factored into scales designed to assess social maturity, emotional difficulties, and inattention problems. Redmond (2002) recommended that to control for potential measurement artifacts, practitioners should remove these items from the scoring of ratings scales when used with children with developmental language disorders. However, one potential risk of subtracting overlapping symptoms from standardized protocols is it may increase “false negative” or “miss” rates and compromise the capacity of an instrument to identify cases of comorbidity. One way to test the tradeoffs inherent in removing overlapping symptoms from clinical protocols would be to compare the diagnostic integrity of unadjusted and adjusted rating scales on samples of children with known ADHD, SLI, and typical developing status.

The possibility that there might be different mechanisms behind the socioemotional behavioral difficulties associated with ADHD and SLI warrants further investigation. Specific questions addressed in this study were the following:

- (1) Are there significant differences in the socioemotional behavioral profiles associated with ADHD and SLI status in 7- to 8-year old children?
- (2) To what extent do socioemotional differences between children with SLI and children with TD remain when variability in nonverbal abilities are treated as a covariate?
- (3) What impact does removing language and academic items from protocols have on the diagnostic accuracy of ADHD symptom scales?

Our predictions for the first question were based on Redmond and Rice’s (1998) supposition that the socioemotional behavior difficulties associated with SLI are probably not homologous to those associated with ADHD or to other psychiatric disorders. Consistent with a large body of research on the topic, we predicted that ADHD status would be associated with a complex socioemotional behavioral profile that reflects a broad range of difficulties in addition to the primary symptoms of inattention, hyperactivity, and impulsivity (e.g. anxiety/depression, social withdrawal, aggressive behavior, oppositional behavior, peer difficulties, psychosomatic symptoms, etc.). In contrast, we predicted SLI status would be associated with a much smaller and more circumscribed set of clinical symptoms and that these symptoms would largely reflect the semantic and the syntactic limitations associated with SLI and the social penalties associated with children’s limited verbal proficiency (inattention and peer difficulties). Consistent with previous reports, we predicted that nonverbal abilities would be responsible for some of the observed differences between the children with SLI and the children with TD. Finally, we predicted that removing language and academic items from symptom scales would result in improved diagnostic precision.

Method

Procedure

Data for this study were collected from parents as a part of a larger investigation of the psycholinguistic and social characteristics of children with SLI and ADHD (Redmond, 2011; Redmond, Thompson, & Goldstein, 2011). Children participated in two-to-three testing sessions lasting approximately 90 min each. During these sessions, parents provided the project with demographic and developmental information and evaluated their children’s socioemotional behavior problems using standardized rating scales. Ethical approval was secured from the University of Utah Institutional Review board and written consent was obtained from participants.

Table 1. Characteristics of children rated: Group means (*M*), standard deviations (*SD*), and ranges.

	ADHD (<i>n</i> = 20)			SLI (<i>n</i> = 20)			TD (<i>n</i> = 20)			<i>F</i> (2, 57)	Contrasts
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range		
Age (months)	94.30	7.4	85–107	94.20	7.9	84–107	93.95	6.4	85–107	0.01	ADHD = SLI = TD
Maternal education ^a	3.55	0.9	2–5	3.35	0.9	2–5	3.85	1.20	1–5	1.20	ADHD = SLI = TD
Nonverbal ^b	101.50	10.3	83–120	97.75	8.2	88–120	110.35	10.4	91–126	9.22***	TD > ADHD = SLI
Verbal ^c	20.90	2.7	17–25	12.50	2.7	8–17	22.60	2.8	17–27	77.24***	ADHD = TD > SLI
DSM-ADHD ^d	72.75	5.2	67–80	56.80	7.7	50–73	53.30	4.6	50–63	61.81***	ADHD > SLI = TD

^aScale of 1 = some high school and 5 = some graduate school/graduate degree.

^bNaglieri Nonverbal Ability Test, standard score (*M* = 100; *SD* = 15).

^cClinical Evaluation of Language Fundamentals, 4th Ed. – Screening Test (range for 5- to 8-year olds = 0–28; criterion scores: 7 years = 16; 8 years = 18).

^dChild Behavior Checklist, DSM-IV ADHD syndrome scale, *T* score (higher values indicate elevate levels of attention/impulsivity difficulties).

p* < 0.05, *p* < 0.01, ****p* < 0.001.

Participants

The majority of ratings were provided by mothers (58/60). The children evaluated were 7- to 8-year-old monolingual Standard American English speakers, predominately white and non-Hispanic and from relatively advantaged households (see Redmond et al., 2011 for details). Information was collected on 20 children with SLI, 20 children with ADHD, and 20 typically developing controls (TD). Table 1 presents the characteristics of the children who were evaluated.

The children with SLI and the children with ADHD were very similar across key variables including age, maternal education levels, and nonverbal test scores. Differences between the clinical groups and the TD group were present. Even though both clinical groups included children who performed in the “above-average” range in terms of nonverbal abilities and the TD group included children in the “low-average” range, the TD group presented with significantly higher mean levels of performance. The observed 8–10 point advantage in nonverbal standard scores in the TD control group was consistent with previous investigations of ADHD and SLI when participants are recruited from similar communities (Frazier, Demaree, & Youngstrom, 2004; Schwartz, 2009).

All the children were required to pass an eligibility protocol which confirmed the presence of articulation skills and nonverbal abilities within the normal range as well as normal hearing acuity (see Redmond et al., 2011 for details). Recruitment and ascertainment procedures used to assign children to one of the three groups are presented below.

ADHD group (15 boys and 5 girls)

Clinical psychologists within the community recruited potential participants with a diagnosis of combined-type ADHD from their caseloads for the study. Recruitment of participants with ADHD was supplemented by notices posted on the Utah chapter of Children and Adults with Attention-Deficit/Hyperactivity website. Inclusion in the ADHD group required a diagnosis of combined-type ADHD by an independent health-care professional and parental ratings above the 93rd percentile (*T* score ≥ 67) on the Child Behavior Checklist DSM-ADHD scale (CBCL: Achenbach & Rescorla, 2001). The CBCL DSM-ADHD scale has been shown to correlate moderately well ($r = 0.80$) with DSM-IV diagnoses of combined-type ADHD based on clinical interviews (p. 130) and has demonstrated excellent levels of sensitivity and specificity across independent investigations (Aebi, Winkler, & Steinhausen, 2010), supporting its use as a criteria for ADHD

status. None of the children in the ADHD group had concomitant diagnoses of intellectual disability, autism, pervasive developmental disability (PDD), or language impairment. Nineteen of the 20 children in the ADHD group were receiving medication for their behavioral difficulties when they participated in the investigations. Parents were instructed to provide ratings of their children's behavior when they are not medicated.

SLI group (12 boys and 8 girls)

Certified speech language pathologists (SLP) within the community helped us to recruit potential participants with SLI by sending out recruitment flyers to the families of those children on their caseloads who presented with language impairments (i.e. children were not recruited who were receiving SLP services for speech impairments). Children in the SLI group had all been identified as having language impairment by an independent SLP and were receiving services at the time of the study. Inclusion in the SLI group required performance below the appropriate cutoff score for their age on the Clinical Evaluation of Language Fundamentals–Fourth Edition Screening Test (CELFST-4: Semel, Wiig, & Secord, 2004). Reported sensitivity and specificity rates for the CELFST-4 against the reference standard of enrollment in clinical services are 0.92 and 0.88 for 7- and 8-year-old children (p. 25). Test–retest reliability associated with this age range is also sufficient ($r = 0.89$; p. 27), making the CELFST-4 a suitable criteria for SLI status. None of the children in the SLI group had concomitant diagnoses of intellectual disability, autism, PDD, or ADHD.

TD group (11 boys and 9 girls)

Recruitment notices were sent home to families of typically developing children attending the same schools that children from the clinical groups were attending. Recruitment of participants with TD was also supplemented by notices posted at community bulletins. None of the children in the TD group were receiving school-based or clinic-based services for cognitive, language, learning, reading, or socioemotional behavioral difficulties. All the children in the TD group performed within normal limits on the CELFST-4 and the CBCL DSM-IV ADHD measures.

Measures

Nonverbal measure

In addition to providing a confirmation that children's nonverbal abilities were within the normal range (i.e. standard scores 80 and above), the *Naglieri Nonverbal Abilities Test-Individual Administration* (NNAT: Naglieri, 2003) served as a covariate in some of the analyses. The NNAT consists of 72 items which assess pattern completion, reasoning by analogy, and serial reasoning. It is similar in format to Raven's Standard Progressive Matrices and these two instruments demonstrate moderately high levels of correlation ($r = 0.78$; p. 51). Sensitivity and specificity rates associated with identifying intellectual disabilities against the reference standard of enrollment in clinical services are 0.69 and 0.98 (p. 51). The NNAT manual provides information on the performance of a sample of 30 children with previously diagnosed language impairments (age range: 5–17 years; mean age: 8.6 years) and reports group performance within normal limits ($M = 92.3$; $SD = 19.8$; p. 53).

Socioemotional behavioral measures

Parents provided norm-referenced information regarding the scale and scope of their children's socioemotional behavioral difficulties by completing the *Child Behavior Checklist* (CBCL Achenbach & Rescorla, 2001) and the *Conners Parent Rating Scale-Revised Long*

version (CPRS-R:L Conners, 2004). These two measures represent the most commonly used instruments for the identification of pediatric ADHD and other socioemotional behavior disorders (Brock et al., 2009). The CBCL consists of 113 items that parents endorse as problems that are “not true,” “somewhat or sometimes true,” or “very true or often true” when applied to their child’s behavior. The 80 items that constitute the CPRS-R:L are rated on a similar scale (“not true,” “just a little true,” “pretty much true,” and “very much true”). Higher scores indicate higher levels of parental concern. Both the CBCL and the CPRS-R:L provide examiners with syndrome scales that have been derived from statistical analyses and reflect clusters of consistently co-occurring socioemotional behavior problems. The CBCL consists of eight primary syndrome scales (*Anxious, Withdrawn, Social Problems, Thought Problems, Attention Problems, Rule-Breaking Behavior, and Aggressive Behavior*), as well as two secondary composite syndrome scales (*Internalizing and Externalizing*). The CPRS-R:L consists of seven primary syndrome scales (*Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious–Shy, Perfectionism, Social Problems, and Psychosomatic*). Two global problem indices (*Restless-Impulsive and Emotional Liability*) as well as a composite *ADHD Index* are available to users. In addition to the main syndrome scales constructed via factor analytic procedures, both the CBCL and the CPRS-R:L provide users with supplemental scales that are designed to align with criteria associated with DSM-IV categories of psychopathology.

Both these instruments use *T* scores based on percentiles derived from the raw scores associated with their normative samples to accommodate for the reality that socioemotional behavioral difficulties are not normally distributed within the general population. A *T* score of 67 or greater on the CBCL DSM-IV ADHD syndrome scale had been used to confirm children’s ADHD status so this scale was not included in the analyses.

Both the CBCL and the CPRS-R:L contain several items that could be interpreted as potential symptoms of primary language impairment or academic weaknesses. Following Redmond and Rice (1998) and Redmond (2002), eight items across both protocols overlap with language and academic domains – three items from the CBCL: “won’t talk,” “speech problems,” and “poor school work,” which contribute to the *withdrawn, internalizing, social problems, and attention problems* syndrome scales and five items from the CPRS-R:L: “difficulty doing or completing homework,” “does not seem to listen to what is being said to him/her,” “cannot grasp arithmetic,” “has sloppy handwriting,” and “spelling is poor,” which contribute to the *cognitive problems/inattention, DSM-IV inattentive, and DSM-IV total* scales.

Analytic approach

To address our three research questions, the following five step data reduction strategy was used. First, the presence of significant group differences between groups in severity levels reported by parents across the different syndrome scales was confirmed using ANOVA procedures with standardized *T* scores. The purpose of this analysis was to address the first research question by exploring the scope and scale of difficulties experienced by children with ADHD and children with SLI relative to each other and to the TD controls. A substantial amount of information is available regarding the range of difficulties experienced by children with ADHD but the empirical record presently lacks a comparable assessment of SLI. Thus, selective exclusion of syndrome scales to guard against experiment-wise error rates would have been arbitrary. Outcomes for all syndrome scales are reported.

The second step in data reduction involved identifying those particular syndrome scales which had robust group differences [i.e. $p < 0.001$; $(0.05/27 = 0.00185)$] and dichotomizing those ratings using the suggested cutoffs provided by the manuals (“borderline clinical” = *T* scores ≥ 65 for the

CBCL and the CPRS-R:L syndrome scales; T scores ≥ 60 for the *Internalizing* and *Externalizing* composites from the CBCL). Chi-square analyses were then used to examine potential differences between groups in the observed rates of positive cases identified by the protocols. Additional adjustments to further guard against experiment-wise error rates to those measures that survived the first step at subsequent steps in data reduction would have been overly restrictive, unnecessarily compounding type II error rates (cf. Perneger, 1998; Rothman, 1990, Savitz & Olshan, 1995), and would have distorted results. Thus, unmodified outcomes are reported. The follow-up Chi-square analysis allowed us to address the first research question from the perspective of case assignment rates, which is the manner in which these instruments are used in clinical practice.

The third step was directed at examining the impact of treating children's nonverbal ability scores as a covariate for those scales displaying a significant difference between the SLI and TD groups (research question 2). The third research question regarding the consequence of removing overlapping language and academic items from the protocols was addressed in the last two steps of data reduction. The impact of removing these eight items from the CBCL and CPRS-R:L protocols for case assignment was first examined by re-running Chi-square analyses after those scales affected by these items had been re-scored. The observed difference between the adjusted and unadjusted outcomes would represent the practical trade-offs for practitioners associated with modifying these protocols while keeping the protocols' cutoff procedures intact.

The final analysis involved using response operating characteristic (ROC) curves and examined the extent to which alternative cutoff values might yield higher levels of discrimination than those provided by the manuals. The ROC graph is a plot of the accuracy of a test as the cutoff score is incrementally adjusted. Sensitivity associated with the different cutoffs is presented on the x -axis and 1-specificity (i.e. rates of "false positives") is presented on the y -axis. The area under the curve corresponds to the overall accuracy of the test and an optimal cutoff score can be calculated by identifying the point on the graph where the value for sensitivity + specificity - 1 has been maximized (the Youden Index). ROC curves are particularly useful when evaluating the integrity of clinical measures for differential diagnosis because cutoff scores suitable for discriminating between different disorders are often not the same as those associated with separating typical from atypical status (Streiner & Cairney, 2007).

Results

Complete data were available for all participants. Homogeneity of variances assumptions held for 12 of the 27 syndrome scales under consideration. This outcome was not surprising given the expected low rates within the general population for many of the socioemotional behavior problems assessed with these instruments. In those cases where homogeneity could be assumed, a univariate ANOVA was conducted to identify significant group differences and follow-up Dunn-Sidak analyses were used to identify pair-wise comparisons that reached the 0.05 level of significance. Welch's robust test of equality of means and Games-Howell analyses were used to identify significant group differences and follow-up pair-wise comparisons when variance homogeneity could not be assumed.

Differences between groups in socioemotional behavioral profiles

Means, standard deviations, and ranges across the CBCL and CPRS-R:L syndrome scales for the three groups of children evaluated are presented in Tables 2 and 3. Mean values associated with the parental ratings provided for children from the SLI and TD groups were consistently below

Table 2. Child Behavior Checklist *T* scores: group means (*M*), standard deviations (*SD*), and ranges.

CBCL scale	ADHD (<i>n</i> = 20)			SLI (<i>n</i> = 20)			TD (<i>n</i> = 20)			<i>F</i> (2,57)	Contrasts
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range		
Anxious/depressed	62.6	11.1	50–88	55.7	8.0	50–74	53.3	5.8	50–72	5.33** ^a	ADHD > SLI = TD
Withdrawn	56.3	6.8	50–76	55.5	5.5	50–66	52.3	3.1	50–60	4.41* ^a	ADHD > TD
Somatic complaints	57.8	8.5	50–78	56.3	8.1	50–76	51.5	2.0	50–57	7.89** ^a	ADHD > TD
Social problems	61.7	9.6	50–93	60.8	8.7	50–82	52.7	4.4	50–68	11.55*** ^a	ADHD = SLI > TD
Thought problems	65.0	9.5	51–84	56.3	8.1	50–77	52.9	4.0	50–62	13.98*** ^a	ADHD > SLI, TD
Attention problems	73.8	7.2	61–88	59.8	8.0	50–73	54.1	5.8	50–69	41.18***	ADHD > SLI > TD
Rule-breaking	62.0	7.7	51–78	55.6	7.6	50–70	53.0	4.5	50–67	10.12*** ^a	ADHD > SLI = TD
Aggressive behavior	65.9	11.5	50–91	57.1	9.1	50–76	52.9	5.5	50–72	10.45*** ^a	ADHD > SLI = TD
Internalizing	58.9	11.7	39–78	53.6	10.5	39–73	46.7	8.5	33–67	7.03**	ADHD > TD
Externalizing	64.4	9.3	44–79	51.9	14.4	33–73	45.7	10.7	33–67	13.37***	ADHD > SLI = TD
DSM-affective	63.5	9.4	52–86	57.8	7.5	50–70	53.9	6.3	50–70	7.13*** ^a	ADHD > TD
DSM-anxiety	60.2	8.9	50–77	55.3	7.9	50–77	53.6	6.5	50–72	3.82*	ADHD > TD
DSM-oppositional	63.1	10.0	51–80	55.4	7.4	50–73	52.7	4.3	50–63	8.94*** ^a	ADHD > SLI = TD
DSM-conduct	63.5	9.3	51–82	56.1	8.5	50–72	52.7	1.1	50–69	10.38*** ^a	ADHD > SLI > TD

^aWelch's robust test of equality of means (asymptotically *F* distributed).

p* < 0.05, *p* < 0.01, ****p* < 0.001.

Table 3. Conners' Parent Rating Scales-Revised Long version *T* scores: group means (*M*), standard deviations (*SD*), and ranges.

CPRS-R:L scale	ADHD (<i>n</i> = 20)			SLI (<i>n</i> = 20)			TD (<i>n</i> = 20)			<i>F</i> (2,57)	Contrasts
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range		
Oppositional	67.5	12.9	49–87	52.3	11.3	40–79	48.7	8.6	29–67	16.27***	ADHD > SLI = TD
Cog probs/inattention	75.0	8.7	60–90	64.6	12.7	48–87	52.6	11.0	40–79	21.13***	ADHD > SLI > TD
Hyperactivity	79.2	8.0	67–90	54.20	9.6	42–77	50.1	7.2	41–68	71.31***	ADHD > SLI = TD
Anxious-shy	57.8	13.5	42–90	53.5	12.9	40–81	50.5	10.1	40–76	1.79	ADHD = SLI = TD
Perfectionism	56.9	13.5	40–85	50.8	9.1	40–71	46.1	7.8	40–71	4.94* ^a	ADHD > TD
Social problems	69.9	13.6	45–90	57.9	14.0	43–88	48.2	5.0	45–64	24.19*** ^a	ADHD > SLI > TD
Psychosomatic	56.0	11.6	43–82	52.8	10.8	43–82	46.15	1.1	43–56	7.79** ^a	ADHD > TD
Restless impulsive	79.9	5.7	70–89	56.1	10.4	43–80	50.6	7.5	39–63	106.63*** ^a	ADHD > SLI = TD
Emotional lability	63.2	11.2	41–79	56.15	13.2	41–89	46.6	8.4	39–73	14.54***	ADHD > SLI > TD
ADHD Index	77.5	6.3	65–87	59.6	11.8	45–83	50.4	9.2	40–67	43.21***	ADHD > SLI > TD
DSM-inattentive	75.3	7.8	64–88	60.2	12.2	45–86	52.0	10.9	40–80	25.64***	ADHD > SLI > TD
DSM-hyperactive	79.6	7.5	69–90	56.9	10.4	45–78	49.5	6.9	41–67	70.12***	ADHD > SLI = TD
DSM total	79.1	6.1	70–90	59.1	8.5	45–82	50.7	8.5	41–68	57.52***	ADHD > SLI > TD

^aWelch's robust test of equality of means (asymptotically *F* distributed).

p* < 0.05, *p* < 0.01, ****p* < 0.001.

clinical thresholds, although there were children from both groups who were rated as having difficulties that reached clinical threshold across the different syndrome scales. In contrast, average ratings provided by the parents of children with ADHD were within the clinical range on 12 of the 27 syndrome scales (CPRS-L:R *Oppositional*, *Cognitive Problems/Inattention*, *Hyperactivity*, *Social Problems*, *Restless Impulsive*, *ADHD Index*, *DSM-Inattentive*, *DSM-Hyperactive*, *DSM-Total*; CBCL: *Attention Problems*, *Thought Problems*, *Aggressive Behavior*). Almost all the group differences on the symptom scales were statistically significant at *p* < 0.05 with the notable exception of the *Anxious-Shy* scale from the CPRS-R:L [*F* (2, 57) = 1.796, *p* = 0.175].

Where significant differences were observed, the pattern of pair-wise comparisons was highly consistent: the parents of children with ADHD reported significantly higher levels of concern than either the parents of children with SLI or TD. The one exception was the *Social Problems* scale from the CBCL where parents from the ADHD and SLI groups rated their children similarly (ADHD = SLI > TD). Significant differences were observed between the ratings for the children with SLI and the children with TD on the *Cognitive Problems/ Inattention*, *Social Problems*, *Emotional Lability*, *ADHD Index*, *DSM-Inattentive*, and *DSM-Total* scales from the CPRS-R:L and the *Attention Problems* and *DSM-Conduct* scales from the CBCL (ADHD > SLI > TD).

Eighteen of the 27 observed group differences were robust enough to be considered further. Group differences in the rates of positive cases identified using manual recommended cutoffs for these scales are displayed in Tables 4 and 5. The proportions of children with SLI identified as meeting the “borderline clinical” levels of concern (i.e. *T* scores ≥ 65 or ≥ 60) across the different scales were more similar to the TD group. However, rates in the SLI group were consistently higher than those associated with the TD group.

Consequences of treating nonverbal achievement levels as a covariate

To examine the possibility that nonverbal differences between the SLI group and the TD were contributing to differences between these groups in parental ratings, ANCOVAs were run on the *Cognitive Problems/Inattention*, *Social Problems*, *Emotional Lability*, *ADHD Index*, *DSM-Inattentive*, and *DSM-Total* scales from the CPRS-R:L and the *Attention Problems*, *Social Problems* and *DSM-Conduct* scales from the CBCL treating children’s standard scores on the Naglieri Nonverbal Achievement Test (NNAT) as a covariate. Results indicated that overall main effects for group remained significant across each of the nine scales after controlling for the variance attributable to differences between groups in children’s nonverbal achievement levels. Treating nonverbal achievement as a covariate on these scales had no impact on the observation of significantly higher levels of difficulty among the follow-up pair-wise comparisons between the

Table 4. Child Behavior Checklist: number of children above recommended cutoffs for likely clinical status.

CBCL scale ^a	ADHD (n = 20)	SLI (n = 20)	TD (n = 20)	χ^2	Contrasts
Withdrawn: # above cutoff	2	2	0	2.14	ADHD = SLI = TD
# below cutoff	18	18	20		
Social problems: # above cutoff	8	5	1	6.89*	ADHD > TD
# below cutoff	12	15	19		
Thought problems: # above cutoff	10	3	0	15.52***	ADHD > SLI = TD
# below cutoff	10	17	20		
Attention problems: # above cutoff	19	6	1	35.19***	ADHD > SLI > TD
# below cutoff	1	14	19		
Rule breaking: # above cutoff	6	4	1	4.23	ADHD = SLI = TD
# below cutoff	14	16	19		
Aggressive behavior: # above cutoff	10	5	1	10.39**	ADHD > TD
# below cutoff	10	15	19		
Internalizing: # above cutoff	12	5	2	12.17**	ADHD > TD = SLI
# below cutoff	8	15	18		
Externalizing: # above cutoff	13	6	3	11.34**	ADHD > SLI = TD
# below cutoff	7	14	17		
DSM-conduct: # above cutoff	8	4	1	7.28*	ADHD > TD
# below cutoff	12	16	19		

^a*T* scores at/above 65 for syndrome scales and at/above 60 for composite scales considered clinically significant.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5. Conners' Parent Rating Scale-Revised Long version: number of children above recommended cutoffs for likely clinical status.

CPRS-R:L ^a	ADHD (n = 20)	SLI (n = 20)	TD (n = 20)	χ^2	Contrasts
Oppositional: # above cutoff	11	3	2	12.43**	ADHD > SLI, TD
# below cutoff	9	17	18		
Cog Probs/Inattention: # above cutoff	17	11	3	19.76***	ADHD > SLI > TD
# below cutoff	3	9	17		
Hyperactivity: # above cutoff	20	3	1	45.42***	ADHD > SLI = TD
# below cutoff	0	17	19		
Social Problems: # above cutoff	13	6	0	19.56***	ADHD > SLI > TD
# below cutoff	7	14	20		
Restless Impulsive: # above cutoff	20	5	0	44.57***	ADHD > SLI > TD
# below cutoff	0	15	20		
Emotional Liability: # above cutoff	9	6	1	8.35*	ADHD = SLI > TD
# below cutoff	11	14	19		
ADHD Index: # above cutoff	20	4	3	36.77***	ADHD > SLI = TD
# below cutoff	0	16	17		
DSM-Inattentive: # above cutoff	17	7	2	23.76***	ADHD > SLI = TD
# below cutoff	3	13	18		
DSM-Hyperactive: # above cutoff	20	16	19	42.93***	ADHD > SLI = TD
# below cutoff	0	4	1		
DSM-Total: # above cutoff	20	5	2	37.58***	ADHD > SLI = TD
# below cutoff	0	15	18		

^aT scores at/above 65 for syndrome and composite scales considered clinically significant.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

children in the ADHD group relative to the other two groups. Nonverbal differences did, however, render the SLI and TD pair-wise comparisons non-significant for seven of the nine scales displaying differences between these groups (CPRS-R:L *Cognitive Problems/Inattention*, *Emotional Liability*, *ADHD Index*, *DSM-Inattentive*, and *DSM-Total*; CBCL *Attention Problems*, and *DSM-Conduct*). This finding suggests that differences between children with SLI and children with typical development in these areas were at least partially determined by differences between these groups in their levels of nonverbal achievement. The exception was the *Social Problems* scales from the CBCL and CPRS-R:L which continued to show significantly higher levels of difficulty in the children with SLI relative to children with TD.

Consequences of removing language and academic items from protocols

Several scales suggesting differences between the children in the SLI and TD groups contained items evaluating children's language abilities or academic skills. Table 6 displays the changes in positive and negative tallies which resulted from removing these items. For the *Withdrawn*, *Social Problems*, and *Attention Problems* CBCL syndrome scales and the *DSM-Inattentive* and *DSM-Total* CPRS-R:L syndrome scales, the decrease in the number of children in the SLI group identified as above threshold levels was modest (1–2 cases). The number of children in the ADHD group identified by the *DSM-Total* was unaffected (all 20 cases remained). Across the other scales modest reductions for the ADHD group were found (1–3 cases). The number of children identified as above threshold in the TD group remained the same across these five syndrome scales. The *Internalizing* syndrome scale from the CBCL was entirely unaffected in all three groups by the adjustment. These findings suggest that removing language and academic items increased specificity for the *Withdrawn*, *Social Problems*, *Attention Problems*, *DSM-Inattentive*, and *DSM-Total* with only modest tradeoffs in sensitivity. Removing language and academic items from the

Table 6. Child Behavior Checklist and Conners' Parent Rating Scales adjusted for language and academic items: number of children above recommended cutoffs for likely clinical status.

	ADHD (n = 20)	SLI (n=20)	TD (n = 20)	χ^2	Contrasts
CBCL^a					
Withdrawn: # <i>above cutoff</i>	2	1	0	2.11	ADHD = SLI = TD
# <i>below cutoff</i>	18	19	20		
Social Problems: # <i>above cutoff</i>	7	4	1	5.63*	ADHD > TD
# <i>below cutoff</i>	13	16	19		
Attention Problems: # <i>above cutoff</i>	16	5	1	25.98***	ADHD > SLI = TD
# <i>below cutoff</i>	4	15	19		
Internalizing: # <i>above cutoff</i>	12	5	2	12.17***	ADHD > SLI = TD
# <i>below cutoff</i>	8	15	18		
CPRS-R:L^b					
Cog Probs/Inattention: # <i>above cutoff</i>	12	4	2	13.33***	ADHD > SLI = TD
# <i>below cutoff</i>	8	16	18		
DSM-Inattentive: # <i>above cutoff</i>	15	6	2	18.75***	ADHD > SLI = TD
# <i>below cutoff</i>	5	14	18		
DSM-Total: # <i>above cutoff</i>	20	3	2	42.03***	ADHD > SLI = TD
# <i>below cutoff</i>	0	17	18		

^aT scores at/above 65 for syndrome scales and at/above 60 for composite scales considered clinically significant.

^bT scores at/above 65 for syndrome and composite scales considered clinically significant.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Cognitive Problems/Inattention syndrome scale of the CPRS-R:L resulted in a more dramatic reduction in the number of children from the SLI group identified as within clinical levels of concern (from 11 to 4 cases). This finding suggests that children with language impairments are likely to be over-identified as having symptoms of inattention when this particular syndrome scale is used to make diagnostic decisions.

Extent to which adjusted ADHD symptom scales accurately classified participants

Up to this point, case assignment has been based on *T* score cutoffs provided by the manuals. ROC curve analysis represents a method for identifying those cutoffs which optimize group segregation. This is important for considerations of differential diagnosis because cutoffs which allow for the discrimination between typical and atypical performance may not be suitable for discriminating between different types of atypical status. Figure 1 displays the ROC curves associated with seven of the ADHD symptom scales and their discrimination of cases of ADHD from cases of SLI. The diagonal reference line represents those values where scales were performing at chance levels (i.e. where the rate of true positives was equal to the rate of false positives). The upper left corner of the graph (0, 1) corresponds to perfect accuracy. The extent to which individual ROC curves move towards the upper left corner indicates the relative accuracy each measure had at segregating cases of ADHD from SLI cases. Table 7 presents the diagnostic outcomes associated with each measure for both the ADHD versus TD and the ADHD versus SLI discriminations. The areas under the ROC curve represent an overall estimate of each measure's accuracy. In this case, it represents the proportion of ADHD cases which received a higher parental rating of concern than the non-ADHD cases (TD or SLI).

The range of area under the curve values associated with the discrimination between the ratings of ADHD and TD cases was 0.825 to 1.00, indicating very good to excellent levels of separation between these groups. Higher levels of separation were associated with scales which assessed the hyperactivity/impulsivity symptoms and relatively lower levels were associated with scales

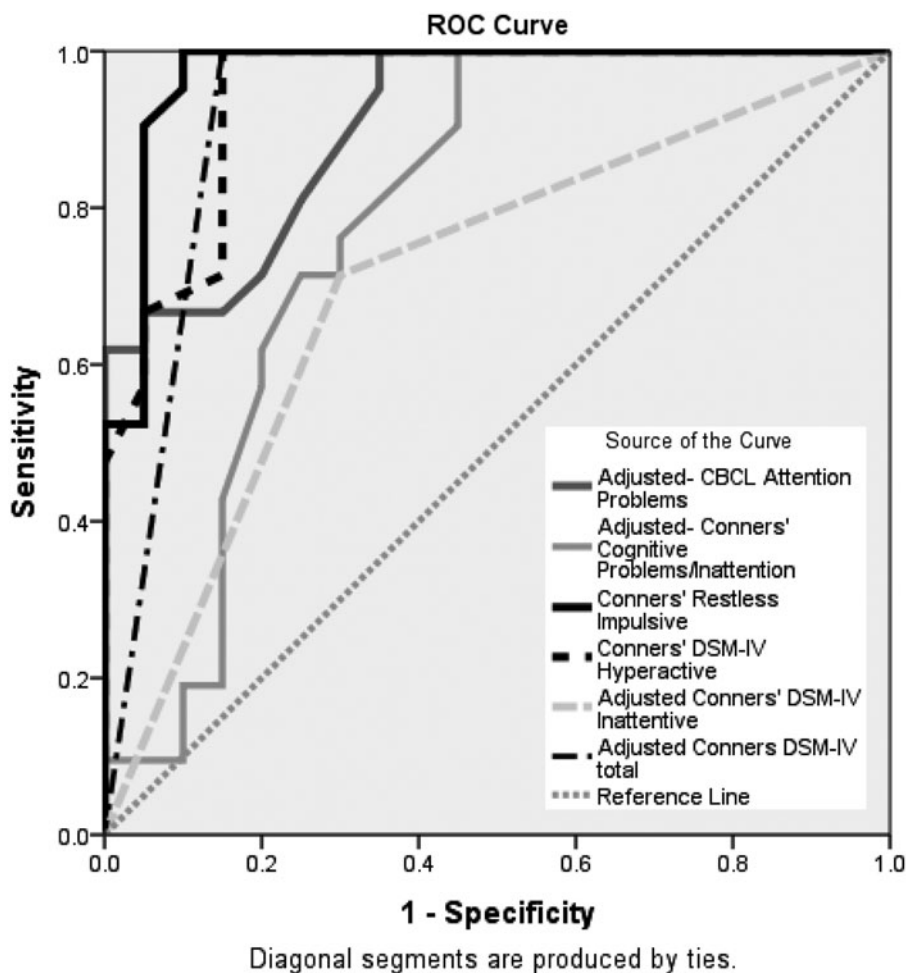


Figure 1. ROC curves associated with discrimination of ADHD and SLI cases for parent ADHD symptom scales adjusted for the presence of language and academic items (reference line indicates test accuracy at "chance").

designed to assess children's inattention symptoms. Perfect levels of discrimination (1.00) between the ADHD and TD groups occurred on the *Restless/Impulsive*, *Hyperactive*, *DSM-Total*, and *DSM-Total* (adjusted) scales. However, the optimal *T* score cutoff identified using the Youden Index procedure (66–69) for these scales was higher than the manual's recommended cutoffs. The range of area values associated with the discrimination between the ADHD and SLI groups was 0.74–0.971, indicating relatively lower levels of discrimination when the distinction being made with these instruments was between clinical groups. However, the overall pattern of hyperactivity/impulsivity scales being relatively better at differentiating ADHD from non-ADHD cases was replicated in the discrimination between ADHD and SLI. For 4 of the 10 scales, the optimal cutoff was considerably higher for the discrimination between the ADHD and SLI cases than it was for the discrimination between ADHD and TD cases: *Cognitive Problems/Inattention*, *Cognitive Problems/Inattention* (adjusted), *DSM-Inattentive*, and *DSM-Inattentive* (adjusted). Modest improvements in specificity for the ADHD versus SLI discrimination were seen with little impact on sensitivity when scales were adjusted to remove items reflecting potential language and academic symptoms.

Table 7. Diagnostic accuracy associated with parent ADHD scales including those adjusted for language and academic items.

Measure	Area under curve	Optimal cutoff ^a	Sensitivity	Specificity	Positive likelihood ratio ^b	Negative likelihood ratio ^c
Subscale						
<i>Discrimination</i>						
CBCL						
Attention problems						
<i>ADHD versus TD</i>	0.976***	64.5	0.95	0.95	19.00	0.0526
<i>ADHD versus SLI</i>	0.889***	63.5	0.95	0.70	3.16	0.0714
Attention problems (adjusted)						
<i>ADHD versus TD</i>	0.979***	63.0	0.95	0.95	19.00	0.0526
<i>ADHD versus SLI</i>	0.906***	62.5	0.80	0.75	5.33	0.2667
CPRS-R:L						
Cog probs/inattention						
<i>ADHD versus TD</i>	0.920***	58.0	1.00	0.85	6.67	<0.0117
<i>ADHD versus SLI</i>	0.740**	69.0	0.80	0.70	2.67	0.2857
Cog probs inattention (adjusted)						
<i>ADHD versus TD</i>	0.909***	55.0	1.00	0.85	6.67	<0.0117
<i>ADHD versus SLI</i>	0.792**	62.5	0.75	0.75	3.00	0.3333
Restless impulsive						
<i>ADHD versus TD</i>	1.00***	66.5	1.00	1.00	>99.00	<0.0101
<i>ADHD versus SLI</i>	0.971***	69.0	1.00	0.90	10.00	<0.0111
DSM-hyperactive						
<i>ADHD versus TD</i>	1.00***	68.0	1.00	1.00	>99.00	<0.0101
<i>ADHD versus SLI</i>	0.943***	68.0	1.00	0.85	6.67	<0.0117
DSM-inattentive						
<i>ADHD versus TD</i>	0.944***	63.5	1.00	0.90	10.00	<0.0111
<i>ADHD versus SLI</i>	0.842***	70.0	0.75	0.80	3.75	0.3125
DSM-inattentive (adjusted)						
<i>ADHD versus TD</i>	0.825***	58.5	1.00	0.85	6.67	<0.0117
<i>ADHD versus SLI</i>	0.822***	67.5	0.75	0.85	5.00	0.2941
DSM-total						
<i>ADHD versus TD</i>	1.00***	69.0	1.00	1.00	>99.00	<0.0101
<i>ADHD versus SLI</i>	0.935***	68.0	1.00	0.85	6.67	<0.0117
DSM-total (adjusted)						
<i>ADHD versus TD</i>	1.00***	67.0	1.00	1.00	>99.00	<0.0101
<i>ADHD versus SLI</i>	0.929***	66.5	1.00	0.85	6.67	<0.0117

^aDetermined using Youden index (J) where $J = \text{maximum} \{ \text{sensitivity} + \text{specificity} - 1 \}$.

^bPositive likelihood ratio = sensitivity/(1 - specificity): values of 1 = "neutral"; 3 = "moderately positive"; ≥ 10 = "very positive."

^cNegative likelihood ratio = (1 - sensitivity)/specificity: values of 1 = "neutral"; ≤ 0.30 = "moderately negative"; ≤ 0.10 = "extremely negative."

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Positive likelihood and negative likelihood ratios indicate the extent to which scores above the cutoff (a positive clinical score) and scores below the cutoff (a negative clinical score) were predictive of children's ADHD status. Positive likelihood ratios for the *Attention Problems*, *Attention Problems* (adjusted), *Restless Impulsive*, *DSM-Hyperactive*, *DSM-Inattentive*, *DSM-Total*, and *DSM-Total* (adjusted) were all at or above 10.00, when the discrimination was between ADHD and TD status indicating that ratings above the cutoff were "very positive" of affected status (Dollaghan, 2007). In other words, high ratings on these scales were much more likely to have come from participants with ADHD than from participants with TD. For example, for the

Attention Problems scale, a participant's odds of having ADHD rather than TD increased 19 times when the *T* score associated with their parent's ratings exceeded 64.5. For the *Cognitive Problems Inattention*, *Cognitive Problems Inattention* (adjusted), and *DSM Inattentive* (adjusted), likelihood ratios were lower but still within the "moderately positive" range. Negative likelihood ratios for the ADHD and TD discrimination were all below 0.10, indicating that scores below the cutoffs were very unlikely to have come from participants with ADHD.

When the discrimination being made was between ADHD and SLI status, syndrome scores above the cutoff were less definitive of ADHD status. However, for 8 of the 10 scales high scores would still be considered at least "moderately positive" or "very positive". For example, for the *Restless Impulsive* scale, a participant's odds of having ADHD rather than SLI increased 10.0 times when the *T* score exceeded 69. Positive likelihood ratios associated with the *Cognitive Problems Inattention*, and *Cognitive Problems* (adjusted) were less than "moderately positive", suggesting that high scores were suggestive but not definitive of ADHD rather than SLI status. Likewise, negative likelihood ratios associated with the ADHD versus SLI discrimination were less definitive, indicating that scores below the identified cutoff were less predictive of non-ADHD status than they were for the ADHD versus TD discrimination. In each case, adjusted scores provided more certainty than the unadjusted scores.

Discussion

This study provides a direct comparison of the socioemotional behavioral profiles associated with ADHD and SLI using two of the most commonly used indices of pediatric psychopathology. Overall, our results confirmed the value of using cross-etiology comparisons to clarify important and clinically useful differences between children with ADHD and children with SLI. Ratings for the children with SLI were more similar in scope and scale to those provided by parents of typically developing children than to the ratings provided for children with ADHD. Observed group differences in severity levels indicated significant differences between the ADHD and TD groups on 27 of the 28 syndrome scales, confirming the consensus view that ADHD is a condition that is associated with multiple socioemotional and behavioral liabilities. In contrast, SLI appeared to be a condition that was associated with a much smaller set of difficulties. Even though the SLI group means were consistently higher than the TD group means, significant group differences between the SLI and the TD groups were only observed on 8 of the 28 syndrome scales. As predicted, these were principally scales designed to tap into children's difficulties with peer relations and their estimated levels of inattention.

Our results confirmed and extended the findings of Helland, Helland, and Heimann (in press). Clear socioemotional behavioral differences existed between the ADHD and SLI groups on almost all the scales displaying significant group differences. The exception was the *Social Problems* scale of the CBCL. This particular scale is notably different from the other scales considered in this study in that it taps into descriptions of children's negative experiences with peers rather than into symptoms specific to DSM-based or ICD-based categories of mental health illness.

Group differences between parent ratings provided for the SLI and TD groups were no longer significant when non-verbal achievement was treated as a covariate. This finding is consistent with previous reports that suggest nonverbal abilities represent an important mediator of the link between language impairment and ADHD (Benasich et al., 1993; Elbro et al., 2011; Gualtieri et al., 1983; Law et al., 2009; Silva et al., 1984), even within the "low-average" to "high-average" ability range associated with our study sample.

As predicted, adjusting protocols for the presence of language and academic items improved accuracy. On one hand, controlling for nonverbal abilities and symptom overlap represent

reasonable accommodations which allowed us to examine the unique influence of language impairments on children's socioemotional behavioral symptoms. On the other hand, an argument could be made that these adjustments removed important, non-random differences between the clinical and control groups yielding non-representative clinical groups. However, one complication with this view is the observation that comparisons between the ADHD and TD groups were unaffected by these adjustments. Taken together, these findings offer support for Redmond and Rice's (1998) claim that the socioemotional behavioral difficulties associated with SLI are qualitatively different than and probably etiologically distinct from those associated with ADHD and other forms of psychopathology. If this is true, then different therapeutic responses are indicated to address these difficulties, which can appear to be homologous at the level of standardized measurement.

The results of this study helped further operationalize Redmond's (2002) suggestions and offer practitioners some practical guidance for utilizing the CBCL and the CPRS-R:L for differential diagnosis and the identification of comorbidity. Given growing concerns associated with rising diagnoses of ADHD and the risks associated with over-treatment, focusing assessments on the presentation of elevated levels of hyperactivity and impulsivity rather than inattention, removing language and academic items from the CBCL and CPRS-R:L protocols, and requiring higher cutoffs when determining ADHD status in children with developmental language disorders seems warranted. Implementation of these adjustments will be challenging because it will require speech language pathologists to adopt a more active role in the psychiatric evaluations of students on their caseloads.

There are limitations associated with this study. The true accuracy of any diagnostic procedure is unknown until cutoffs have been replicated in other settings by independent investigations (Sackett & Haynes, 2002). This certainly applies to our suggestions for modifying the CBCL and CPRS-R:L protocols and using more conservative cutoffs than those provided by the manuals when assessing children with SLI and other developmental language disorders. Their clinical value will need to be established with additional investigations. The study sample associated with this investigation was small and relatively homogenous and it may be unrealistic to expect replication within older, younger, or more diverse study samples. This study may have been underpowered. As a consequence, the non-significant results reported here may have been masking small but potentially reliable differences between the participants with SLI and TD. Future investigations should address this issue. Finally, we did not explore the possibility that additional mediators other than nonverbal status were influencing ratings of children's behavior problems. Tomblin et al. (2000) found that levels of teacher reported classroom behavior problems were significantly higher among children with SLI who also had reading difficulties than among children who presented with SLI alone. The links between SLI and ADHD are complex. Additional investigations are needed to untangle the contributions of potential mediators, moderators, and measurement error.

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References

- Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA school-age forms & profiles*. Burlington, VT: University of Vermont Research Center for Children, Youth, and Families.
- Aebi, M., Winkler, C., & Steinhausen, H. (2010). Accuracy of the DSM-oriented attention problem scale of the Child Behavior Checklist in diagnosing attention-deficit hyperactivity disorder. *Journal of Attention Disorders, 13*, 454–463.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Archibald, L. M., & Joanisse, M. F. (2009). On the sensitivity and specificity of nonword repetition and sentence recall to language and memory impairments in children. *Journal of Speech, Language, and Hearing Research, 52*, 899–914.
- Baker, L., & Cantwell, D. P. (1982). Language acquisition, cognitive development, and emotional disorder in childhood. In K. E. Nelson (Ed.), *Children's language* (pp. 286–321). Hillsdale, NJ: Lawrence Erlbaum.
- Baker, L., & Cantwell, D. P. (1983). Developmental, social, and behavioral characteristics of language disordered children. In S. Chess & A. Thomas (Eds.), *Annual progress in child psychiatry and child development* (pp. 205–216). New York, NY: Brunner, Mazel Publishers.
- Baker, L., & Cantwell, D. P. (1987a). A prospective psychiatric follow-up of children with speech language disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 26*, 546–553.
- Baker, L., & Cantwell, D. P. (1987b). Comparison of well, emotionally disordered, and behaviorally disordered children with linguistic problems. *Journal of the American Academy of Child & Adolescent Psychiatry, 26*, 193–196.
- Barkley, R. A. (2006). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment* (3rd ed.). New York: Guilford.
- Beitchman, J. H., Hood, J., & Inglis, A. (1990). Psychiatric risk in children with speech and language disorders. *Journal of Abnormal Child Psychology, 3*, 283–296.
- Beitchman, J. H., Hood, J., Rochon, J., & Peterson, M. (1989). Empirical classification of speech/language impairment in children: II. Behavioral characteristics. *Journal of the American Academy of Child and Adolescent Psychiatry, 28*, 118–123.
- Beitchman, J. H., Peterson, M., & Clegg, M. (1988). Speech and Language impairment and psychiatric disorder: The relevance of family demographic variables. *Child Psychiatry and Human Development, 18*, 191–207.
- Beitchman, J. H., Wilson, B., Johnson, C. J., Atkinson, L., Young, A., Adlaf, E., Escobar, M., & Douglas, L. (2001). Fourteen-year follow-up of speech/language-impaired and control children: Psychiatric outcomes. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*, 75–82.
- Benasich, A. A., Curtis, S., & Tallal, P. (1993). Language, learning, and behavioral disturbance in childhood: A longitudinal perspective. *Journal of the American Academy of Child and Adolescent Psychiatry, 32*, 585–594.
- Berkson, J. (1946). Limitations of the application of fourfold tables to hospital data. *Biometrics Bulletin, 2*, 47–53.
- Biederman, J., Keenan, K., & Faraone, S. V. (1990). Parent-based diagnosis of Attention Deficit Disorder predicts a diagnosis based on teacher reports. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*, 698–701.
- Botting, N., & Conti-Rasden, G. (2000). Social and behavioral difficulties in children with language impairment. *Child Language Teaching and Therapy, 16*, 105–120.
- Brock, S. E., Jimerson, S. R., & Hansen, R. L. (2009). *Identifying, assessing, and treating ADHD at school*. New York, NY: Springer.

- Brown, T. E. (2000). *Attention-deficit disorders and comorbidities in children, adolescents, and adults*. Washington DC: American Psychiatric Press.
- Cantwell, D. P., & Baker, L. (1985). Psychiatric and learning disorders in children with speech and language disorders: A critical review. *Advances in Learning and Behavioral Disabilities*, 4, 29–47.
- Cardy, J. E. O., Tannock, R., Johnson, A., & Johnson, C. J. (2010). The contributions of processing impairments to SLI: Insights from attention-deficit/hyperactivity disorder. *Journal of Communication Disorders*, 43, 77–91.
- Centers for Disease Control and Prevention (March, 2013). 2011–2012 *National Survey of Children's Health*. Available from URL: <http://www.cdc.gov/nchs/slaitis/nsch.htm>.
- Charach, A., Chen, S., Hogg-Johnson, S., & Schachar R. (2009). Using the Conners' Teacher Rating Scale-Revised in school children referred for assessment. *The Canadian Journal of Psychiatry*, 54, 232–241.
- Chess, S., & Rosenberg, M. (1974). Clinical differentiation among children with initial language complaints. *Journal of Autism and Childhood Schizophrenia*, 4, 99–109.
- Clegg, J., Hollis, C., Mawhood, L., & Rutter, M. (2005). Developmental language disorders – A follow-up in later adult life. Cognitive, language and psychosocial outcomes. *Journal of Child Psychology and Psychiatry*, 46, 128–149.
- Cohen, N. J., Davine, M., & Meloche-Kelly, M. (1989). Prevalence of unsuspected language disorders in a child psychiatric population. *Journal of the American Academy of Child and Adolescent Psychiatry*, 28, 107–111.
- Cohen, N. J., Menna, R., Vallance, D. D., Barwick, M. A., Im, N., & Horodezky, N. B. (1998). Language, social cognitive processing, and behavioral characteristics of psychiatrically disturbed children with previously unsuspected language impairments. *Journal of Child Psychology and Psychiatry*, 39, 853–864.
- Conners, C. K. (2004). *Conners' Rating Scales—Revised: Technical manual*. North Tonawanda, NY: Multi-Health Systems.
- Dollaghan, C. A. (2007). *The handbook for evidence-based practice in communication disorders*. Baltimore, MD: Brookes.
- Elbro, C., Dalby, M., & Maarbjerg, S. (2011). Language-learning impairment: A 30-year follow-up of language-impaired children with and without psychiatric, neurological and cognitive difficulties. *International Journal of Communication Disorders*, 46, 437–448.
- Frazier, T. W., Demaree, H. A., & Youngstrom, E. A. (2004). Meta-analysis of intellectual and neuropsychological performance in Attention-Deficit/Hyperactivity Disorder. *Neuropsychology*, 18, 543–555.
- Gualiteri, C. T., Ursala, K., Van Bourgondien, M., & Saleeby, N. (1983). Language disorders in children referred for psychiatric services. *Journal of American Academy of Child Psychiatry*, 22, 165–171.
- Helland, W. A., Helland, T., & Heimann, M. (in press). Language profiles and mental health problems in children with specific language impairment and children with ADHD. *Journal of Attention Disorders*. doi: 10.1177/1087054712441705.
- Johnson, C., Beitchman, J. H., Escobar, M., Atkinson, L., Wilson, B., Brownlie, E. B., Douglas, L., Taback, N., Lam, I., & Wang, M. (1999). Fourteen-year follow-up of children with and without speech/language impairments: Speech/language stability and outcomes. *Journal of Speech, Language, and Hearing Research*, 42, 744–760.
- Law, J., Rush, R., Schoon, I., & Parsons, S. (2009). Modeling developmental language difficulties from school entry into adulthood: Literacy, mental health, and employment outcomes. *Journal of Speech, Language, and Hearing Research*, 52, 1401–1416.
- Lindsay, G., & Dockrell, J. (2008). Outcomes for young people with a history of specific language impairment at 16–17 years: A more positive picture? In V. Joffe, M. Cruice, & S. Chiat (Eds.), *Language disorders in children and adults: New issues in research and practice* (pp. 138–159). Hoboken, NJ: Wiley-Blackwell.
- Lindsay, G., Dockrell, J. E., & Strand, S. (2007). Longitudinal patterns of behaviour problems in children with specific language difficulties: Child and contextual factors. *British Journal of Educational Psychology*, 77, 811–828.
- Love, A. J., & Thompson, M. G. G. (1988). Language disorders and attention deficit disorders in young children referred for psychiatric services: Analysis of prevalence and a conceptual synthesis. *American Journal of Orthopsychiatry*, 58, 52–64.
- Mervis, C. B. (2004). Cross-etiology comparisons of cognitive and language development. In M. L. Rice & S. E. Warren (Ed.), *Developmental language disorders: From phenotypes to etiologies* (pp. 153–185). Mahwah, NJ: Lawrence Erlbaum Associates.
- Milberger, S., Biederman, J., Faraone, S. V., Murphy, J., & Tsuang, M. T. (1995). Attention deficit hyperactivity disorder and comorbid disorders: Issues of overlapping symptoms. *American Journal of Psychiatry*, 152, 1793–1799.
- Mueller, K., & Tomlin, J. B. (2012). Examining the comorbidity of language impairment and attention-deficit/hyperactivity disorder. *Topics in Language Disorders*, 32, 228–246.
- Naglieri, J. A. (2003). *Naglieri nonverbal ability test – Individual administration*. San Antonio, TX: Harcourt Assessment.
- Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, E. J. S. (2005). Causal heterogeneity in attention-deficit/hyperactivity disorder: Do we need neuropsychologically impaired subtypes? *Biological Psychiatry*, 57, 1224–1230.
- Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *BMJ*, 18, 1236–1238.

- Redmond, S. M. (2002). The use of rating scales with children who have language impairments: A tutorial. *American Journal of Speech Language Pathology*, *11*, 124–138.
- Redmond, S. M. (2011). Peer victimization among students with specific language impairment, attention-deficit/hyperactivity disorder, and typical development. *Language, Speech, and Hearing Services in Schools*, *42*, 520–535.
- Redmond, S. M., & Rice, M. L. (1998). The socioemotional behaviors of children with SLI: Social adaptation or social deviance? *Journal of Speech, Language and Hearing Research*, *41*, 688–700.
- Redmond, S. M., & Rice, M. L. (2002). Stability of behavioral ratings of children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *45*, 190–201.
- Redmond, S. M., Thompson, H. L., & Goldstein, S. (2011). Psycholinguistic profiling differentiates specific language impairment from typical development and from attention-deficit/hyperactivity disorder. *Journal of Speech, Language, and Hearing Research*, *54*, 99–117.
- Rescorla, L., Ross, G. S., & McClure, S. (2007). Language delay and behavioral/ emotional problems in toddlers: Findings from two developmental clinics. *Journal of Speech, Language and Hearing Research*, *50*, 1063–1078.
- Riccio, C. A., Reynolds, C. R., & Lowe, P. A. (2001). *Clinical Applications of continuous performance tests: Measuring attention and impulsive responding in children and adults*. New York, NY: John Wiley.
- Rothman, K. J. (1990). No adjustments are needed for multiple comparisons. *Epidemiology*, *1*, 43–46.
- Sackett, D. L., & Haynes, R. B. (2002). The architecture of diagnostic research. *BMJ*, *324*, 539–541.
- Savitz, D. A., & Olshan, A. F. (1995). Multiple comparisons and related issues in the interpretation of epidemiologic data. *American Journal of Epidemiology*, *142*, 904–908.
- Scahill, L., & Schwab-Stone, M. (2000). Epidemiology of ADHD in school-age children. *Child and Adolescent Psychiatric Clinics of North America*, *9*, 541–555.
- Schoon, I., Parsons, S., Rush, R., & Law, J. (2010). Children's language ability and psychosocial development: A 29-year follow-up study. *Pediatrics*, *126*, e73–e80.
- Schwartz, R. G. (2009) Specific language impairment. In R.G. Schwartz (Ed.), *Handbook of child language disorders* (pp. 3–43). New York, NY: Psychology Press.
- Semel, E., Wiig, E. H., & Secord, W. A. (2004). *Clinical Evaluation of Language Fundamentals – Fourth Edition Screening Test*. San Antonio, TX: Harcourt Assessment.
- Silva, P. A., Justin, C., McGee, R., & Williams, S. M. (1984). Some developmental and behavioral characteristics of seven-year-old children with delayed speech development. *British Journal of Disorders of Communication*, *19*, 147–154.
- Snowling, M. J., Bishop, D. V. M., Stothard, S. E., Chipchase, B., & Kaplan, C. (2006). Psychosocial outcomes at 15 years of children with a preschool history of speech-language impairment. *Journal of Child Psychology and Psychiatry*, *47*, 759–765.
- St. Clair, M. C., Pickles, A., Durkin, K., & Conti-Ramsden, G. (2011). A longitudinal study of behavioral, emotional and social difficulties in individuals with a history of specific language impairment (SLI). *Journal of Communication Disorders*, *44*, 186–199.
- Stanton-Chapman, T. L., Justice, L. M., Skibbe, L. E., & Grant, S. L. (2007). Social and behavioral characteristics of preschoolers with specific language impairment. *Topics in Early Childhood Special Education*, *27*, 98–109.
- Streiner, D. L., & Cairney, J. (2007). What's under the ROC? An introduction to receiver operating characteristics curves. *The Canadian Journal of Psychology*, *52*, 121–128.
- Tirosh, E., & Cohen, A. (1998). Language deficit with attention-deficit disorder: A prevalent comorbidity. *Journal of Child Neurology*, *13*, 493–497.
- Tomblin, J. B., Records, N. L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). The prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research*, *40*, 1245–1260.
- Tomblin, J. B., Zhang, X., Buckwalter, P., & Catts, H. (2000). The association of reading disability, behavioral disorders, and language impairment among second-grade children. *Journal of Child Psychology and Psychiatry*, *41*, 473–482.
- Wadman, R., Botting, N., Durkin, K., & Conti-Ramsden, G. (2011). Changes in emotional health symptoms in adolescents with specific language impairment. *International Journal of Language and Communication Disorders*, *46*, 641–656.
- Whitehouse, A. J. O., Robinson, M., & Zubrick, S. R. (2011). Late talking and the risk for psychosocial problems during childhood and adolescence. *Pediatrics*, *128*, 325–332.
- Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*, 1336–1346.
- Willinger, U., Brunner, E., Diendorfer-Radner, G., Mag, J. S., Sirsch, U., & Eisenwort, B. (2003). Behaviour in children with language development disorders. *Canadian Journal of Psychiatry*, *48*, 607–614.

Notice of Correction:

Changes have been made to this article since its original online publication date of 23 January 2014.