

Research Article

Consequences of Co-Occurring Attention-Deficit/Hyperactivity Disorder on Children's Language Impairments

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Purpose: Co-occurring attention-deficit/hyperactivity disorder (ADHD) and communication disorders represent a frequently encountered challenge for school-based practitioners. The purpose of the present study was to examine in more detail the clinical phenomenology of co-occurring ADHD and language impairments (LIs).

Method: Measures of nonword repetition, sentence recall, and tense marking were collected from 57 seven- to nine-year-old children. The performances of children with ADHD+LI status were compared with those of children with specific language impairment (SLI) and children with typical development (TD).

Results: ADHD status had no independent detrimental impact on the affected children's LIs (SLI = ADHD+LI < TD). A modest positive correlation was found between the severity of children's ADHD symptoms and their sentence recall performance, suggesting a tendency for affected children who had higher levels of ADHD symptoms to perform better than those children with lower levels.

Conclusion: These outcomes are difficult to reconcile with attention-deficit/information-processing accounts of the core deficits associated with SLI. Potential protective mechanisms associated with ADHD status are discussed.

Attention-deficit/hyperactivity disorder (ADHD) refers to the presence of pronounced difficulties in the areas of inattention, distractibility, and hyperactivity that lead to significant impairments in academic and social functioning. ADHD is one of the most commonly diagnosed clinical conditions worldwide, affecting approximately 5%–7% of the student population (American Psychiatric Association, 2013; Willcutt, 2012). Co-occurring ADHD and communication disorders represent a frequently encountered challenge for school-based practitioners (American Speech-Language-Hearing Association, 2008), and determining the source of children's academic and social difficulties as language based, attention based, or a combination of both can be a daunting task for assessment teams. ADHD has also been one of the most frequently reported co-occurring neurodevelopmental disorders in study samples of children with language impairments (LIs; Beitchman, Hood, & Inglis, 1990; Benasich, Curtiss, &

Tallal, 1993; Lindsay, Dockrell, & Strand, 2007; St. Clair, Pickles, Durkin, & Conti-Ramsden, 2011; Willinger et al., 2003), although the literature provides some discrepant findings on the extent to which co-occurrence rates have exceeded expectations based on general population estimates (Lindsay & Dockrell, 2008; Redmond & Rice, 2002; Rescorla, Ross, & McClure, 2007; Whitehouse, Robinson, & Zubrick, 2011).

Even though the significance to clinical practice has long been recognized (Chess, 1974), the implications of the co-occurrence of ADHD and LI still remain poorly understood. The purpose of the present study was to examine in more detail the clinical phenomenology of co-occurring ADHD and LI. We were interested in whether the presence of ADHD in children's developmental profiles provided additional deficits to their linguistic proficiencies that exceeded what could be attributed to their primary LI. In other words, we were interested in whether LIs and attention deficits represented interactive comorbid disorders (Wachs, 2000). To address this question, we compared the performances of 7- to 9-year-old children with LIs only (i.e., specific language impairment [SLI]) with the performances of (a) children with profiles representing co-occurring ADHD and LI (ADHD+LI) and (b) children with typical development (TD) across three established psycholinguistic indices: nonword repetition, sentence recall, and tense marking.

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A clearer understanding of the nature of the co-occurrence between ADHD and LI would make important contributions to the management of children's LIs (Mueller & Tomblin, 2012). For example, comorbid and pure forms of LI might demonstrate different etiologies or be associated with different risk factors, might represent different developmental pathways associated with different prognoses, or might be responsive to different intervention strategies. Accommodation for these differences would eventually lead to more effective interventions and the more efficient allocation of limited clinical resources. Comorbidity also has potentially important theoretical implications. For example, models of LI which suggest that attention deficits and related weaknesses in executive functioning, implicit learning, and other components of information processing are causal contributors to children's core LIs (e.g., Gillam, Montgomery, & Gillam, 2009; Hedenius et al., 2011; Henry, Messer, & Nash, 2012; Hughes, Turkstra, & Wulfeck, 2009; Windsor & Kohnert, 2009) predict that children with comorbid ADHD+LI will present with more severe language symptoms than children with LI alone. Failure to find links between more severe attention deficits and more severe linguistic symptoms would challenge the explanatory value of these particular mechanisms.

Categories of Comorbidity

First (2005) discussed the impact of three different types of comorbidity on diagnostic procedures: artifactual, spurious, and true comorbidity. Each of these has the potential to inform our understanding of the interplay between LIs and co-occurring disorders.

Artifactual Comorbidity: Measurement Imprecision at Clinical Boundaries

Artifactual comorbidity refers to situations in which observations of co-occurrence between two disorders are at least partially the result of imprecision either in the conceptualization of clinical symptomatology or in the development of indices designed to identify affected individuals. For example, measurement schemes directed at evaluating symptoms for one disorder might unintentionally confound symptoms from another disorder in the assessment process. Although LIs and attention deficits are assessed using very different instruments, the potential for overlap exists. Redmond (2002) reviewed several commonly used pediatric psychiatric rating scales and found that all of them contained items that could potentially overlap with LIs or academic proficiencies (e.g., "speech problems," "poor schoolwork," "does not seem to listen to what is being said to him/her") and suggested caution when using these tools to identify ADHD and other socioemotional and behavioral disorders in children with LIs. Recently, Redmond and Ash (2014) showed that removing language and academic items from clinical rating scales improved their capacity to differentiate cases of ADHD from cases of SLI without

compromising their capacity to differentiate ADHD from typically developing status.

In a similar fashion, concerns have been raised regarding the extent to which nonlinguistic demands associated with standardized language tests might unduly penalize children with ADHD who have demonstrated deficits in sustained attention, inhibition, working memory, and planning and organization (Denckla, 1996; Oram, Fine, Okamoto, & Tannock, 1999). For some children, language tests might be invalid because poor performance does not reflect inherent weaknesses in their psycholinguistic mechanisms but is due instead to performance limitations imposed by their ADHD.

Referral and ascertainment biases represent additional mechanisms by which the co-occurrence between two disorders can be artificially elevated. For example, relying on teacher referral to initiate school-based assessment for LI may lead to overrepresentations of male students and students with concomitant speech and behavioral problems (Zhang & Tomblin, 2000). There is some direct evidence that teachers are particularly likely to overidentify ADHD symptoms in students with LIs when standardized rating scales are used. Charach, Chen, Hogg-Johnson, and Schachar (2009) compared the rates of ADHD identified using teacher ratings against a reference standard of blinded *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) psychiatric interviews and found twice as many false positives as true positives in their group of children with LIs. In contrast, these investigators found that teacher ratings and psychiatric interviews were highly concordant for the group with low IQ.

To ensure that observed cases of comorbidity between LI and ADHD are not the result of measurement limitations, evidence needs to be presented that psycholinguistic indices exist that are in fact capable of differentiating known cases of pure LI from known cases of pure ADHD. Oram et al. (1999) reported that their study sample of children with ADHD performed within normal limits on a standardized measure of sentence recall. More recently, Redmond, Thompson, and Goldstein (2011) provided evidence with regard to the discriminative capacities of sentence recall, nonword repetition, and tense marking. Measurements collected from 7- to 8-year-old children with SLI, children with ADHD, and TD children were used to test the diagnostic integrity of these measures. Observed areas under the receiver operating characteristic curve indicated that overall accuracy rates when differentiating cases of SLI from ADHD ranged from 87.5% to 96.3%. Equally important, the performance of the ADHD group was indistinguishable from that of the TD control group. Parigger (2012) replicated these findings with a sample of Dutch-speaking children and showed further that across all three groups, children's proficiencies were not significantly associated with their behavioral symptoms or with their performances on clinical measures of executive function. Taken together, these results suggest that nonword repetition, sentence recall, and tense marking indices represent good markers for

the purpose of evaluating the consequences of co-occurring ADHD on children's core LIs.

Spurious Comorbidity: Reading Disorder and LI

Clinical designations that appear to be comorbid might be more appropriately regarded as different manifestations of a single disorder. Similarly, symptoms associated with one disorder may appear in prominence at an early stage of development, whereas symptoms associated with another disorder may figure more prominently at a later stage, even though both disorders reflect a common underlying neurodevelopmental disruption. These scenarios represent examples of *spurious comorbidity* (First, 2005). The possibility of spurious comorbidity has been considered in the frequently reported co-occurrence of LI and reading disorder (RD). Because school-age children with dyslexia often present with positive histories of preschool language delays and impairments (Lyytinen et al., 2004; Scarborough, 1990), dyslexia has been characterized as a later developing manifestation of underlying LI (Catts & Hogan, 2003). However, more recent studies (Bishop, McDonald, Bird, & Hayiou-Thomas, 2009; Catts, Adlof, Hogan, & Ellis Weismer, 2005) have shown that dyslexia is separate from and truly comorbid with LI, with each impairment stemming from a different causal mechanism. For example, Catts and colleagues, using data from a large longitudinal study of LI, showed that although dyslexia and SLI were likely to co-occur, in Grade 2, 80% of children with dyslexia had language skills within normal limits, and 73% of children with SLI did not have dyslexia. Further, students with dyslexia and a comorbid LI did not exhibit a more severe form of dyslexia than children with dyslexia only or a more severe form of phonological memory impairment, as measured by nonword repetition. Likewise, students with LI and dyslexia did not show a more severe form of LI than students from the SLI group or with a more severe form of morphosyntactic impairment, as measured by a tense-marking production task. Follow-up studies confirmed these results in different longitudinal samples (e.g., Bishop et al., 2009).

Interactive Comorbidity: Low Nonverbal IQ and LI

Rather than exerting a neutral influence on the severity of symptoms affected individuals experience, as seems to be the case with language deficits and LI+RD comorbidity, the impact of multiple truly comorbid disorders might be *additive* or *interactive* (cf. Wachs, 2000). In other words, neurodevelopmental linkages between disorders might make significant contributions to children's symptoms—above and beyond what can be attributed to either disorder on its own. A *subtractive* effect might also be associated with comorbidity if protective factors associated with one disorder offset risk factors associated with the other disorder.

Additive as well as interactive effects have been documented in recent study samples of children with LI who have concomitant limitations in nonverbal IQ. In earlier

eras, children with this sort of profile would have been referred to by school professionals as having *borderline mental retardation* (cf. MacMillan & Siperstein, 2002). This condition is often referred to as *nonspecific language impairment* (NLI) in the current literature. Rice, Tomblin, Hoffman, Richman, and Marquis (2004) examined the linguistic proficiencies and growth outcomes of children with SLI and children with NLI and found evidence that nonverbal deficits provided an additional decrement to affected children's core LI symptoms (NLI < SLI). Kindergarten children with NLI performed significantly worse than children with SLI in their overall levels of tense marking, as indexed by a composite measure that pooled accuracy levels with third-person, singular, present tense *-s* (*he walk-s*), regular past tense (*he walk-ed*), and finiteness marking on irregular past tense (*he ran/he runned*). In addition, growth-curve modeling indicated that the NLI disadvantage was persistent up to Grades 2 and 3, with the children from the NLI group demonstrating a significant lag in tense-marking production when compared with children from the SLI group. However, by Grade 4, children in both groups were performing at similar levels. In an examination of group differences in this cohort at Grade 8, Nippold, Mansfield, Billow, and Tomblin (2008) found that students in the NLI group scored significantly lower than students from the SLI group on standardized language tests. Yet, in the same study sample, there were few differences between the SLI and NLI groups and the TD controls on syntactic measures taken from expository and conversational language samples. Evidence from those studies that have compared the linguistic abilities of individuals with SLI with those of individuals with NLI suggests that the magnitude of the NLI disadvantage may depend on the particular language measures used and the age at which comparisons are made.

It appears that socioemotional and behavioral difficulties represent a particular area of risk for children with NLI relative to children with SLI. An epidemiological study by Beitchman, Hood, Rochon, and Peterson (1989) indicated that 5-year-old children with NLI had significantly higher levels of hyperactivity and school attendance problems than did children with typical cognition and language, children with poor language comprehension, and children with poor articulation. A longitudinal investigation of psychosocial outcomes of preschool children at ages 15 and 16 years found that the rates of ADHD, social phobia, and general anxiety were higher in children from an NLI group than in children from an SLI group (Snowling, Bishop, Stothard, Chipchase, & Kaplan, 2006). In a 30-year follow-up of 198 children originally diagnosed with LIs at 3 to 9 years of age, Elbro, Dalby, and Maarjberg (2011) found that nonverbal IQ was a better predictor of negative adult social and academic outcomes than were verbal abilities. Similarly, Law, Rush, Schoon, and Parsons (2009) found, in a retrospective cohort study of 406 cases of LI identified at age 5 years, that the risk for poorer social and mental health outcomes at age 34 years was approximately three times higher in those with NLI than in those with SLI.

These lines of evidence suggest that LIs that co-occur with low nonverbal IQ reflect a developmental pathway separate from SLI. The presence of low nonverbal IQ represents an additional liability to children's language development that may be most prominent during the early elementary grades. NLI also appears to expose individuals to more psychiatric risk than SLI over the course of their development.

Present Study

Different comorbid conditions can affect children's LIs in different ways. We focused this initial investigation into the impact of ADHD on children's LI symptoms on proficiencies with nonword repetition, sentence recall, and tense marking because these particular indices of LI have demonstrated strong psychometric properties and have been shown in previous investigations to be capable of reliably differentiating cases of LIs from cases of ADHD. These metrics represent the best control available for artifactual comorbidity. We were interested in determining whether the impact of ADHD+LI status on children's core LIs was more like the impact associated with NLI status, where reports have indicated that the co-occurrence of low nonverbal IQ aggravates affected children's LIs (NLI < SLI). Alternatively, with regards to linguistic symptomatology, ADHD+LI status might operate in a more neutral fashion, reflecting comorbid but noninteractive disorders, as appears to be the case with comorbid RD+LI (SLI = RD+LI). We controlled for the potential impact of low nonverbal IQ on children's language proficiencies by excluding potential participants with NLI profiles. We also controlled for the effects of medication on ADHD+LI performance by testing our comorbid participants on a day when they were not given their medication. By comparing children with TD on these measures with children with ADHD+LI and SLI, we were able to examine differences between the clinical groups in the severity of their symptoms relative to normative expectations. Thus, evidence of more deficient performance within cases of ADHD+LI relative to cases of SLI would constitute direct support for the supposition that LI and ADHD represent interactive disorders. Such a finding would support the premise that information processing deficits of the sort that have been attributed to ADHD represent contributing factors to children's core LIs.

Method

Participants

Twenty-seven boys and 30 girls participated in this study (age range: 7;0–9;9 [years; months]). This particular age range was selected because it encompasses a time period in which important decisions regarding service designations are often made. For example, 7 years represents the average age of ADHD diagnosis in the United States (Centers for Disease Control and Prevention, 2013). Three groups of 19 children were matched for age and gender: SLI,

ADHD+LI, and TD. Each group consisted of 9 boys and 10 girls. Racial and ethnic information was provided by most of the participants' parents (54 of 57). The study sample was predominantly White and non-Hispanic (44 of 54), and it included representation from Hispanic (six of 54), African American (two of 54), and Asian (two of 54) communities. Relative representations of majority (White) to nonmajority (Hispanic, African American, and Asian) were similar across groups (SLI: 78.90%; ADHD+LI: 72.22%; TD: 78.90%) and mirrored local demographics.

The study sample reported here represents a pooled group from two related projects. In both projects, children with SLI, children with ADHD+LI, and children with TD participated in a battery of psycholinguistic, socio-emotional behavioral, and academic assessments that lasted 2.5–3.0 hours, spread out over two or three testing sessions in a laboratory setting. Ethical approvals for these projects were secured from the University of Utah Institutional Review Board. Written parental consents and participant assents were obtained. The inclusionary and exclusionary criteria used in both projects are provided in Table 1.

The first project involved recruiting affected children with independently identified SLI and ADHD status from the caseloads of certified speech-language pathologists (SLPs) and clinical psychologists, respectively. Because these initial investigations (Redmond, 2011; Redmond & Ash, 2014; Redmond et al., 2011) were directed at examining similarities and differences between children with "pure" SLI and children with "pure" combined-type ADHD, data from children who presented with comorbid ADHD+LI profiles during eligibility testing were not included in those reports. The focus of the present study was on the consequences of co-occurring ADHD+LI, so measurements collected on cases of comorbidity uncovered during recruitment were used in the present analysis ($n = 8$). An equal number of cases of SLI and cases of TD from the clinically sourced sample—matched to the ADHD+LI group for age and gender—were also included in the present study sample.

Criteria for inclusion in the clinically sourced SLI group were the following: (a) an independent diagnosis of LI by a certified SLP, (b) receipt of services for this LI during the time of the study, and (c) performance at or below the appropriate cutoff score on the Clinical Evaluation of Language Fundamentals—Fourth Edition Screening Test (CELF-4ST; Semel, Wiig, & Secord, 2004). Children who met these criteria but who also met the project criteria for ADHD status were identified as *ADHD+LI*. The ADHD criteria were as follows: (a) an independent diagnosis by a qualified health care professional as having combined-type ADHD (cf. Centers for Disease Control and Prevention, 2013), (b) receipt of services for ADHD during the time of the study, and (c) standardized ratings provided by parents on the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) *DSM-IV* ADHD subscale that were at least 1.0 standard deviation above normative values, indicating clinical levels of concern (CBCL *T* scores >59; Achenbach & Rescorla, 2001). Children in the TD

Table 1. Inclusionary and exclusionary criteria associated with the clinical and community samples.

Sample	Criteria	
	Inclusionary	Exclusionary
Clinical		
LI	Independent diagnosis of LI Receipt of services	
ADHD	Performance at or below age-based cutoff on CELF-4 ST Independent diagnosis of combined-type ADHD Receipt of services Parent ratings above 1.0 SD on the CBCL <i>DSM-IV</i> ADHD subscale (<i>T</i> score > 59)	
Community		
LI	Performance below 1.0 SD on CELF-4 composite language (standard score < 86)	
ADHD	Independent diagnosis of combined-type ADHD Receipt of services Parent ratings above 1.0 SD on the CBCL <i>DSM-IV</i> ADHD subscale (<i>T</i> score > 59)	
Combined		Diagnosis of autism Hearing screening fail Phonological screening fail Low nonverbal IQ (standard score < 80 on NNAT) Multilingual status Diagnosis of ADHD (participants with specific language impairment and typically developing designations)

Note. LI = language impairment; CELF-4 ST = Clinical Evaluation of Language Fundamentals–Fourth Edition Screening Test (Semel, Wiig, & Secord, 2004); CBCL = Child Behavior Checklist (Achenbach & Rescorla, 2001); *DSM-IV* = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994); ADHD = attention-deficit/hyperactivity disorder; CELF-4 = Clinical Evaluation of Language Fundamentals–Fourth Edition (Semel, Wiig, & Secord, 2003); NNAT = Naglieri Nonverbal Ability Test (Naglieri, 2003).

comparison group were recruited through notices sent home to families attending the same schools that the children with ADHD+LI and SLI were attending. Children in the TD group were enrolled in regular education, had not been diagnosed with any neurodevelopmental disorder, and were not receiving any special services. This exclusion extended to enrollments in “gifted” or “enrichment” educational services or programs.

The second project that provided cases to the present study sample represents an ongoing investigation that has been using community screenings within public elementary schools and follow-up blinded confirmatory testing to identify children with LIs. Children enrolled in regular education as well as children receiving school-based services for communication disorders, reading disabilities, learning disabilities, or emotional behavioral disturbances have been invited to participate through notices sent home to families attending targeted schools within the Salt Lake City School District. When data used in the present study were collected, 443 second-to-third grade students had participated in language screenings. Sixty-five children who failed the screening and 57 children who passed the screening participated in confirmatory testing. In the community-sourced sample, a preexisting clinical diagnosis of LI was not required for LI designation. Instead, all children who achieved a composite language standard score below 86 on the Clinical Evaluation of Language Fundamentals—Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003) during blinded confirmatory testing were identified as having an LI ($n = 47$).

The co-occurrence of ADHD within the cases of LI identified in the community sample was determined using the same criteria that were used in the clinically sourced sample. These procedures yielded an additional 11 cases of ADHD+LI. These cases were matched to 11 cases of SLI and 11 cases of TD from the community sample on the basis of age and gender.

Six children with SLI (54.5%) and eight children with ADHD+LI (72.7%) from the community-sourced sample were enrolled in school-based language services when they participated. The levels of unidentified and untreated LI observed within our confirmed cases of SLI and ADHD+LI were consistent with previous reports based on community samples (Cohen, Davine, & Meloche-Kelly, 1989; Johnson et al., 1999; Tomblin et al., 1997) and reflect the unfortunate reality that LIs in elementary students often go unidentified. When examining the potential impact of ADHD comorbidity, it would be important to include unidentified cases of LI, because the literature suggests that this represents an important aspect of the condition.

A standard set of exclusionary criteria was applied to all three groups from both sources (see Table 1). All participants in this study were monolingual speakers of Standard American English. All participants were screened for the presence of low nonverbal abilities, hearing impairments, phonological disorders, and additional neurodevelopmental disorders (see Redmond et al., 2011, for details). Data from two potential ADHD+LI participants were excluded because of low performances (standard scores <80) on the

Naglieri Nonverbal Abilities Test (NNAT; Naglieri, 2003), the measure used in both the clinical and community-sourced samples to estimate participant's nonverbal abilities. Four children with concomitant diagnoses of autism were excluded.

The characteristics of participants with SLI, ADHD+LI, and TD from the clinical and community sources are displayed in Table 2. To facilitate comparisons between the CELF-4ST and the CELF-4 measures, the CELF-4ST screening scores were transformed to standard scores using age-level means and standard deviations provided by the CELF-4ST manual (Semel et al., 2004). The SLI and ADHD+LI groups were very similar with regard to age, nonverbal ability, and overall levels of verbal proficiency. For children affected with LIs, mean verbal scores were more than 2.0 standard deviations below normative values in both samples, indicating the presence of moderate-to-severe levels of LI within the SLI and ADHD+LI groups. The presence of very similar means and standard deviations between the sample sources across the language measures suggests that at a global level, clinically ascertained and community-ascertained LIs were comparable.

Differences between the two clinical groups were observed. The group of children with SLI presented with somewhat higher average levels of maternal education than the group of children with ADHD+LI, although this

advantage failed to reach statistical significance, $t(36) = 1.754, p = .088$. And as expected, children with ADHD+LI presented with significantly higher average levels of ADHD symptoms than children with SLI, $t(36) = 5.226, p < .001$.

Differences between the TD comparison group and the clinical groups were observed as well. Children with TD, especially those from the community-sourced sample, tended to perform at higher levels on the nonverbal ability measure than did children from the clinical groups, $F(2, 54) = 3.44, p = .039$. On average, the community-sourced sample was older than the clinically sourced sample across all three groups, $t(54) = 4.497, p = .001$.

Measures

ADHD symptoms. The *DSM-IV* ADHD subscale from the CBCL (Achenbach & Rescorla, 2001) was used to examine potential associations between the severity of children's difficulties in the areas of inattention, hyperactivity, and impulsivity and their language abilities. The CBCL protocol consists of 113 items describing a wide variety of socioemotional and behavioral difficulties that parents endorse as being *not true, somewhat or sometimes true, or very true or often true* of their children's behavior. Higher values correspond to higher levels of reported concern, and the CBCL manual provides users with *T* score ($M = 50, SD = 10$)

Table 2. Characteristics of participants with specific language impairment (SLI), co-occurring ADHD and language impairment (ADHD+LI), and typical development (TD) from clinical and community sources.

Variable and sample	SLI		ADHD+LI		TD		<i>F</i> (2, 54)	Partial η^2	Contrast
	<i>n</i>	<i>M</i> (<i>SD</i>)	<i>n</i>	<i>M</i> (<i>SD</i>)	<i>n</i>	<i>M</i> (<i>SD</i>)			
Age (months)									
Clinical	8	94.5 (7.2)	8	92.5 (8.4)	8	92.4 (4.8)			
Community	11	102.3 (8.9)	11	104.2 (8.9)	11	101.5 (9.1)			
Combined	19	99.0 (8.9)	19	99.3 (10.1)	19	97.7 (8.7)	0.157	.006	SLI = ADHD+LI = TD
Maternal education ^a									
Clinical	8	4.00 (0.8)	8	3.10 (0.6)	8	3.30 (1.3)			
Community	11	3.20 (0.6)	11	3.00 (1.0)	11	3.45 (1.1)			
Combined	19	3.50 (0.8)	19	3.05 (0.8)	19	3.40 (1.1)	1.185	.044	SLI = ADHD+LI = TD
Nonverbal ^b									
Clinical	8	100.6 (6.3)	8	101.6 (6.4)	8	101.5 (6.2)			
Community	11	100.4 (13.4)	11	93.6 (11.2)	11	107.7 (7.9)			
Combined	19	100.5 (10.7)	19	99.9 (10.2)	19	105.1 (7.7)	3.44*	.113	SLI = ADHD+LI < TD
Verbal									
Clinical ^c	8	65.9 (11.8)	8	70.1 (9.0)	8	106.5 (9.0)			
Community ^d	11	73.3 (10.7)	11	74.3 (14.4)	11	100.4 (8.6)			
Combined	19	70.2 (11.4)	19	72.5 (12.3)	19	102.9 (9.1)	52.35***	.660	SLI = ADHD+LI < TD
DSM-ADHD ^e									
Clinical	8	56.1 (7.4)	8	70.8 (9.2)	8	52.5 (4.5)			
Community	11	58.2 (7.4)	11	69.0 (5.9)	11	52.2 (4.9)			
Combined	19	57.31 (7.3)	19	69.7 (7.3)	19	52.3 (4.6)	35.59***	.569	SLI = TD < ADHD+LI

Note. ADHD = attention-deficit/hyperactivity disorder.

^aFive-point scale: 1 = *some high school*, 2 = *high school degree*, 3 = *some college*, 4 = *college degree*, and 5 = *some graduate school/advanced degree*. ^bNaglieri Nonverbal Ability Test (Naglieri, 2003) standard score ($M = 100, SD = 15$). ^cClinical Evaluation of Language Fundamentals—Fourth Edition Screening Test (Semel, Wiig, & Secord, 2004) linearized standard scores using screening score means and standard deviations ($M = 100, SD = 15$). ^dClinical Evaluation of Language Fundamentals—Fourth Edition (Semel, Wiig, & Secord, 2003) composite language score ($M = 100, SD = 15$). ^eChild Behavior Checklist DSM-IV ADHD subscale (Achenbach & Rescorla, 2001) *T* score ($M = 50, SD = 10$; higher scores indicate elevated levels of inattention, impulsivity, and hyperactivity difficulties).

* $p < .05$. *** $p < .001$.

conversions based on percentiles associated with normative samples of nonreferred children for comparative purposes (T scores of 60 and 70 represent 1.0 and 2.0 standard deviations above the mean, respectively). The seven items that constitute the instrument's *DSM-IV* ADHD subscale have been shown to correlate moderately well ($r = .80$) with diagnoses based on psychiatric interviews (Achenbach & Rescorla, 2001), and independent investigations of the subscale have reported moderate-to-excellent levels of sensitivity and specificity (Hudziak, Copeland, Stanger, & Wadsworth, 2004).

Language: Nonword repetition. In addition to deficits in lexical and morphosyntactic development, children with LIs have consistently displayed weaknesses in phonological short-term memory, as measured through the repetition of nonsense words (see Estes, Evans, & Else-Quest, 2007, for a recent meta-analysis). The precise mechanisms responsible for observed separations between typical and atypical levels of performance have been a matter of considerable debate. However, the utility of using nonword repetition to identify cases of LI is widely recognized. Dollaghan and Campbell's (1998) nonword repetition task was selected to measure children's proficiencies in repeating nonsense words. This protocol consists of 16 nonwords ranging in length from 1 to 4 syllables from which the overall percentage of phonemes correctly produced is calculated.

Language: Sentence recall. Sentence recall represents one of the oldest diagnostic tasks developed to assess children's linguistic proficiencies (e.g., Carrow, 1974; Lee, 1971) and is regularly featured on modern omnibus language tests. Sentence recall procedures have also demonstrated value as a clinical marker of SLI (cf. Conti-Ramsden, Botting, & Faragher, 2001). In these tasks, the examiner produces sentences and prompts children to repeat them verbatim. The particular sentence recall measures used in this study were the 16 items from Redmond (2005). Stimuli consist of simple declarative active and passive sentences matched for length (9–12 words). The scoring procedures developed by Archibald and Joannis (2009) were used, in which credit is awarded for each sentence using a three-point scale: two points for no errors, one point for one to three errors, and 0 points for four or more errors (maximum score = 32).

Language: Tense marking. Difficulties in tense marking represent one of the hallmark features of LI in English-speaking children (see Schwartz, 2009, for a review; see also American Psychiatric Association, 2013). By age 5 years, most typically developing children have mastered the obligatory nature of tense marking on finite clauses, whereas children with LIs continue to display weaknesses with this grammatical feature for several more years (Rice, Wexler, & Hershberger, 1998). One aspect of English tense marking that continues to develop beyond age 5 for typically developing children is proficiency with the various alternations that mark past tense on irregular verb forms (e.g., learning to say *wrote* instead of *writed*). Children with LIs have displayed protracted development with working out these irregular distinctions as well (Rice, Wexler,

Marquis, & Hershberger, 2000). In this study, the present tense and past tense probes from the Test of Early Grammatical Impairment (TEGI; Rice & Wexler, 2001) were used to examine children's proficiency with tense marking on lexical verbs. The present tense probe consists of 10 items on which children respond to prompts to tell the examiner what the person in each picture does (e.g., "a dentist cleans your teeth"). The past tense probe provides children with a sequence of two pictures: a picture of a person engaged in an ongoing action and a picture of that action completed. After the second picture, the examiner prompts children to say what the person in the pictures did (e.g., "he brushed his teeth"). Ten high-frequency regular past and eight irregular past verbs are targeted in this probe. Children receive credit for correctly including the past tense affix *-ed* on their regular verb productions, and a percentage of correct use of regular verbs is calculated. Irregular verb productions are scored in two ways in the TEGI protocol. First, the percentage of irregular verbs that were marked for the past is calculated. This finiteness metric pools together those productions that were correctly alternated to the irregular target and those that were incorrectly marked for past via an overregularization. Second, the irregular verb measure represents the percentage of irregular verbs correctly produced and excludes overregularization errors. For both the present tense and the past tense on the TEGI probes, only those responses containing a subject and a verb are scored. The TEGI manual, protocol, and picture stimuli are available online (http://www2.ku.edu/~cldp/MabelRice/screener_pack/).

Medication Status

According to parent report, 12 of 19 participants in the ADHD+LI group were being treated with behavioral medications during the time of the study. To examine the direct impact of ADHD on participants' linguistic proficiencies, parents were instructed to suspend their children's medication for 24 hours prior to language testing.

Reliability

Data for the study were collected by graduate students in the University of Utah speech-language pathology program. Recordings of children's responses collected during the administration of the language measures were used by examiners to transcribe children's responses offline and to check the accuracy of online scoring of test protocols. A second examiner provided an independent check of scored protocols against the recording and corrected any errors. Interrater agreements were calculated using two checked protocols randomly selected from each group against the judgments of a third examiner. Scoring consistency was calculated using the number of scored items in agreement divided by the total number of items in agreement plus the total number of items in disagreement. This yielded the following values: nonword repetition: 92.5%;

sentence recall: 86.5%; TEGI present tense: 95%; and TEGI past tense: 94.4%.

Results

Complete data were available for all participants. The means, standard deviations, and ranges associated with each group's performance across the three psycholinguistic measures considered in this study are displayed in Table 3. Because significant group differences were present in levels of nonverbal performance, the outcomes associated with a series of analyses of covariance (ANCOVAs) treating standard scores on the NNAT as a covariate were compared with outcomes associated with a series of univariate analyses of variance (ANOVAs) to determine whether potential sampling biases would need to be considered before examining group differences on the nonword repetition, sentence recall, and tense-marking measures. NNAT standard scores were not a significant predictor for any of the language measures, and the observed pattern of main group effects and follow-up pairwise comparisons was identical in both the ANCOVAs and ANOVAs. Thus, the results associated with the univariate ANOVAs are provided below.

The homogeneity of variances assumption held for the nonword repetition, sentence recall, and the irregular past percentage correct score from the TEGI. For these measures, a univariate ANOVA was conducted to identify significant group effects, and follow-up Dunn-Sidak analyses were used to identify significant pairwise comparisons that reached the .05 level of significance. For the present tense, regular past tense, and irregular past finite scores from the TEGI, Welch's robust test of equality of means and Games-Howell analyses were used to identify group effects and significant pairwise comparisons because variances between groups on these measures were significantly different. As reported in Table 3, the variance associated with the TD control group's performance with these morphosyntactic

forms was considerably smaller than that for the clinical groups.

As expected, significant and large group effects were observed for each language measure: nonword repetition, $F(2, 54) = 8.71, p = .001, \eta^2 = .244$ (95% confidence interval [CI] for SLI [75.31, 82.90]; 95% CI for ADHD+LI [77.25, 84.84]; 95% CI for TD [85.81, 93.40]); sentence recall, $F(2, 54) = 21.33, p < .001, \eta^2 = .441$ (95% CI for SLI [8.84, 14.56]; 95% CI for ADHD+LI [11.86, 17.61]; 95% CI for TD [21.50, 27.24]); TEGI present tense, $F(2, 54) = 3.56, p = .001, \eta^2 = .117$ (95% CI for SLI [77.22, 92.67]; 95% CI for ADHD+LI [83.22, 98.67]; 95% CI for TD [91.70, 107.15]); TEGI regular past tense, $F(2, 54) = 4.66, p = .014, \eta^2 = .147$ (95% CI for SLI [68.28, 86.57]; 95% CI for ADHD+LI [75.49, 93.78]; 95% CI for TD [87.75, 106.04]); TEGI irregular past finite, $F(2, 54) = 5.86, p = .005, \eta^2 = .179$ (95% CI for SLI [71.18, 87.66]; 95% CI for ADHD+LI [81.28, 97.77]; 95% CI for TD [91.13, 107.61]); and TEGI irregular past correct, $F(2, 54) = 15.85, p < .001, \eta^2 = .370$ (95% CI for SLI [38.45, 60.60]; 95% CI for ADHD+LI [31.87, 54.02]; 95% CI for TD [72.83, 94.97]). In each case, pairwise comparisons confirmed that the TD control group's performance was significantly better than that of the SLI and ADHD+LI groups, which were not significantly different from each other (SLI = ADHD+LI < TD). As indicated by the presence of nonoverlapping 95% CIs, the highest levels of differentiation between the control group and the affected groups was achieved with the nonword repetition, sentence recall, and the TEGI irregular past correct measures.

Group-level comparisons failed to identify a detrimental effect for ADHD status on our affected participants' psycholinguistic proficiencies. Another way to consider the potential impact of ADHD symptoms on children's LIs would be to pool data from the SLI and ADHD+LI groups and examine the associations among parent-reported levels of ADHD difficulties and the language measures. If elevated levels of ADHD symptoms exerted a detrimental influence

Table 3. Psycholinguistic indices of language impairment.

Measure	SLI (<i>n</i> = 19)		ADHD+LI (<i>n</i> = 19)		TD (<i>n</i> = 19)		<i>F</i> (2, 54)	Partial η^2	Contrast
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range			
Nonword repetition ^a	79.1 (9.2)	54.2–90	81.1 (8.6)	66–97.9	89.6 (6.7)	69.8–97.9	8.71**	.244	SLI = ADHD+LI < TD
Sentence recall ^b	11.7 (6.9)	0–26	14.7 (7.3)	1–27	24.4 (4.1)	15–31	21.33***	.441	SLI = ADHD+LI < TD
TEGI									
Third person present ^c	84.9 (24.1)	0–100	91.0 (16.1)	33–100	99.4 (2.5)	89–100	3.6*	.117	SLI = ADHD+LI < TD
Regular past ^d	77.4 (29.7)	0–100	84.63 (16.8)	40–100	97.0 (4.7)	90–100	4.7*	.147	SLI = ADHD+LI < TD
Irregular finite ^e	79.4 (27.4)	0–100	89.53 (14.5)	63–100	99.4 (2.8)	88–100	5.9**	.179	SLI = ADHD+LI < TD
Irregular correct ^f	49.5 (19.7)	0–75	42.9 (28.4)	0–100	83.9 (23.3)	25–100	15.9***	.370	SLI = ADHD+LI < TD

Note. SLI = specific language impairment; ADHD = attention-deficit/hyperactivity disorder; TD = typical development; LI = language impairment; TEGI = Test of Early Grammatical Impairment (Rice & Wexler, 2001).

^aPercentage of phonemes correctly produced (Dollaghan & Campbell, 1998). ^bMaximum score = 32 (Redmond, 2005). ^cPresent tense probe (percentage of correct use of *-s* tense inflection in obligatory contexts). ^dRegular past tense score from past tense probe (percentage of correct use of *-ed* tense inflection in obligatory contexts). ^eIrregular finite score from past tense probe (percentage of use of correct [e.g., "he wrote on the chalkboard"] and overregularized irregular forms [e.g., "he writed on the chalkboard"] in obligatory contexts). ^fIrregular correct score from past tense probe (percentage of correct use of irregular forms in obligatory contexts).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4. Pearson product zero-order correlations among psycholinguistic indices and the *DSM-ADHD* subscale from the *Child Behavior Checklist* for the participants with language impairments (SLI and ADHD+LI groups).

Variable	1	2	3	4	5	6	7
1. <i>DSM-ADHD</i>	—	.225	.322*	.314 [†]	.124	.225	.124
2. Nonword repetition		—	.408*	.545***	.532**	.487**	.427**
3. Sentence recall			—	.569**	.433**	.507**	.388*
4. Third person present				—	.700***	.743***	.536**
5. Regular past					—	.852***	.494**
6. Irregular finite						—	.523**
7. Irregular correct							—

Note. $N = 38$. SLI = specific language impairment; ADHD = attention-deficit/hyperactivity disorder; LI = language impairment; *DSM-ADHD* = Child Behavior Checklist DSM-IV ADHD subscale (Achenbach & Rescorla, 2001).

[†] $p = .055$. * $p < .05$. ** $p < .01$. *** $p < .001$.

on our participants' core language abilities, then we would expect to find robust significant negative correlations among the CBCL *DSM-IV* ADHD subscale and the language measures. As displayed in Table 4, this did not occur—all correlations between the ADHD measure and the language measures were small and in the positive direction. Further, a significant positive correlation was found between ratings provided on the CBCL *DSM-IV* ADHD subscale and children's performance on the sentence recall measure ($r = .322, p = .05$). A nonsignificant association of a similar magnitude was observed between the rating measure and children's performance on the TEGI present tense ($r = .314, p = .055$). Among our participants with LIs, these associations indicated a tendency for those children with more severe ADHD symptoms to do better than children with less severe ADHD symptoms.

One way to compare the relative magnitudes of the LIs associated with SLI and ADHD+LI designations is to use the means and standard deviations associated with the performance of the TD control group to calculate Z scores and standard scores for the affected groups. These results are displayed in Table 5. From this perspective, the performance of the ADHD+LI group was considerably better than that of the SLI group across all but one (TEGI irregular past correct) of the psycholinguistic indices used in this study. In other words, the LI associated with SLI relative to the observed variation associated with the control group's

performance was appreciably more severe than the LI associated with ADHD+LI.

Discussion

Comparisons between children with SLI and children with LIs and co-occurring disorders provide helpful clinical and theoretical information. In a previous report, we found that on measures of nonword repetition, sentence recall, and tense marking, children with ADHD were indistinguishable from children with typical development (Redmond et al., 2011), suggesting that these particular indices represented good controls for artifactual comorbidity. In this study, we examined the impact that co-occurring ADHD had on children's core LIs. Our results did not support models of ADHD+LI comorbidity as reflecting the combination of interactive comorbid disorders or one that implicates ADHD as an independent risk factor or an additional liability that aggravates children's primary LIs. Instead, we found overall that ADHD status had little noticeable impact. The performances of children with ADHD+LI were similar to the performances of a matched group of children with SLI.

Additional disconnects between predictions motivated by various attention deficits/information-processing accounts of LI and the performance of our participants can be found elsewhere in the data. For example, as shown in

Table 5. Standard scores and Z score conversions of SLI and ADHD+LI group performances across the psycholinguistic indices.

Measure	SLI		ADHD+LI	
	Standard score	Z score	Standard score	Z score
Nonword repetition	76.6	-1.57	81.0	-1.27
Sentence recall	53.5	-3.10	64.5	-2.37
Third person present	13.0	-5.80	49.6	-3.36
Regular past	37.5	-4.17	60.4	-2.64
Irregular finite	<1	-7.14	47.1	-3.53
Irregular correct	78	-1.48	73.6	-1.76

Note. SLI = specific language impairment; ADHD = attention-deficit/hyperactivity disorder; LI = language impairment.

Table 3, the group means for the ADHD+LI group were, in most cases, higher than the observed group means for the children with SLI. In addition, symptoms associated with the SLI group were much more severe than the symptoms associated with the ADHD+LI group when both affected groups were compared with the control group. Correlation analyses detected a weak but statistically significant positive association between children's ADHD symptoms and their performance on the sentence recall measure as well as a nonsignificant association between ADHD symptoms and present tense marking of a similar magnitude ($r_s = \sim .30$). Children who had higher levels of behavioral difficulties tended to perform better on our language measures than children whose parents reported fewer ADHD symptoms. Thus, rather than an additive or interactive effect for ADHD+LI comorbidity, we observed a limited and modest subtractive/protective effect associated with elevated ADHD symptoms. The observed association clearly warrants caution because it might have reflected an uncontrolled confound in our study sample, and independent replications are needed. However, taken at face value, this association was counterintuitive: The presence of multiple neurodevelopmental disorders should have resulted in more severe language symptoms. So, why didn't it?

At this stage, we can only speculate on why our participants with ADHD+LI outperformed our participants with SLI. One possibility is that ADHD status functioned as a clinically protective factor for children with LIs in our study sample. Perhaps the presence of salient behavioral difficulties increased the likelihood of earlier referral and identification in our cases of ADHD+LI relative to our cases of SLI. A related possibility is that the presence of co-occurring behavioral difficulties encouraged the provision of more intensive or different kinds of interventions for children with ADHD+LI. Stated differently, LIs in the absence of additional behavioral difficulties may have needed to be relatively more severe in cases of SLI to trigger the same level of concern among teachers and other referral sources or the same kind of therapeutic response from clinicians. Our data cannot address this issue directly because we did not collect detailed service histories from the parents of our participants. However, in our community-sourced sample, more cases of unidentified LI were associated with the SLI group than with the ADHD+LI group, providing some support for this interpretation. The suggestion of protective effects associated with ADHD+LI comorbidity aligns with the results of Zhang and Tomblin (2000), who reported that the presence of behavioral difficulties was one of the strongest predictors of service provision in their epidemiological and longitudinal study sample of individuals with LIs.

One complication for the suggestion of service provision as a protective mechanism in comorbid cases is the observation that the ADHD+LI advantage did not appear on the broader composite language measure used in this study to determine eligibility (see group CELF-4 scores in Table 2). This raises the possibility that the beneficial effects of service provision and other protective mechanisms

associated with comorbid status might be limited to particular language skills. Additional investigations are needed to determine if this is the case.

Limitations

This study has various limitations that should be addressed in future studies. The study sample covered a limited age range. This allowed us to consider the impact of comorbidity relative to clear and consistent developmental benchmarks, but it limited the extent to which our data can be used to evaluate the possibility of a spurious comorbid relationship between SLI and ADHD. A longitudinal study covering a larger age range would permit examination of potential distal links between these two common neurodevelopmental disorders and could test the possibility that some cases of early SLI develop into later ADHD+LI. Because the criteria of onset of ADHD symptoms has been recently adjusted from prior to age 7 years in the *DSM-IV* (American Psychiatric Association, 1994) to prior to age 12 years in the *DSM-5* (American Psychiatric Association, 2013), it will be important for future studies to closely track the emergence of symptoms in children affected by LI up to age 12 years. Although combined-type ADHD represents the most commonly diagnosed form of ADHD and is associated with the most severe symptoms (Barkley, 2006), another important direction for future studies would be to examine the impact of the other subtypes and presentations of ADHD (predominately inattentive presentation and predominately hyperactive/impulsive presentation) on children's LIs.

The study sample was opportunistic in the sense that measurements collected on clinically and community-ascertained cases of LI were repurposed from other projects and were combined to address our research question. As a result, although eligibility criteria were very similar for the two sources, they were not identical, and small differences could have introduced heterogeneity. However, this concern is mitigated by a couple of observations. First, performance levels observed with the CELF4-ST were very similar to those observed with the CELF-4, suggesting that the two ascertainment methods captured similar levels of LI. Second, ratings of ADHD symptoms provided by parents from the clinical and community-sourced samples were likewise nearly identical.

Although we selected indices with robust psychometric properties, our language measures represent a small subset of the range of linguistic abilities that could potentially be considered. Verbal proficiency is a complex construct, and future studies should consider the impact of ADHD comorbidity on other language domains. For example, the recent inclusion of pragmatic (social) communication disorder in the *DSM-5* taxonomy (American Psychiatric Association, 2013) warrants a consideration of the potential impact that ADHD+LI comorbidity might have on children's difficulties following rules for conversation, storytelling, or matching communication to the needs of the listener. However, the issue of potential artifactual comorbidity

between pragmatics and ADHD would need to be addressed first. For instance, are the available pragmatic measures capable of differentiating topic-maintenance problems resulting from a pragmatic deficit from problems with inattention and impulsive responding resulting from ADHD? If not, it would be difficult to estimate the impact of co-occurring ADHD on this language domain.

Additive or synergistic effects between ADHD symptoms and LIs might also be found in related areas outside of children's primary linguistic proficiency. For example, both LIs and ADHD have been associated with reading and writing disabilities (e.g., Catts et al., 2005; Rabiner & Coie, 2000), and it is possible that children with ADHD+LI profiles experience more severe or qualitatively different difficulties with literacy than do children with SLI. Other important gaps remain. For example, the impact of comorbidities on children's responses to language interventions remains relatively unexplored territory. Additional investigations are needed to determine whether ADHD+LI status is associated with more persistent LIs or if children with ADHD+LI respond differently than do children with SLI to standard interventions.

Clinical Implications

Comorbidity is a reality that practitioners face on a regular basis. To provide students with optimum services, it will be important to partition academic and social difficulties that can be attributed to LI, ADHD, and combination of the two. The results of this study, in concert with those from previous reports, suggest that proficiencies with nonword repetition, sentence recall, and tense marking control for artifactual overlap with ADHD, making them valid markers for children's core LIs. Practitioners do not need to worry about the need to accommodate for children's ADHD status when these measures are used to detect LI. Each of the measures used in this study is brief, requiring 3–10 minutes to administer (see Redmond et al., 2011), and all are freely available, suggesting that they might be good choices for general use with 7- to 9-year-old students.

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