

Differentiating SLI from ADHD using children's sentence recall and production of past tense morphology

SEAN M. REDMOND

Department of Communication Sciences and Disorders, University of Utah, UT, USA

(Received 29 September 2003; accepted 29 January 2004)

Abstract

Measures of sentence recall and past tense marking were used to examine the similarities and differences between children with Attention Deficit/Hyperactivity Disorder (ADHD), children with specific language impairment (SLI), and typically developing (TD) children. Both SLI and ADHD group means for sentence recall tasks were significantly lower than the TD control group (SLI < ADHD < TD). In contrast, limitations in past tense marking were characteristic of the SLI group (SLI < ADHD = TD). Frequent affix omissions or bare stem errors (e.g. *the girl colour the picture; the girl fall in the net*) differentiated the SLI group from the other two groups. Over-regularization errors (e.g. *the girl falled into the net*) did not (SLI = ADHD = TD). Clinical implications are discussed.

Keywords: *SLI, ADHD, morphology, sentence recall, production, tense marking, differential diagnosis*

Introduction

Children with specific language impairment (SLI) demonstrate significant and long-standing limitations in the development of their language skills in the presence of normal levels of hearing acuity, age-appropriate scores on non-verbal tests of intelligence and no obvious signs of neurological or socioemotional impairment (Johnston, Beitchman, Escobar, Atkinson, Wilson, Brownlie, Douglas, Taback, Lam and Wang, 1999; Leonard, 1998). SLI affects children across the socioeconomic spectrum and does not appear to be determined by environmental factors commonly associated with developmental disruptions in other areas (Tomblin, 1996). Recent epidemiological evidence suggests that children with SLI represent the largest segment of children with language impairments, estimated at roughly 7% of the general population (Johnston *et al.*, 1999; Tomblin, Records, Buckwalter, Zhang, Smith and O'Brien, 1997). In spite of the high incidence of SLI, a significant proportion of these children do not receive speech-language services during their academic careers (Johnston *et al.*, 1999; Zhang and Tomblin, 2000). Ironically, the educational needs of children with SLI may frequently be overlooked by school personnel due to the absence of 'red flags' in other developmental areas.

There is reason to believe that this course may be corrected in the near future. Recently, investigators have directed their efforts toward specifying what inclusionary criteria should be associated with the diagnosis of SLI (see Tager-Flusberg and Cooper, 1999). A focus on clinical markers for SLI has the potential for improving screening and identification procedures (Rice and Wexler, 1996). Better diagnostic procedures should eventually increase the likelihood that affected children will receive the services they need as well as enhance efforts toward the identification of the genetic and environmental contributions to the risk for SLI (Rice, 1996; Tager-Flusberg and Cooper, 1999; Tomblin and Zhang, 1999). Consensus has been converging on three promising pathognomonic indices for SLI. Measurements that tap into children's proficiencies with sentence recall, non-word repetition, and tense marking have all demonstrated high levels of specificity and sensitivity in differentiating children with SLI from their typically developing peers (Bishop, North and Donlan, 1996; Bishop *et al.*, 1999; Conti-Ramsden, 2003; Conti-Ramsden, Botting and Faragher, 2001; Dollaghan and Campbell, 1998; Ellis Weismer, Tomblin, Zhang, Buckwater, Gaura Chynoweth and Jones, 2000; Oetting and Horohov, 1997; Rice, 2000; Rice and Wexler, 1996; Rice, Wexler and Cleave, 1995; SLI Consortium, 2002; Tager-Flusberg and Cooper, 1999; Tomblin, Records and Zhang, 1996). In this study, we examined the extent to which two of these three nascent clinical markers discriminate between children with SLI, children with Attention Deficit/Hyperactivity Disorder, and children with typical language skills. Specifically, we were interested in whether sentence recall measures and the production of past tense morphology would reveal similarities or differences between these two clinical populations.

How specific are the linguistic deficits associated with SLI?

Recently, the evaluation of the clinical markers for SLI has been expanded to include comparisons with other developmental language impairments (Eadie, Fey, Douglas and Parsons, 2002; Ellis Weismer *et al.*, 2000; Frazier Norbury, Bishop and Briscoe, 2001; Laws and Bishop, 2003; Rice, 2003; Rice, Mervis, Klein and Rice, 1999; Rice, Tomblin, Marquis, Richman, Zhang and Hoffman, under review; Tomblin and Zhang, 1999). These comparisons between affected groups of children are of considerable theoretical interest because they allow us to evaluate the extent to which the psycholinguistic profile associated with SLI is unique to SLI, or if the weaknesses in sentence recall, non-word repetition, and tense marking observed in SLI index a common discomposure of language that is associated with many kinds of developmental disruption. This new line of research provides a preliminary and complex picture of similarities and differences across children with developmental language impairments.

Tomblin and Zhang (1999) compared the language profiles of children with SLI to a 'general delay' group of children, defined as children with language impairments and non-verbal intelligence quotients below 85. Both groups of children were ascertained through a large longitudinal, epidemiological study involving thousands of kindergarten children living in Iowa (see Tomblin *et al.*, 1996 and Tomblin *et al.*, 1997, for further details). Group means on individual sub-tests of the Test of Language Development-Primary, 2nd Edition (TOLD-P2) revealed that the linguistic deficits of children in the general delay group closely paralleled children with SLI. Mean scores across all of the language sub-tests were very similar for the two groups, although the general delay group's performance tended to be slightly lower. Of particular interest to the topic of this study was the finding that the TOLD-P2 sentence imitation sub-test means for the two groups were nearly identical (z scores around -1.25).

Ellis Weismer *et al.* (2000) examined non-word repetition at second grade within the same group of children but stratified the epidemiological sample into the following categories based on children's cognitive profiles: children with typical development (TD); children with SLI; children with non-specific language impairment (NLI), defined as children with language impairments and non-verbal intelligence quotients below 85; and children with low cognition (LC) who performed below 85 on non-verbal IQ but did not meet the criteria for language impairment. Results indicated that children in the language impaired groups (SLI, NLI) performed at similar levels, and received significantly lower scores than children in either the TD or LC groups. In contrast, children in the LC groups received scores that were similar to the TD group (SLI=NLI<LC=TD).

Rice *et al.* (in press, also presented in Rice, in press) examined the development of tense marking in these children from kindergarten to fourth grade. Tense marking was measured using picture-elicitation tasks targeting the third person singular present tense *-s* and past tense morphology (regular past *-ed* and irregular verbs). The pattern of group differences at kindergarten was similar to that observed for non-word repetition at second grade by Ellis Weismer *et al.* (2000), with children from the LI groups lagging far behind the TD and LC groups. Growth curves representing the maturation of tense marking over 5 years for the two LI groups were also highly similar with the exception that the NLI group started lower and took longer to reach mastery levels of performance (90%) on these tasks than the SLI group did (fourth grade vs. third grade). At first blush, this difference between the two LI groups appears to be attributable to the lower nonverbal IQ levels of the NLI group. However, the performance of the LC group demonstrates that some children with low non-verbal IQs nevertheless perform well on the grammatical tense marker.

The potential disassociation between low nonverbal IQ and indices of language impairment may be most clearly evident within the psycholinguistic profiles of children with William Syndrome (WS). Rice *et al.* (1999) matched 5-year-old children with SLI, 7-year-old children with WS and 3-year-old children with typical development on the basis of MLU and compared their productions of tense marking morphemes during conversational samples. A comparison group of 5-year-old typically developing children was also included. Statistical analyses found that although the MLU levels were equivalent for the SLI, WS, and 3-year-old typically developing groups, there were striking differences in the levels of tense marking observed. Children in the WS group were found to be marking tense at levels similar to the 5-year-old unaffected group (i.e. >90% correct) whereas children in the 3-year-old unaffected group and SLI groups were marking tense around 70% and 50% of the time, respectively. In other words, although the children in the WS group had MLU values that were similar to unaffected children 4 years younger, their performance on the grammatical tense marker was at near adult-like levels. A comparison between SLI and WS on measures of sentence recall or non-word repetition is unfortunately not available. However, sentence recall and non-word repetition may also represent areas of relative strength for children with WS (Robinson, Mervis and Robinson, 2003).

Eadie *et al.* (2002) matched children with SLI, children with Down syndrome (DS), and children with typical language development on the basis of MLU and compared their performances on sentence recall and production of tense marking during conversational samples. Results indicated that children in the typically developing group performed significantly better than the SLI and DS groups on both measures (SLI=DS<LM). Although not statistically significant, the DS group median on regular past tense was considerably lower than the SLI group median (38% vs. 76%). Within group variation on the production of regular past tense was large in both clinical groups (0–100% and

33–100%). Laws and Bishop (2003) matched 19 adolescents with DS to 17 5-year-old children with SLI on the basis of non-verbal mental age. Another comparison group of 5-year-old mental age matches was composed of typically developing children. Children's performances on various language tasks were compared including sentence recall, non-word repetition, and past tense marking recall. Results were similar to those reported by Eadie *et al.* (2002) in that children in both the DS and SLI groups displayed similar profiles of weaknesses relative to mental age expectations. Similar levels of difficulty were also observed between the two clinical groups on correct productions of regular past tense, sentence recall and non-word repetition (SLI=DS<MA). Laws and Bishop (2003) found that children in the SLI group, however, produced significantly more irregular verb stem errors (e.g. *Yesterday, he ride a bike*) than the other two groups (SLI>DS=MA).

Children with sensorineural hearing impairments (SNH) provide another important contrast to children with SLI. Current theoretical accounts on the nature of SLI differ greatly on the amount of emphasis that is placed on children's perceptual/information processing skills (e.g. Chiat, 2000; Leonard, 1998; Rice, 2000; Tallal, 2000; van der Lely, 2003). Thus, a comparison between children with SLI and children with known limitations in auditory perception/information processing allows for a test of competing hypotheses. Frazier-Norbury *et al.* (2001) compared sentence recall, non-word repetition, and tense marking in children with SLI to children with mild-moderate sensorineural hearing impairments (SNH). Tense marking in this study was examined through children's productions of regular and irregular past tense verbs during an elicitation task. Performance by children in the clinical groups was also compared relative to expectations based on age-matched and language-matched control groups. Results indicated that both the SLI and SNH groups performed significantly poorer than the age-matched controls on the sentence recall measure. Furthermore, children in the SLI group performed significantly worse than the language-matched group, whereas the SNH group's level of performance was similar to the language-matched group. Observed group differences on the non-word repetition measure produced a similar pattern (SLI<SNL=LM<AM). In contrast, elicited productions of tense marking morphemes appeared to be primarily compromised in the SLI group (SLI<SNL=LM=AM). This was particularly true for regular and irregular past tense marking, where the SLI group marked tense, on average, around 50% of the time, compared to the other groups which marked past tense 80–90% of the time. The authors suggested caution, however, with interpreting their results as an indication that degraded auditory input does not affect learning of tense marking because some children in the SNH group (22%) experienced difficulty marking tense.

In sum, deficits on all three of the working pathognomonic indices of SLI have been observed in other clinical populations. Comparisons of different groups of children with language impairments have also revealed that although deficits in sentence recall and non-word repetition often co-occur with tense marking deficits they can also exist independently, suggesting that these indices tap into different linguistic domains (see Rice, 2003, for further discussion). Additionally, evaluations of children with cognitive limitations have revealed that low non-verbal IQ is neither necessary nor sufficient for deficits in these areas. Important gaps remain but continued comparisons of the psycholinguistic profiles of populations known to be at risk for language impairments promise to sharpen our understanding of the nature and scope of developmental language impairments.

Language impairments in children with ADHD

A population that speech clinicians are frequently called upon to evaluate and document the presence of comorbid language impairments is children with Attention Deficit/Hyperactivity Disorder (ADHD) (American Speech-Language-Hearing Association, 1997, spring). ADHD is the most common psychiatric disorder diagnosed in childhood, affecting 3–5% of the school-age population (NIH Consensus Development Panel, 2000; Scchill and Schwab Stone, 2000; Szatmari, Offord and Boyle, 1989). The diagnosis of ADHD is based on the presence of a persistent pattern of developmentally inappropriate levels of impulsivity, inattention and hyperactivity that cause functional impairments in multiple settings (American Psychiatric Association, 1994). Although children with ADHD represent a highly heterogeneous group, a significant proportion presents with additional language, learning, and reading limitations (Barkley, 1997; NIH Consensus Development Panel, 2000). For example, children with ADHD have been shown to be at elevated risk for several markers of language impairment including delayed onset of first words and word combinations, poor performance on standardized language tests and pragmatic difficulties (Barkley, 1997; Cohen, Davine and Meloche-Kelly 1989; Cohen *et al.* 1993; Cohen, Menna, Vallance, Barwick, Im and Horodezky, 1998; Cohen, Vallance, Barwick, Im, Menna, Horodezky and Isaacson, 2000; Kim and Kaiser, 2000; Love and Thompson, 1988; Purvis and Tannock, 1997; Tirosh and Cohen, 1997). Epidemiological studies suggest that significant levels of language impairment can be expected to co-occur in 35–50% of children who present with ADHD symptoms and rates as high as 90% have been observed in studies using clinically referred samples (see Tannock and Schachar, 1996, for a review).

There are several hypotheses regarding the relationship between language impairments and attention disorders, including the possibility that deficits in one area may be causing or fostering deficits in the other (e.g. Beitchman, Brownlie and Wilson, 1996; Love and Thompson, 1988; Tannock and Schachar, 1996). Alternatively, both language impairments and attention deficits may be caused by a third underlying neurodevelopmental deficit (e.g. Beitchman, Nair, Clegg, Ferguson and Patel, 1986; Goodyer, 2000; Melamed and Wozniak, 1999; Tallal, Dukette and Curtiss, 1989). However, an important consideration for the evaluation of different accounts is the extent to which the linguistic deficits observed in some children with ADHD are in fact similar to those associated with other developmental language impairments. Do children with ADHD demonstrate difficulties in sentence recall, non-word repetition, or tense marking?

Although the literature on children with ADHD is substantial and the increased risk for language, learning, and reading difficulties is well-documented, very little information exists on the performance of these children on the three clinical markers of language impairment. Most of the information regarding the language skills of children with ADHD has been based on verbal IQ scores and other omnibus language achievement tests. Collectively, these investigations suggest that working memory deficits can be expected in many children with ADHD, including poor performance on sentence recall measures (Barkley, 1997; Cohen *et al.*, 1989, 1993, 1998, 2000; Kim and Kaiser, 2000; Love and Thompson, 1988; Purvis and Tannock, 1997; Tannock and Schachar, 1996; Tirosh and Cohen, 1997). For example, Cohen *et al.* (2000) compared children with ADHD to children with ADHD and language impairment (ADHD+LI) using the Clinical Evaluation of Language Fundamentals-Revised test battery and found that both groups performed below-average on the recalling sentences sub-test and were significantly lower than a control group of children receiving psychiatric services. These authors suggested that

'working memory may be the zone of overlap in children with ADHD and learning disabilities (including both language and non-language based learning disabilities)' (Cohen *et al.*, 2000, p. 358). Information on the other two markers in children with ADHD is not available. The author is unaware of any previous reports examining production of tense marking morphology or non-word repetition in children with ADHD (e.g. an article search through *PsycInfo* conducted on 19 September 2003 yielded 5118 references for the keyword *ADHD* and yet no appropriate references for *ADHD* and any of the following keywords: *non-word repetition*, *phonological working memory*, *past tense*, *grammatical tense*, *grammatical morphology*, *morphosyntax*).

Questions directing the current study

The psycholinguistic profiles of children with ADHD warrant further investigation. Two specific questions directed the current study:

1. Do children with ADHD show deficits in sentence recall and the production of past tense morphology?
2. Are the differences between children with SLI and ADHD on these measures more a matter of degree or do qualitatively different profiles emerge?

Method

Participants

Participant characteristics are displayed in Table I. All of the participants were monolingual speakers of English and demonstrated normal levels of hearing acuity, non-verbal achievement, and speech production skills. Three groups of children (age range 5;0 to 8;2 yrs;mos) were matched within 6 months for chronological age: ten children diagnosed with SLI, ten children diagnosed with ADHD and 13 children with typical development. Significant group differences were not observed on the matching variable, mother's education level or children's non-verbal IQ scores [age in months: $F(2, 30) = 1.981, p = 0.156$; mother's education: $F(2, 30) = 0.244, p = 0.786$; non-verbal IQ: $F(2, 30) = 2.842, p = 0.075$]. The conversational profiles of these participants were provided in an earlier report (see Redmond, 2004).

Each participant completed the following assessment protocol: (a) a parental questionnaire, documenting the participant's developmental, academic, and family histories and current status of service receipt; (b) a hearing screening at 25 dB at 1000, 2000 and 4000 Hz, establishing normal hearing acuity; (c) the Columbia Mental Maturity

Table I. Participant characteristics: group means and (standard deviations)

	Age ^a	Maternal education ^b	Non-verbal ^c	Behavioural ^d	Language ^e
SLI	79 (11)	3.0 (0.67)	104 (11)	62 (11)	74 (11)
ADHD	83 (10)	2.9 (1.4)	99 (8)	71 (8)	95 (13)
TD	79 (9)	3.2 (1.2)	107 (6)	53 (6)	111 (9)

^aAge: in months. ^bMaternal Education: scale of 1=some high school and 5=some graduate school. ^cNonverbal: Columbia Mental Maturity Scale, age deviation score (M=100, SD=15). ^dBehavioural: Child Behavior Checklist, attention problems scale T score (M=50, clinical cut-off=67). ^eLanguage: Test of Language Development Primary-3rd Ed., spoken language quotient (M=100, SD=15).

Scale (CMMS; Burgemesiter, Blum and Lorge, 1972), establishing normal levels of non-verbal achievement (i.e. an age deviation score 85 or higher); (d) a phonological screening, verifying consistent use of word final -s, -z, -t and -d (9/10 items correct); (e) the Test of Language Development Primary-3rd Edition (TOLDP-3; Newcomer and Hammill, 1997), documenting the participant's general language levels; and (f) the Child Behavior Checklist (CBCL; Achenbach, 1991), documenting the participant's behavioural status.

Potential SLI participants were recruited from the University of Utah Speech, Language, and Hearing Clinic and from the caseloads of certified speech language pathologists in neighbouring school districts. To be included in the SLI group (seven boys, three girls; ten Caucasian), children needed to demonstrate the following characteristics: (a) a diagnosis of language impairment by a certified speech language pathologist and receipt of services at the time of the study; (b) a performance below 1.0 SD on at least two of the six core subtests from the test of TOLD-P 3; and (c) no concomitant diagnosis of autism, PDD, or ADHD.

Potential ADHD participants were recruited through referrals from paediatricians, psychiatrists and clinical psychologists practicing in Salt Lake City and surrounding communities. To be included in the ADHD group (nine boys, one girl; nine Caucasian, one Hispanic), children needed to demonstrate the following characteristics: (a) a diagnosis of ADHD by a licensed psychiatrist or clinical psychologist and receipt of services at the time of the study; (b) a behavioural rating greater than 1.0 SD above the mean on the Attention Problems sub-scale of the CBCL (Achenbach, 1991); (c) no concomitant diagnosis of autism, PDD, language impairment, phonological disorder or learning/reading disability. All of the children in the ADHD group had been diagnosed as having the 'combined type' ADHD (i.e. they had met criteria for both 'inattention' and 'hyperactivity-impulsivity'). All of the children with ADHD were receiving stimulant medication for the management of their symptoms at the time of the study and all data were collected from these children under medication (within 4 hours of their last dose). The decision to assess children on medication was motivated by the guidelines for best practice provided by the American Speech-Language-Hearing Association, (ASHA, 1997, spring), and was considered to be consistent with the principles of reasonable accommodation.

Potential TD participants were recruited through after-school and day-care programmes in the same communities as the children in the other two groups. Children included in the TD group (nine boys, four girls, 12 Caucasian, one Hispanic) presented with unremarkable developmental and educational histories (as indicated by parental report), were not receiving any special or remedial services at the time of the study, and scored within normal limits (≥ 1.0 SD) on each of the standardized measures of verbal, non-verbal and behavioural performance used in this study.

Procedures

In addition to the assessment protocol, participants in the study completed experimental tasks measuring their sentence recall and production of past tense morphology. Children's responses were recorded online by an examiner as well as audiotape recorded using Sony TC-D5 PRO II tape recorders with tiepin ECM-T140 external microphones.

Two measures of sentence recall performance were collected. The sentence imitation subtest of the TOLD-P3 (Newcomer and Hammill, 1997) provides a norm referenced measure of children's ability to repeat sentences of increasing length and grammatical complexity. Like most standardized measures of sentence recall, children's responses are

recorded as either 'correct' or 'incorrect' and a ceiling procedure is used to discontinue item administration. In order to insure an equal number of items across groups and to examine more closely the errors children produced, an experimental sentence recall probe was developed consisting of 16 sentences (Appendix A). These stimuli sentences were each composed of ten words (representing ten to 14 syllables) and contained an equal number of active and passive sentences. This particular stimuli length and these specific sentence types were chosen to insure that children in the typically developing group would produce enough errors during the task to permit group comparisons.

Children's production of past tense morphology was measured using the past tense elicitation procedure developed by Rice and her colleagues (Rice, Wexler and Cleave, 1995; Rice, Wexler and Hershberger, 1998). With minor stimuli differences, the protocol used in this study was similar to the one available in the Test of Early Grammatical Impairment (TEGI; Rice and Wexler, 2001). Briefly, a picture depicting a person engaged in an ongoing action followed by a second picture showing the action completed was presented to each participant. The examiner then instructed the participant to tell them what the person in the pictures did. Complete sentences containing eleven different regular verbs and eight irregular verbs were elicited (see Rice *et al.*, 1995, for further details).

Reliability

Responses from six children (two selected randomly from each group) were used to measure inter-rater reliability on the experimental probes. An undergraduate student in the Department of Communication Sciences and Disorders served as an independent judge and compared her responses to those recorded online by the examiner. Inter-rater agreement was calculated for the probes using the total number of agreements divided by the total number of agreements+disagreements and yielded a value of 95% for the sentence recall probe and 98% for the past tense elicitation probe.

Results

Table II displays the group means and standard deviations associated with each of the dependent measures. Group differences were explored through parametric analyses. Omnibus one-way between subjects ANOVAs were used to verify the presence of significant group differences.¹ In those instances where homogeneity of variance could be assumed, follow-up Dunn-Sidak analyses identified pair-wise comparisons that reached the 0.05 level of significance. In those instances where Levene's Test for Homogeneity of Variances was significant, follow-up Dunnett's C analyses identified pair-wise comparisons that reached the 0.05 level of significance. Box-plots were used to examine further the degree of overlap between groups on the dependent variables, which are presented in figures 1–6.

Deficits in sentence recall have been previously reported in study samples of children with SLI as well as in samples of children with ADHD. Group means and standard deviations for the three measures of sentence recall were as follows: standard scores on the TOLD-P3 sentence imitation subtest, SLI $M=4.3$, $SD=1.57$; ADHD $M=8.0$, $SD=4.06$; TD $M=11.08$, $SD=1.89$, total number correct on the recall probe, SLI $M=0.70$,

¹ Since the obtained alpha level for the group matching measure (chronological age) was relatively low ($p=0.156$), an alternative strategy for the data analyses reported here would be to treat chronological age as a covariate. This strategy was carried out in a series of ANCOVAs which yielded identical outcomes. We conclude that variance in chronological age did not influence the results and report the ANOVA outcomes only.

Table II. Sentence recall and past tense marking: group means and (standard deviations)

	SLI	ADHD	TD
Sentence Recall			
1. TOLD-P 3 Sentence Imitation standard score	4.3 (1.57)	8.0 (4.06)	11.08 (1.89)
2. Recall Probe: Total number correct	0.70 (0.82)	5.20 (3.12)	7.60 (2.44)
3. Recall Probe: Total number of errors	67.50 (21.67)	32.0 (22.78)	19.92 (15.53)
Past Tense Marking			
1. Regular verbs marked for tense	0.55 (0.48)	0.97 (0.04)	0.97 (0.04)
2. Irregular verbs marked for tense	0.60 (0.35)	0.97 (0.06)	0.98 (0.05)
3. Irregular verbs over-regularized	0.32 (0.34)	0.25 (0.21)	0.35 (0.27)

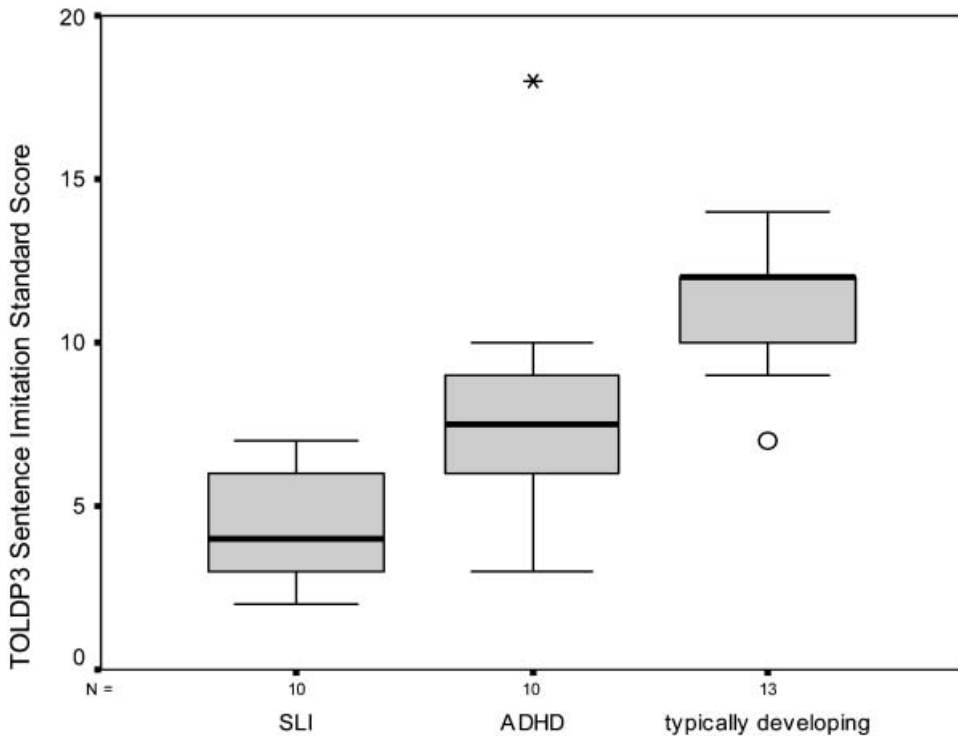


Figure 1. Box-plots for TOLDP-3 sentence imitation standard scores, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (o) and extreme scores (*).

SD=0.82, ADHD M=5.20, SD=3.12, TD M=7.60, SD=2.44, and total number of errors produced during the recall probe, SLI M=67.50, SD=21.67, ADHD M=32.00, SD=22.78, TD M=19.92, SD=15.53. On all three measures of sentence recall, group differences were significant and observed effect sizes were large [TOLD-P3 standard scores: $F(2, 30)=18.287, p<0.0001 (\eta^2 0.549)$; total correct on the recall probe: $F(2, 30)=24.828, p<0.0001 (\eta^2 0.623)$; total errors on the recall probe: $F(2, 30) 16.941, p<0.0001 (\eta^2 0.530)$]. Homogeneity of variances was assumed for TOLD-P3 standard scores and total errors on the recall probe and the following Dunn-Sidak pair-wise comparisons reached the 0.05 level of significance for both measures: TOLD-P3 standard scores: $SLI<ADHD<TD$; total recall probe errors: $TD<ADHD<SLI$. Homogeneity of variance

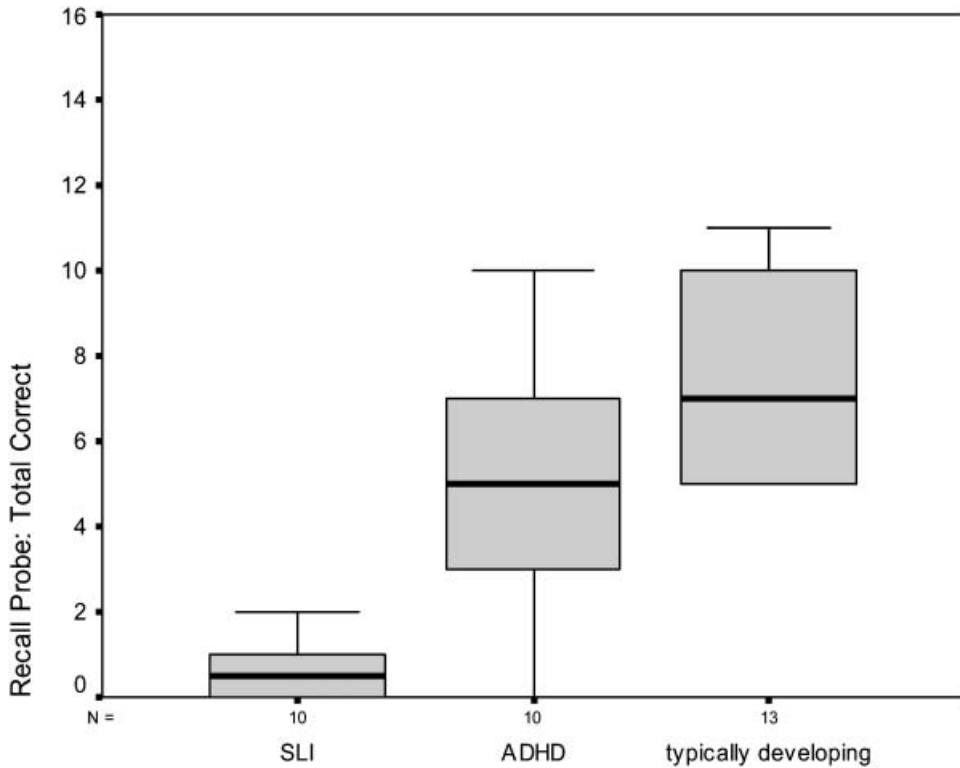


Figure 2. Box-plots for sentence recall probe total correct, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

was not assumed for total correct on the recall probe. The following Dunnett's C pairwise comparisons reached the 0.05 level of significance: $SLI < ADHD = TD$. Box-plots for measures of sentence recall are presented in figures 1–3 and document the presence of outliers and extreme scores within the ADHD and TD groups. As displayed in figure 1, an outlier was observed within the ADHD group and an extreme score was present within the TD group on the TOLD-P3 sub-test. In this case, one ADHD participant scored significantly higher than any of the other children in the ADHD group (receiving the highest score across all three groups on this task). One child in the TD group performed significantly poorer than the other children in this group and had a standard score that was similar to the median performance of the ADHD group. Extreme scores were also observed in the ADHD and TD groups on the measure of total errors produced during the recall probe (see figure 3). In this case, children's performances were closer to the SLI group median than their respective group medians.

These results suggest that deficits in sentence recall were generally characteristic of both groups of affected children, and that differences between the SLI and ADHD groups of children on this measure were more a matter of degree, with children in the SLI group demonstrating relatively greater difficulty with these tasks and producing more errors than children in the ADHD group. However, within group variation was also large, especially within the ADHD group.

Production of past tense morphology has been shown to be particularly challenging for children with SLI as well as for other groups of children with developmental language

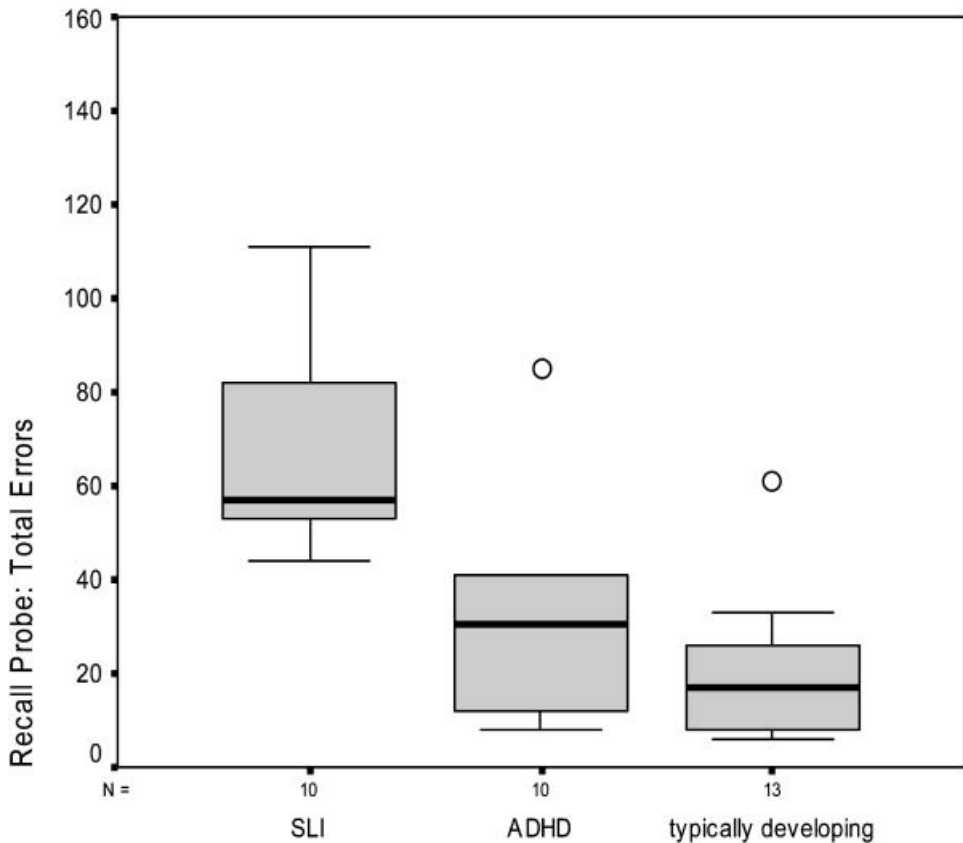


Figure 3. Box-plots for sentence recall probe total number of errors produced, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (o) and extreme scores (*).

impairments. This study is the first to examine this particular area of grammatical development in children with ADHD. Children's productions of regular verb targets and irregular verb targets were considered separately. Group means and standard deviations for regular verbs marked for tense were as follows: SLI $M=0.55$, $SD=0.48$; ADHD $M=0.97$, $SD=0.04$; TD $M=0.97$, $SD=0.04$. Group differences were significant and the observed effect size was large [$F(2, 30)=11.264$, $p<0.0001$ ($\eta^2=0.429$)]. Homogeneity of variances was not assumed. The following Dunnett's C pair-wise comparisons were significant at the 0.05 level of significance: $SLI < ADHD = TD$. As the box-plots in figure 4 show, considerable variation was present within the SLI group but that near-uniformly high levels of past tense marking were present within both the ADHD and TD groups. There were two outliers within the ADHD group, but even in these cases, their performances were still considerably higher than the median performance of the SLI group (85–90% vs. 75%).

Children's productions of irregular verbs were considered in two different ways. Following the analytical procedures outlined in Rice, Wexler, Marquis and Hershberger's (2000) study of the acquisition of irregular verbs, a proportion of irregular verbs responses marked for tense was calculated for each participant. Under this analysis, both irregular past tense and over-regularized past tense forms were considered 'correct' (e.g. *she fell into the net* and *she falled into the net*) and unmarked bare stems or non-finite verb forms were

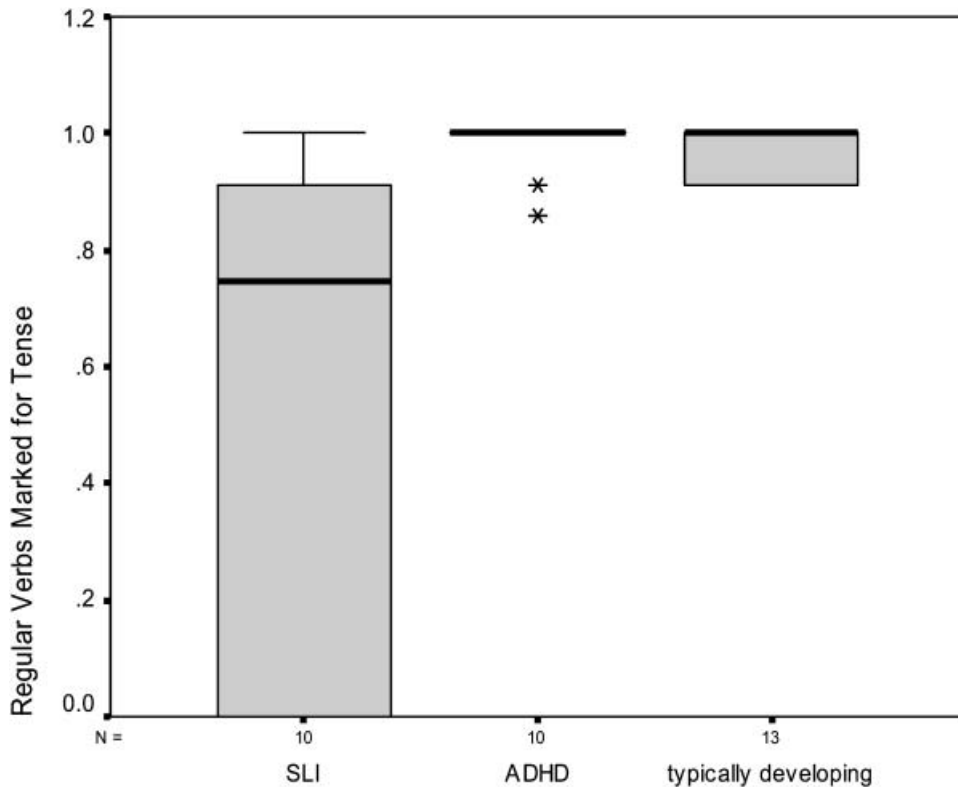


Figure 4. Box-plots for proportion of regular verbs marked for tense, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

considered 'incorrect' (e.g. *she fall into the net*). This calculation yields an estimate of how often children chose to mark tense on irregular verbs, regardless of whether or not it was correctly marked. Group means and standard deviations for irregular verbs marked for tense were as follows: SLI $M=0.60$, $SD=0.35$; ADHD $M=0.97$, $SD=0.06$; TD $M=0.98$, $SD=0.05$. Group differences were significant and observed effect sizes were large [$F(2, 30)=12.884$, $p<0.0001$ ($\eta^2 0.462$)]. Homogeneity of variance was not assumed for the production of irregular verbs marked for tense. The following Dunnett's C pair-wise comparisons reached the 0.05 level of significance: $SLI < ADHD = TD$. Box-plots for the proportion of irregular verbs marked for tense mirror quite closely those produced for regular verbs marked for tense (compare figures 4 and 5), including the presence of the same outliers within the ADHD and TD groups. This suggests that these two measures tapped into the same mechanisms of linguistic maturation. From a morphophonological standpoint, this outcome is somewhat surprising given that the operations of past tense marking are quite different between regular and irregular verbs. In the first case, past tense is marked with the inclusion of the brief, unstressed, suffix *-ed* to the bare stem and in the second, various irregular alternations are involved, many of which include highly salient internal vowel changes. This result is consistent, however, with the morphosyntactic framework offered by Wexler (1994) and Rice and Wexler (1996). Under this account, the free and bound morphemes involved in tense marking in English (i.e. the regular past tense *-ed*, the irregular past tense forms, the regular third person singular present tense *-s*, the

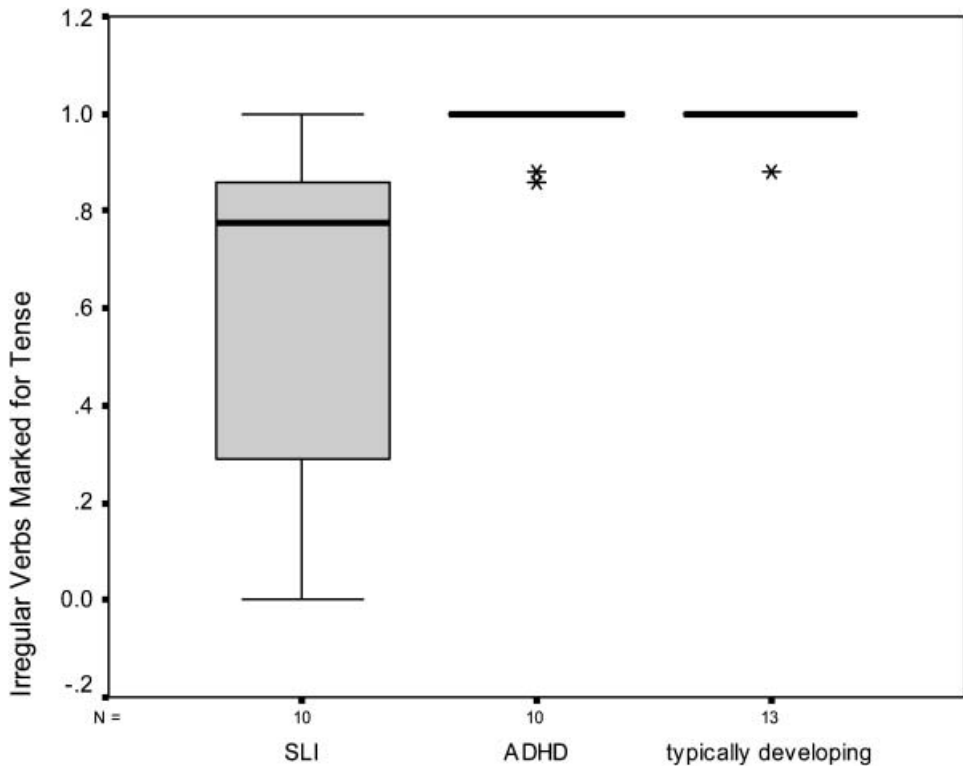


Figure 5. Box-plots for proportion of irregular verbs marked for tense, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (o) and extreme scores (*).

irregular third person singular, the copula BE, the auxiliary BE and other auxiliary forms) develop as a coherent set representing the maturation of children's appreciation that the grammatical feature of tense is an obligatory aspect of main clauses.

For each participant, the proportion of their irregular verb responses that represented over-regularization errors was also calculated. Group means and standard deviations for children's productions of over-regularized irregular verbs were as follows: SLI $M=0.25$, $SD=0.21$; ADHD $M=0.32$, $SD=0.34$; TD $M=0.35$, $SD=0.27$. Group differences were not significant: $p=0.694$. As the box-plots in figure 6 illustrate, considerable overlap was present across the three groups on this measure. This suggests that over-regularization errors offer little diagnostic information for children between the ages of 5 to 8 years. This result also suggests that we cannot attribute the problems that children with SLI have with the production of past tense morphology to a general limitation in knowing or applying the morphological mechanisms associated with indicating tense.

Discussion

Historically, SLI has been a diagnosis based on exclusion. Children with language impairments are required to be cognitively, motorically, perceptually and socioemotionally intact before this classification can be applied to them (cf. Stark and Tallal, 1981). In the last decade, there has been shift away from investigations focusing on the integrity of the exclusionary criteria used to diagnose the condition toward a more deliberate evaluation of

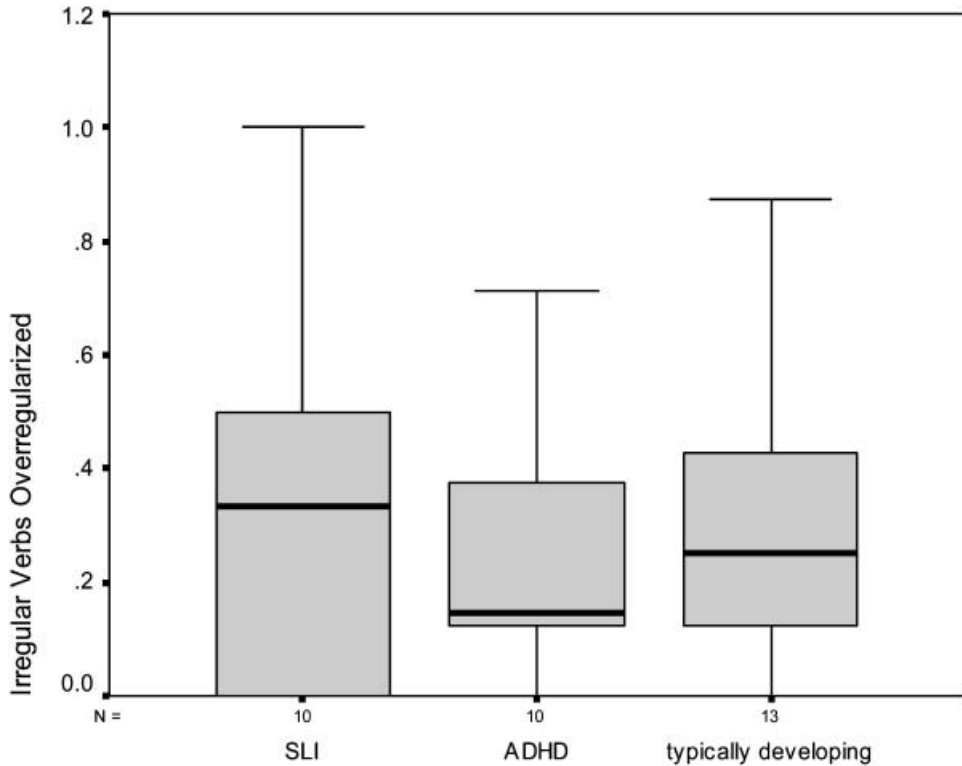


Figure 6. Box-plots for proportion of irregular verbs over-regularized, displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

the inclusionary criteria (cf. Tager-Flusberg and Cooper, 1999). Three indices of language impairment have consistently demonstrated very high levels of sensitivity and specificity: sentence recall, non-word repetition, and production of tense marking morphology. In this study, sentence recall and the production of past tense morphology was examined in children with SLI and compared to children with ADHD and children with typical development.

Important similarities and differences were noted between the SLI and ADHD groups of children. Both clinical groups performed significantly poorer than the typically developing controls on measures of sentence recall. In particular, children in the SLI group found these tasks especially challenging. These results suggest that some overlap may exist between SLI and ADHD in the areas of working memory/language processing and appear to support Cohen *et al.*'s (2000) characterization of the language deficits associated with ADHD. Another possibility, however, is that children with ADHD did poorly on the sentence recall tasks because these represent rote, de-contextualized, non-meaningful activities and their performance limitations were more the result of problems these children have with distractibility/impulsivity than an internalized problem with working memory/language processing.

Production of past tense morphology during a rote, de-contextualized, non-meaningful task, however, was not compromised in this study sample of children with ADHD. It was only characteristic of children in the SLI group. Children with SLI produced more bare

stems with both regular and irregular verbs than children in the ADHD and TD groups. All three groups, however, demonstrated similar levels of over-regularization errors, suggesting that only bare stem errors or non-finite forms have any diagnostic value.

Interestingly, the psycholinguistic profiles of participants in the ADHD group were very similar to the profiles reported by Frazier Norbury *et al.* (2001) for children with mild-moderate sensorineural hearing loss. The finding that sentence recall could be compromised in children with ADHD in the presence of intact command of past tense marking further supports Rice's (2003) suggestion that the maturation of tense indexes a specific linguistic deficit in children with SLI that exists in the presence of a general language delay. Other groups of children with language delays may also demonstrate this particular deficit (as in the case of children with general delays/non-specific language impairments or Down syndrome). However, significant language delays can also exist in the absence of deficits in tense marking (as in the cases of children with William's syndrome, sensorineural hearing loss, or ADHD).

The results of this study have some implications for clinical practice. Sentence recall tasks have long been used by speech clinicians to screen children for potential language impairments (Carrow, 1974; Hammill and Newcomer, 1977; Lee, 1971). The validity of these measures has also been called into question because sentence recall does not necessarily reflect children's performance during spontaneous productions (Lahey, Launer and Schiff-Myers, 1983; Prutting and Connolly, 1976). On the other hand, sentence recall has been shown to be sensitive to subtle, sub-clinical deficits that might persist in some older children with language impairments as well as in compensated adults with a positive history of language impairments (Conti-Ramsden, 2003; Conti-Ramsden *et al.*, 2001; Records, Tomblin and Freese, 1992). The results of this study support the continued use of sentence recall for language screening purposes. As a group, children in the typically developing group performed considerably better than children in either the ADHD or SLI groups, suggesting that sentence recall measures represent a quick and efficient procedure for screening large numbers of children for language impairments.

The extent to which sentence recall could be used to differentiate children with ADHD from children with SLI, however, is less clear. For example, Tomblin *et al.* (1996) established a language screening measure based on the predictive validity of selected items from the TOLD-P2. A large portion of these items (38%) were taken from the test battery's sentence imitation sub-test. If we use the suggested standard score cut-off of greater than 1.25 standard deviations below the mean on the TOLD-P3 sentence imitation subtest, we would have identified most of the children in the SLI group and about half of the children in the ADHD group. However, if a more stringent cut-off value is used or if we considered the amount of errors children produced during sentence recall as well as their overall levels of accuracy, then the two clinical groups could potentially be separated with greater accuracy. Future research should identify which modifications of sentence recall protocols yield the highest levels of sensitivity and specificity.

Differentiation of SLI from ADHD was much clearer for the past tense morphology production task. This suggests that an assessment of children's command of tense marking should be included in protocols used by speech clinicians and mental health care professionals to differentially diagnosis SLI and ADHD. Other measures of grammatical development, such as complex sentence production (cf. Schuele and Tolbert, 2001) or other indices of working memory, such as non-word repetition, may also prove to be discriminative and future research should investigate these possibilities as well.

In this study, all of the children in the ADHD group had received a primary diagnosis of ‘combined type’ ADHD by their physicians/clinical psychologists. Thus, the results of this study may not generalize to children with either ‘predominately inattentive type’ ADHD or ‘predominately hyperactive-impulsive type’ ADHD. Future studies should examine clinical markers of language impairment across different sub-groups of ADHD as well as across children with ADHD comorbid with other conditions (e.g. reading disability, conduct disorder, tic disorder). Another limitation of the current study is that children in the ADHD group were receiving a variety of stimulant medications/doses. Testing was conducted while the children were under medication so it is unclear how much of the variation observed within the group’s performance could have been attributed to these differences. Future investigations should consider the potential impact that different pharmaceutical regimens have on children’s sentence recall, non-word repetition, or tense marking. These new lines of research have the potential to further improve current clinical practices. A greater appreciation of the psycholinguistic similarities and differences between SLI and ADHD represents an important first step towards insuring that children with all different kinds of developmental language impairments receive the full range of therapeutic services they deserve.

Acknowledgements

Portions of this study were presented at the 2000 American Speech, Language, and Hearing Association annual convention, Washington, DC. This study was supported by an intramural development grant provided by the University of Utah. I am greatly indebted to the children and their families for their generosity. Appreciation is extended to the following people for their assistance in recruiting potential ADHD participants: Dr. Dave Folland, M.D., Mountain View Pediatrics, Sandy, Utah; Dr. Sam Goldstein, Ph.D., director of the Neurology, Learning, and Behavior Center, Salt Lake City, Utah; and Dr. Marvin Goldstein, Ph.D., director of Valley Mental Health, Midvale, Utah. Appreciation is also extended to the program directors and speech-language pathologists from the Granite School District and the University of Utah Speech-Language-Hearing clinic and to the teachers and staff at the Professional Child Care and Learning Center and the Kindercare day care centres of Salt Lake City for their help locating potential SLI and typically developing participants. Several graduate and undergraduate students from the University of Utah Department of Communication Sciences and Disorders assisted in various aspects of the project and deserve recognition for their contributions: Andrea Ash, Sarah Deimund, Jennifer Driggs, Alycia Jordison, Kristen Copeland, Carol Huitema, Kristy Jack, Monika Liebergesell, Elizabeth Nelson, Kim Newcom, Heather Nielsen, Joelle Rasmussen and Jayne Shaum.

References

- Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist/4-18*. Burlington, VT: University of Vermont Press.
- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition. Washington, DC: American Psychiatric Association.
- American Speech-Language-Hearing Association. (1997). Roles of Audiologists and speech-language pathologists working with persons who have attention deficit hyperactivity disorder, position statement and technical report. *Asha*, 39(Suppl 17), 273–300.
- Barkley, R. A. (1997). *ADHD and the Nature of Self-control*. New York, NY: Guilford.
- Beitchman, J. H., Brownlie, E. B., & Wilson, B. (1996). Linguistic impairment and psychiatric disorder: pathways to outcome. In J. H. Beitchman, N. J. Cohen, M. M. Konstantareas, & R. Tannock (Eds.), *Language, Learning,*

- and Behavior disorders: *Developmental, biological, and clinical perspectives* (pp. 494–514). New York: Cambridge University Press.
- Beitchman, J. H., Nair, R., Clegg, M., Ferguson, B., & Patel, P. G. (1986). Prevalence of psychiatric disorders in children with speech and language disorders. *Journal of the American Academy of Child Psychiatry*, 25, 528–535.
- Bishop, D. V. M., Bishop, S. J., Bright, P., James, C., Delaney, T., & Tallal, P. (1999). Different origin of auditory and phonological processing problems in children with language impairment: Evidence from a twin study. *Journal of Speech, Language, and Hearing Research*, 42, 155–168.
- Bishop, D. V. M., North, T., & Donlan, C. (1996). Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study. *Journal of Child Psychology and Psychiatry*, 37, 391–403.
- Burgemeister, B. B., Blum, L. H., & Lorge, I. (1972). *The Columbia Mental Maturity Scale*. San Antonio, TX: Psychological Corporation.
- Carrow, E. (1974). A test using elicited imitations in assessing grammatical structure in children. *Journal of Speech and Hearing Disorders*, 39, 437–444.
- Chiat, S. (2000). *Understanding Children with Language Problems*. Cambridge: Cambridge University Press.
- Cohen, N. J., Davine, M., Horodezky, N., Lipsett, L., & Isaacson, L. (1993). Unsuspected language impairment in psychiatrically disturbed children: Prevalence and language and behavioral characteristics. *Journal of the American Academy of Child and Adolescent Psychiatry*, 32, 595–603.
- 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.
- Cohen, N. J., Vallance, D. D., Barwick, M., Im, N., Menna, R., Horodezky, N. B., & Isaacson, L. (2000). The interface between ADHD and language impairment: An examination of language, achievement, and cognitive processing. *Journal of Child Psychology and Psychiatry*, 41, 353–362.
- Conti-Ramsden, G. (2003). Processing and linguistic markers in young children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 46, 1029–1037.
- Conti-Ramsden, G., Botting, N., & Faragher, B. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology, Psychiatry, and Allied Disciplines*, 42, 741–748.
- Dollaghan, C., & Campbell, T. (1998). Non-word repetition and child language impairment. *Journal of Speech, Language, and Hearing Research*, 42, 1414–1431.
- Eadie, P. A., Fey, M. E., Douglas, J. M., & Parsons, C. L. (2002). Profiles of grammatical morphology and sentence imitations in children with specific language impairment and Down syndrome. *Journal of Speech, Language, and Hearing Research*, 45, 720–732.
- Ellis Weismer, S., Tomblin, J. B., Zhang, X., Buckwalter, P., Gaura Chynoweth, J., & Jones, M. (2000). Non-word repetition performance in school-age children with and without language impairment. *Journal of Speech, Language, and Hearing Research*, 43, 865–878.
- Frazier Norbury, C., Bishop, D. V. M., & Briscoe, J. (2001). Production of English finite verb morphology: A comparison of SLI and mild-moderate hearing impairment. *Journal of Speech, Language, and Hearing Research*, 44, 165–178.
- Goodyer, I. M. (2000). Language difficulties and psychopathology. In D. V. M. Bishop, & L. B. Leonard (Eds.), *Speech and Language Impairments in Children: Causes, characteristics, intervention and outcome* (pp. 227–244). Philadelphia, PA: Taylor & Francis.
- Hammill, D. D., & Newcomer, P. L. (1977). *Construction and statistical characteristics of the Test of Language Development*. Austin, TX: PRO-ED.
- 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.
- Kim, O. H., & Kaiser, A. P. (2000). Language characteristics of children with ADHD. *Communication Disorders Quarterly*, 21, 154–165.
- Lahey, M., Launer, P., & Schiff-Myers (1983). Prediction of production: Elicited imitation and spontaneous speech productions of language-disordered children. *Applied Psycholinguistics*, 4, 319–343.
- Laws, G., & Bishop, D. V. M. (2003). A comparison of language abilities in adolescents with Down syndrome and children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 46, 1324–1339.
- Lee, L. (1971). *The Northwestern Syntax Screening Test*. Evanston, IL: Northwestern University Press.
- Leonard, L. B. (1998). *Children with Specific Language Impairment*. Cambridge, MA: MIT Press.

- 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.
- Melamed, L. E., & Wozniak, J. R. (1999). Neuropsychology, language, and behavior. In D. Roger-Adkinson, & P. Griffith (Eds.), *Communication Disorders and Children with Psychiatric and Behavioral Disorders* (pp. 99–139). San Diego, CA: Singular.
- Newcomer, P. L., & Hammill, D. D. (1997). *Test of Language Development-Primary*, 3rd edition. Austin, TX: Pro-Ed.
- NIH Consensus Development Panel. (2000). National Institutes of Health Consensus Development Conference statement: Diagnosis and treatment of attention-deficit/hyperactivity disorder (ADHD). *Journal of the American Academy of Child and Adolescent Psychiatry*, 39, 182–193.
- Oetting, J. B., & Horohov, J. E. (1997). Past-tense marking by children with and without specific language impairment. *Journal of Speech, Language, and Hearing Research*, 40, 62–74.
- Prutting, C. A., & Connolly, J. E. (1976). Imitation: A closer look. *Journal of Speech and Hearing Disorders*, 41, 412–422.
- Purvis, K. L., & Tannock, R. (1997). Language abilities in children with attention deficit hyperactivity disorder, reading disabilities, and normal controls. *Journal of Abnormal Child Psychology*, 25, 133–144.
- Records, N. L., Tomblin, J. B., & Freese, P. R. (1992). The quality of life of young adults with histories of specific language impairment. *American Journal of Speech-Language Pathology*, 1, 44–53.
- Redmond, S. M. (in press). Conversational profiles of children with ADHD, SLI, and typical development. *Clinical Linguistics and Phonetics*.
- Rice, M. L. (1996). *Toward a Genetics of Language*. Mahwah, NJ: Lawrence Erlbaum.
- Rice, M. L. (2000). Grammatical symptoms of specific language impairment. In D. V. M. Bishop, & L. B. Leonard (Eds.), *Speech and Language Impairments in Children: Causes, characteristics, intervention and outcome* (pp. 17–34). Philadelphia, PA: Taylor & Francis.
- Rice, M. L. (2003). A unified model of specific and general language delay: Grammatical tense as a clinical marker of unexpected variation. In Y. Levy, & J. Schaeffer (Eds.), *Language Competence Across Populations: Toward a definition of specific language impairment* (pp. 63–95). Mahwah, NJ: Lawrence Erlbaum Associates.
- Rice, M. L. (in press). Growth models of developmental language disorders. In M. L. Rice, & S. F. Warren (Eds.), *Developmental Language Disorders: From phenotypes to etiologies*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Rice, M. L., & Wexler, K. (1996). Toward tense as a clinical marker of specific language impairment in English speaking children. *Journal of Speech and Hearing Research*, 39, 1239–1257.
- Rice, M. L., & Wexler, K. (2001). *Rice/Wexler Test of Early Grammatical Impairment*. San Antonio, TX: The Psychological Corporation.
- Rice, M. L., Mervis, C., Klein, B. P., & Rice, K. J. (1999). Children with William's syndrome do not show an EOI stage. Paper presented at the Boston University Conference in Child Language Disorders, Madison, WI.
- Rice, M. L., Tomblin, J. B., Marquis, J., Richman, W. A., Zhang, X., & Hoffman, L. (under review). Grammatical tense deficits in children with SLI and non-specific language impairment: relationships with non-verbal IQ over time.
- Rice, M. L., Wexler, K., & Cleave, P. (1995). Specific language impairment as a period of Extended Optional Infinitive. *Journal of Speech and Hearing Research*, 38, 850–863.
- Rice, M. L., Wexler, K., Marquis, J., & Hershberger, S. (2000). Acquisition of irregular past tense by children with SLI. *Journal of Speech, Language, and Hearing Research*, 43, 1126–1145.
- Rice, M. L., Wexler, K., & Hershberger, S. (1998). Tense over time: The longitudinal course of tense acquisition in children with specific language impairment. *Journal of Speech and Hearing Research*, 41, 1412–31.
- Robinson, B. F., Mervis, C. B., & Robinson, B. W. (2003). The roles of verbal short-term memory and working memory in the acquisition of grammar by children with Williams syndrome. *Developmental Neuropsychology*, 23, 13–31.
- Scahill, L., & Schwab Stone, M. (2000). Epidemiology of ADHD in school-age children. *Child and Adolescent Psychiatric Clinics of North America*, 9, 541–555.
- Schuele, C. M., & Tolbert, L. (2001). Omissions of obligatory relative markers in children with specific language impairment. *Clinical Linguistics and Phonetics*, 15, 257–274.
- SLI Consortium. (2002). A genome wide scan identifies two novel loci involved in specific language impairment. *American Journal of Human Genetics*, 70, 384–398.
- Stark, R., & Tallal, P. (1981). Selection of children with specific language deficits. *Journal of Speech and Hearing Disorders*, 46, 114–122.
- Sztamari, P., Offord, D. R., & Boyle, M. H. (1989). Ontario child health study: Prevalence of attention deficit disorder with hyperactivity. *Journal of Child Psychology and Psychiatry*, 30, 219–230.
- Tager-Flusberg, H. (1999). Language development in atypical children. In M. Barrett (Ed.), *The Development of Language* (pp. 311–348). Hove: Psychology Press.

- Tager-Flusberg, H., & Cooper, J. (1999). Present and future possibilities for defining a phenotype for specific language impairment. *Journal of Speech, Language, and Hearing Research, 42*, 1275–1278.
- Tallal, P. (2000). Experimental studies of language learning impairments: From research to remediation. In D. V. M. Bishop, & L. B. Leonard (Eds.), *Speech and Language Impairments in Children: Causes, characteristics, intervention and outcome* (pp. 131–156). Philadelphia, PA: Psychology Press.
- Tallal, P., Dukette, D., & Curtiss, S. (1989). Behavioural/emotional profiles of preschool language-impaired children. *Development and Psychopathology, 1*, 51–67.
- Tannock, R., & Schachar, R. (1996). Executive dysfunction as an underlying mechanism of behaviour and language problems in attention deficit hyperactivity disorder. In J. H. Beitchman, N. J. Cohen, M. M. Konstantareas, & R. Tannock (Eds.), *Language, Learning, and Behaviour Disorders: Developmental, biological, and clinical perspectives* (pp. 128–155). Cambridge: Cambridge University Press.
- Tirosh, E., & Cohen, A. (1998). Language deficit with attention-hyperactivity disorder: A prevalent comorbidity. *Journal of Child Neurology, 13*, 493–497.
- Tomblin, J. B. (1996). Genetic and environmental contributions to the risk of specific language impairment. In M. L. Rice (Ed.), *Toward a Genetics of Language* (pp. 191–210). Mahwah, NJ: Lawrence Erlbaum.
- Tomblin, J. B., & Zhang, X. (1999). Language patterns and etiology in children with specific language impairment. In H. Tager-Flusberg (Ed.), *Neurodevelopmental Disorders* (pp. 361–382). Cambridge, MA: MIT Press.
- Tomblin, J. B., Freese, P. R., & Records, N. L. (1992). Diagnosing specific language impairment in adults for the purpose of pedigree analysis. *Journal of Speech and Hearing Research, 35*, 832–843.
- Tomblin, J. B., Records, N. L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research, 6*, 1245–1261.
- Tomblin, J. B., Records, N. L., & Zhang, X. (1996). A system for the diagnosis of specific language impairment in kindergarten children. *Journal of Speech and Hearing Research, 39*, 1284–1294.
- van der Lely, H. K. J. (2003). Do heterogeneous deficits require heterogeneous theories? SLI sub-groups and the RDDH hypothesis. In Y. Levy, & J. Schaeffer (Eds.), *Language Competence Across Populations: Toward a definition of specific language impairment* (pp. 109–134). Mahwah, NJ: Lawrence Erlbaum Associates.
- Wexler, K. (1994). Optional infinitives. In D. Lightfoot, & N. Hornstein (Eds.), *Verb Movement* (pp. 305–350). New York: Cambridge University Press.
- Zhang, X., & Tomblin, J. B. (2000). The association of intervention receipt with speech-language profiles and social demographic variables. *American Journal of Speech-Language Pathology, 9*, 345–357.

Appendix A

Sentence Recall Probe

Introducing Scenario: ‘Listen. I am going to say some sentences. After I have finished, I want you to say exactly what I have said. Say the same thing. Let’s try a sentence. Are you ready? Tom and his brother like to eat all the candy’.

1. The big football player washed the car with the hose.
2. All of the pictures were coloured by his little sister.
3. The rose bushes were planted yesterday by the girl scouts.
4. The happy little girl kicked the ball over the fence.
5. His little brother cleaned the dirty dishes and cups.
6. A special cage was made to hold the dangerous animals.
7. Everybody in my school coloured Easter eggs for the picnic.
8. A new hole was dug for the kid’s swimming pool.
9. Only the first graders made a birdhouse for their parents.
10. My little sister’s dog caught the ball on the first bounce.
11. The soccer ball was kicked into the school’s parking lot.
12. The lion’s teeth were cleaned with a giant toothbrush.
13. Some of the kids dug holes in the sand two feet deep.
14. The little white mouse was caught by our neighbour’s cat.
15. The second grade students planted coconuts in the garden.
16. The dirty clothes were washed with soap one more time.

Copyright of Clinical Linguistics & Phonetics is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.