

## Review Article

# Markers, Models, and Measurement Error: Exploring the Links Between Attention Deficits and Language Impairments

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**Purpose:** The empirical record regarding the expected co-occurrence of attention-deficit/hyperactivity disorder (ADHD) and specific language impairment is confusing and contradictory. A research plan is presented that has the potential to untangle links between these 2 common neurodevelopmental disorders.

**Method:** Data from completed and ongoing research projects examining the relative value of different clinical markers for separating cases of specific language impairment from ADHD are presented.

**Results:** The best option for measuring core language impairments in a manner that does not potentially penalize individuals with ADHD is to focus assessment on key grammatical and verbal memory skills. Likewise, assessment of ADHD symptoms through standardized informant rating scales is optimized when they are adjusted for overlapping language and academic symptoms.

**Conclusion:** As a collection, these clinical metrics set the stage for further examination of potential linkages between attention deficits and language impairments.

Reports of children displaying developmentally inappropriate levels of inattention, hyperactivity, and impulsivity date back over two centuries (cf. Barkley, 2006). With the publication of the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., rev.) by the American Psychiatric Association (1987), *attention-deficit/hyperactivity disorder* (ADHD) became recognized as the officially sanctioned term to refer to this particular neurodevelopmental profile, replacing a series of earlier clinical designations (e.g., minimal brain damage, minimal brain dysfunction, hyperkinetic reaction of childhood, and attention deficit disorder). Around the same time, the term *specific language impairment* (SLI) appeared in the clinical literature to refer to children who presented with diminished linguistic proficiencies in the absence of significant limitations in hearing acuity, cognitive development, or social development (Fey & Leonard, 1983; Leonard, 1981; Stark & Tallal, 1981). Recognition of the SLI profile is equally venerable. Reports going as far back as the 1800s had been variously referring to cases of idiopathic language

impairment as congenital aphasia, developmental aphasia, dysphasia, and developmental language disorder (cf. Leonard, 2014).

As modern diagnostic entities, ADHD and SLI produce a stark contrast across several important aspects. The most obvious difference between ADHD and SLI exists at the level of public awareness. For all intents and purposes, ADHD has become a household term on a global scale, one that is regularly featured in all forms of consumed media with thousands of books designed specifically for families seeking a better understanding of the condition. ADHD also represents one of the most well-resourced neurodevelopmental disorders in terms of the levels of research and public support it has received relative to its prevalence and to the impact the disorder has on affected individuals' overall levels of functioning (Bishop, 2010a). Although the prevalence rate of 5%–7% for ADHD has been established via several recent epidemiological studies (cf. Willcutt, 2012), actual rates of ADHD diagnoses in children and adolescents in the United States have been steadily rising over the last decade and recently peaked at 11% overall and 15% for males (Visser et al., 2014). Regional variation in ADHD diagnoses has been considerable over this time period, with states in the northeast and south reporting higher rates and the western states reporting lower rates than the national average.

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In contrast, the term SLI remains, for the most part, unrecognized outside of the research literature, and relative to other neurodevelopmental disorders, SLI has been notably underresourced (Bishop, 2010a). A small number of epidemiological reports, with the most recent dating back more than 15 years ago, provide us with a rough estimate of 7%–8% for the expected occurrence of idiopathic language impairments in the general population (Johnson et al., 1999; Tomblin et al., 1997). Unlike ADHD, actual rates of SLI diagnoses are not tracked by the Centers for Disease Control and Prevention, the U.S. Department of Education, the American Speech-Language-Hearing Association, or any other public or professional agency. Rather, the available census data provide the public with aggregate values, combining individuals with SLI with other individuals receiving services from speech-language pathologists for a variety of conditions (e.g., stuttering, speech and voice disorders, and concomitant intellectual disabilities). The numbers of children with SLI currently receiving clinical services across different regions is unavailable, as is the extent to which treatment rates have changed over time. This blind spot is unfortunate, because neurodevelopmental disorders, such as SLI and ADHD, result from combinations of environmental, biological, and genetic risk factors, and geographical and temporal variation could potentially provide important clues to the underlying nature of these interactions.

In addition to being two of the most commonly occurring neurodevelopmental disorders, some empirical reports suggest that ADHD and SLI might also be commonly co-occurring conditions as well. Literature reviews on the topic offer 30%–50% as the expected co-occurrence rate between attention deficits and language impairments (Cohen, 2004; Cross, 2004; Gallagher, 1999), but this estimate is clearly based on a wide range of reported values, and the empirical record is confusing and contradictory. Some studies report the co-occurrence of attention deficits and language impairments within their study samples at more than 65% (e.g., Gualtieri, Koriath, Van Bourgondien, & Saleeby, 1983; Trautman, Giddan, & Jurs, 1990; Walsh, Scullion, Burns, MacEvilly, & Bronson, 2014; Warr-Leeper, Wright, & Mack, 1994), whereas others provide rates that are less than 20% (Lindsay & Dockrell, 2008; Redmond & Rice, 2002; Rescorla, Ross, & McClure, 2007; Whitehouse, Robinson, & Zubrick, 2011; Willinger et al., 2003). Between these antipodes, additional reports provide intermediary levels of co-occurrence (Baker & Cantwell, 1987; Beitchman, Hood, & Inglis, 1990; Cohen et al., 1998; Love & Thompson, 1988; Sciberras et al., 2014; St. Clair, Pickles, Durkin, & Conti-Ramsden, 2011; Tirosh & Cohen, 1998). Given that reports can be selected for the purpose of assigning nearly any possible value to the ADHD plus language impairment (ADHD+LI) co-occurrence rate, it is not surprising that synthesizing across studies has been difficult. Variability across studies cannot be easily attributed to the common culprits of noisy signals within comorbidity research. For example, both high and low estimates are available within clinically and epidemiologically

ascertained groups, within studies that primarily recruited for cases of SLI and those that recruited for ADHD, within older and younger study samples, and within those studies that controlled for potential developmental confounds, such as low IQ or bilingual status, and those that did not.

Yet, clarity on the nature of co-occurrence is important because there are potentially direct implications for clinical practice. For example, language impairments in children with co-occurring ADHD might be of a different kind associated with different risk factors than language impairments in children with SLI only, requiring the development of interventions tailored to address the unique interactions of comorbid disorders. On the other hand, elevated levels of co-occurrence between these two disorders might implicate common underlying pathways between linguistic and attention mechanisms, which, if better understood, could lead to more effective intervention procedures for all children with language impairments.

In this review article, a line of inquiry is considered that has the potential to bring us closer to untangling the links between attention deficits and language impairments. Some preliminary elements of this research program have already been accomplished and await additional independent replications, while other key pieces remain for future investigations. Although several reports exist on the co-occurrence of ADHD and SLI, an important precondition to the pursuit of modeling linkages between these two disorders has rarely been met. Co-occurrence is only meaningful when the clinical measures brought in can be trusted to reliably differentiate between disorders. Even though language impairment and attention deficits are assessed with very different instruments, the risk of bias due to overlapping symptoms exists. Data will be presented from completed and ongoing projects that have examined the relative value of different clinical markers for separating cases of ADHD from cases of SLI. Armed with clinical markers providing reasonably good controls against overlapping symptoms, we can then more precisely examine the consequences of co-occurring ADHD on children's core language impairments and, likewise, the extent to which co-occurring language impairments contribute to the severity of children's ADHD symptoms.

The next steps will be to capitalize on these advances to examine more closely potential mechanisms for ADHD-LI linkages, including the possibility that third factors operate as mediators or moderators. New rounds of epidemiological studies using these clinical markers will be needed to update our estimates of the prevalence of SLI, as well as the expected co-occurrence rate of ADHD and language impairments. Given the observed regional variability associated with ADHD diagnoses, it would be important to base these new estimates on multiple community samples. Additional longitudinal studies of both SLI and ADHD are needed to observe potential linkages more closely as they unfold in individual development over extended periods of time. Thus, these clinical markers pave the way for more precise evaluations of potential shared genetic liabilities.

## Measuring Language Impairment in a Way That Does Not Penalize Individuals With ADHD

Identifying a language impairment is not the same as recording a below-average score on a language test. For any particular test to inform clinical decisions, there needs to be a priori evidence that when the instrument is administered to a group of children with known language impairments, they perform considerably worse than children without language impairments. This seems like an obviously important criterion, but in their review, Spaulding, Plante, and Farinella (2006) noted that, based on information available in their manuals, many commonly used standardized language tests cannot be trusted to reliably differentiate affected from unaffected cases. Vocabulary-centric metrics were particularly weak in their capacity to segregate groups, whereas those instruments that incorporated measurements of grammatical and/or verbal memory skills tended to do a better job of identifying language impairments.

Other language measures may yield adequate separation of children affected with language impairments from children with typical development (TD) but on their own are not suitable for differentiating between disorders, and this appears to be the case for indices of pragmatic deficit. Pragmatics, or the use of language in social interaction and the knowledge of constraints associated with deixis, implicature, presupposition, speech acts, registers, and discourse genres has been an active area of interest for the field of speech-language pathology for decades. However, from the start, concerns were expressed that perhaps the boundaries between pragmatic deficits, socioemotional difficulties, personality traits, and interpersonal challenges brought in by psychiatric conditions required clarification. For example, Camarata and Gibson (1999) noted that the primary ADHD symptoms of inattention, hyperactivity, and distractibility map directly onto deficiencies in key pragmatic skills, such as turn-taking, initiation, repairs, and topic use (introduction, maintenance, and change).

More recently, Fine (2006) has developed this line of reasoning further in a book-length treatment that reframes key clinical symptoms associated with ADHD and other mental health conditions, such as psychotic disorders, personality disorders, and mood disorders into pragmatic deficits. In other words, Fine's (2006) analysis demonstrates that under an inclusionary framework, where the construct of pragmatic incompetence encompasses any disruption of successful interpersonal relations, regardless of the source, all psychiatric disorders are essentially pragmatic disorders. The resulting lack of differentiation between psychiatric and pragmatic constructs obfuscates differential diagnosis and renders comorbidity uninterpretable. The problem of overlapping constructs, unfortunately in this case, cannot be dismissed as an inconsequential difference of terminological aesthetics between clinical disciplines (i.e., what speech-language pathologists call pragmatics is simply what clinical psychologists prefer to refer to as interpersonal and social skills). As Redmond and

Timler (2007) noted in their review of intervention approaches in the area, the manner in which social difficulties experienced by children affected by language impairments are conceptualized can have dramatic consequences. For example, widely different and potentially contraindicating treatments are encouraged if concerning behaviors are taken as supporting evidence for either a co-existing psychiatric disorder, an underlying sociopragmatic cognitive deficit, or as secondary consequences of underlying semantic and syntactic impairments.

There is some evidence that pragmatic and social communication difficulties do not track with deficiencies affected individuals display in other language domains but rather appear to align better with general psychiatric constructs. For example, Tomblin (2014) conducted a principal component analysis on measures collected on participants from the Iowa epidemiological study sample of SLI at Grade 8, which included language sample metrics (e.g., total number of independent clauses), as well as standardized tests of vocabulary, grammar, and pragmatics. Pragmatic symptoms, as measured by the Children's Communication Checklist's Social Interaction Deviance Composite (Bishop, 2003), only loaded significantly onto its own component onto which none of the other language measures loaded. Ash and Redmond (2014) replicated Tomblin's (2014) finding of pragmatics as a separate language dimension with a younger study sample (second and third grades) but extended the scope of their factor analysis to include clinical measures of psychiatric symptoms (e.g., ADHD, oppositional defiant disorder, anxiety disorder, and affective disorder). In this case, the Social Interaction Deviance Composite measure and the psychiatric scales loaded onto a common factor that was orthogonal to the factor onto which the other language measures loaded.

Now, the best option for measuring core language impairments in a manner that does not potentially penalize individuals with ADHD or introduce measurement artifacts is to focus language assessments on key grammatical and verbal memory skills. This is particularly appropriate given long-standing interests in the value of targeted measurements of individuals' proficiencies with tense marking, sentence recall, and nonword repetition for demarcating the phenotype of SLI for genetic linkage studies (Falcaro et al. 2008; Monaco, 2007; Rice, Smith, & Gayan, 2009; SLI Consortium, 2002). Recently, Redmond, Thompson, and Goldstein (2011) administered these psycholinguistic measures to 7- to 8-year-old children with SLI, ADHD, and TD. Group means for the participants with ADHD were nearly identical to those with TD across all three measures, and both groups performed considerably higher than the group of participants affected by SLI. Evaluation of these indices at the individual level using optimal cutoff scores determined by receiver operating characteristic curve analyses indicated moderate-to-high levels of sensitivity and specificity both for the differentiation of SLI from TD (sensitivity range: .84-.95; specificity range: .90-.95) and for the differentiation of SLI from ADHD (sensitivity range: .79-.90; specificity range: .70-.95). Parigger (2012)

replicated these results in a sample of Dutch-speaking children and examined whether proficiencies with tense marking, nonword repetition, or sentence recall were associated with standardized measures of children's inhibition, spatial working memory, planning, and cognitive flexibility. Within each group, correlations between the psycholinguistic measures and these executive function measures were all weak and nonsignificant.

## Measuring ADHD in a Way That Does Not Penalize Individuals With SLI

Measures of the sort used in the Parigger (2012) study to examine participants' executive function skills were motivated by their widespread use in studies of children with ADHD. A substantial body of research documents that, relative to groups of TD controls, deficiencies in executive function and continuous performance measures can be expected to be present in study samples of children with ADHD across a wide age range (see Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005, for a review). A highly influential theory of ADHD proposed that the disorder essentially represents a developmental disruption of executive functions (Barkley, 1997). However, these indices suffer from some of the same limitations associated with pragmatic measures. Relying on behavioral measures of executive function to identify ADHD status in individual cases would result in unacceptably high levels of false-positives and misdiagnoses because children from a variety of clinical populations besides ADHD have also demonstrated limitations in these areas (e.g., intellectual deficits, learning disabilities, sleep disorders, hearing impairments, and cases of maltreatment). Another factor complicating their application to differential diagnosis is that approximately 50% of children with ADHD can be expected to perform within the normal range on executive function measures (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; Riccio, Reynolds, & Lowe, 2001; Willcutt et al., 2005; Willoughby & Blair, 2011; Zelnik, Bennett-Back, Miari, Goez, & Fattal-Valevski, 2012). This was true for the participants with ADHD in the Parigger (2012) study.

In general practice, the measurement of ADHD symptoms for the purposes of differential diagnosis and identification of comorbidity relies heavily on standardized informant rating scales (Barkley, 2006; Brock, Jimerson, & Hansen, 2009). These scales consist of symptom checklists in which parents (and sometimes teachers) endorse psychiatric and other behavioral difficulties as well as indicate severity and/or frequency. These instruments represent an objective, norm-based method of assessment that is considerably more cost-effective and reliable than other procedures. Alternative assessment methods, such as clinical interviews, self-reports, and projective techniques rely heavily on children's verbal responses to make inferences about their underlying socioemotional competence and would be inappropriate for children with language impairments (see Redmond, 2002; Webster, Brown-Triolo, &

Griffith, 1999). However, even though standardized informant rating scales would be preferred over other options because they do not require children to produce a verbal response, they are not necessarily free of potential language bias. Redmond (2002) reviewed several commonly used rating scales and found that all of them contained items that could be construed as primary symptoms of language impairment or academic difficulties (e.g., *speech problems, won't talk, does not seem to listen to what is being said to him/her, and difficulty doing or completing homework*). Redmond (2002) recommended removing these particular items from scoring protocols when rating scales are used with cases of known or suspected language impairment to control for potential measurement artifacts. But subtracting overlapping symptoms from standardized protocols could have the unintended consequence of compromising an instrument's capacity to identify cases of ADHD. This concern may be overstated. Redmond and Ash (2014) examined the impact of removing language and academic items from two of the most commonly used scales in pediatric psychopathology: the Child Behavior Checklist (Achenbach & Rescorla, 2001) and the Conners' Parent Rating Scales-Revised (Conners, 2004). Parents of children with SLI, ADHD, and TD provided ratings of their children's behavioral difficulties, and results indicated that adjusting for language and academic items had little impact on the capacity of the syndrome scales to successfully differentiate cases of ADHD from TD. Adjustments did, however, improve the discrimination of cases of ADHD from SLI on the Child Behavior Checklist and Conners' Parent Rating Scales-Revised, especially on those scales targeting inattention symptoms.

## The Impact of Co-Occurrence on Symptom Presentation

Additional independent replications are needed to further confirm the value of using adjusted socioemotional behavioral rating scales, tense marking, nonword repetition, and sentence recall indices to differentiate SLI from ADHD in more diverse samples and across a wider age range. Further investigations might uncover additional clinical markers that are either equally or even more suitable for differential diagnosis. However, preliminary findings encourage the examination of these metrics in cases of comorbid ADHD+LI. A key question is whether attention deficits and language impairments represent interactive disorders such that their co-occurrence within individuals' profiles would result in more severe clinical symptoms. The answer would have implications for theories of SLI. For instance, demonstration that ADHD+LI < SLI in performance on either tense marking, nonword repetition, or sentence recall would provide support to the premise that components of information processing that have been implicated in ADHD represent potential causal contributors to children's language impairments. Redmond, Ash, and Hogan (2015) compared the performances of

children with ADHD+LI on tense marking, nonword repetition and sentence recall to those of a matched group of children with SLI and those of children with TD. Data for some of the participants in the SLI and TD group were taken from the Redmond et al. (2011) study sample. Results indicated that the ADHD+LI and SLI group means were not significantly different from each other, and means for both of the affected groups were considerably lower than for the TD control group (SLI = ADHD+LI < TD). An observed tendency for the participants with ADHD+LI to actually perform slightly better than the participants with SLI across the three clinical markers was examined more closely. A modest but significant positive correlation was found between the severity of children's ADHD symptoms and their sentence recall performance. This result was unexpected because it suggests that, rather than providing an additional decrement on children's language abilities, comorbid ADHD status appeared to be operating as a modest and limited protective factor for some of the participants. These outcomes are difficult to reconcile with attention deficit and information-processing accounts of the language deficits associated with SLI. If further replicated by independent investigations, the absence of a detrimental impact of the ADHD+LI comorbidity on children's language impairments would indicate that significant modifications to standard language interventions are not necessary to accommodate for ADHD+LI comorbidity.

The impact of co-occurring language impairments on children's ADHD symptoms might be a different situation. In an early report, Cohen et al. (1998) compared parent behavior ratings of three groups of children receiving services for various psychiatric conditions: those with a diagnosed concomitant language impairment, those with an undiagnosed language impairment that was identified during eligibility testing for the study, and those who performed within the normal range on language measures. A significant group difference was found, indicating that parents of children with concomitant diagnoses of language impairment rated them as having more severe ADHD symptoms than the parents of either children with undiagnosed language impairments or those without concomitant language impairments. In other areas of behavioral disturbance (e.g., internalizing, externalizing, and social problems), the three groups were rated similarly. This finding suggests that, in some cases, the combination of ADHD+LI might have been making children's ADHD symptoms more severe. However, caution is encouraged in this case, because the study sample was very heterogeneous and included a wide variety of psychiatric conditions in addition to ADHD. In addition, the rating scales used had not been adjusted for the presence of overlapping symptoms, and the observed elevation of ADHD symptoms in the comorbid group could have been a measurement artifact. More recently, Redmond, Ash, and Hogan (2013) compared ratings of ADHD symptoms provided by parents of children diagnosed with ADHD+LI and children diagnosed with ADHD only that had been adjusted for the presence of overlapping language and academic items.

In contrast to the outcomes of Cohen et al. (1998), parents of both groups provided very similar ratings of their children's ADHD symptoms. The parents of the children in the ADHD+LI group in the Redmond et al. (2013) study sample reported higher levels of social problems than the parents of the children in the ADHD group, whereas in the Cohen et al. (1998) study sample, this was not the case. Redmond et al. (2013) observed similar levels of parental concern between the ADHD and ADHD+LI groups on internalizing and externalizing behavior problems, a finding that did align with the outcomes of Cohen et al. (1998). Discrepancies between reports on the impact of concomitant language impairment on the behavioral difficulties associated with ADHD warrants further investigation. The key to unraveling the source of these effects in future studies will be to control for overlapping symptoms.

### Potential Influences of Third Factors on ADHD–SLI Linkages

One possible mechanism for establishing ADHD–SLI linkages is the intercession of a third variable functioning as either a moderator or mediator of the relationship. A variety of neurodevelopmental and environmental factors could be considered as potential third factors in links between language impairment and attention deficit, but the available evidence suggests that reading status represents a viable candidate. For example, both SLI and ADHD have been linked to literacy difficulties (Brock & Knapp, 1996; Catts, Fey, Tomblin, & Zhang, 2002; Justice, Bowles, & Skibbe, 2006; Rabiner & Coie, 2000), but in both cases, comorbidity has been incomplete, suggesting that SLI and ADHD are distinct disorders from reading disability (Catts, Adlof, Hogan, & Ellis Weismer, 2005; Riccio & Jemison, 1998). Very few investigations have directly examined associations of language impairments, attention deficits, and reading disabilities within the same study sample, but in those that have, reading disabilities has been offered as a viable mediator between language impairment and ADHD (Tomblin, Zhang, Buckwalter, & Catts, 2000), as well as an outcome of language impairment moderated by ADHD (McGinty & Justice, 2009).

Tomblin et al. (2000) examined socioemotional behavioral difficulties in a community-based sample of 581 second-grade children (164 cases of language impairment). Elevated levels of teacher-reported externalizing and hyperactivity difficulties were found among participants with language impairments and reading deficits but not in affected children who presented with language impairments alone. Results of regression analyses indicated that the best model was one in which behavioral symptoms in children with language impairments were conditioned by their reading status. Tomblin et al. (2000) hypothesized that it might have been the negative experiences brought into children's lives by reading difficulties and repeated academic failure that aggravated their behavioral symptoms. Different associations between language impairments,

attention deficits, and reading status were reported by McGinty and Justice (2009) in a younger study sample. These investigators examined the predictive value of children's linguistic abilities on measures of print knowledge in 41 preschool children with SLI. Regression analyses indicated that severity of language impairment was not an adequate explanation for the presence of print knowledge delays in some of the affected children. Instead, home literacy experiences predicted children's print knowledge, and this association was only present in the subgroup of children who had been rated by their parents as having elevated attention problems. McGinty and Justice (2009) suggested that the presence of elevated levels of inattention, distractibility, and impulsivity compromised the potential benefit that this subgroup could get from joint reading activities and other emergent literacy experiences.

Redmond, Hogan, Ash, and Guarino (2014) used path analyses to examine relationships between language abilities, reading skills, and ADHD symptoms in a study sample of 122 second- and third-grade students (46 cases of language impairment). Ascertainment used community-based verbal screenings to recruit children enrolled in regular education and children receiving school services for a communication disorder, reading disorder, or emotional-behavioral disorder. Results did not provide support for either a moderator or mediator model of the sort reported by Tomblin et al. (2000) or by McGinty and Justice (2009). Instead, parent-reported ADHD symptoms only predicted participants' reading difficulties when their language abilities were within normal limits. For children with language impairments, the severity of their language impairment (in particular, their performance on a nonword repetition task) was the only significant predictor of reading difficulties. These results suggest that attention deficits and language impairments represent separate and non-interactive risk factors for reading difficulties. Discrepancies across Tomblin et al. (2000), McGinty and Justice (2009), and Redmond et al. (2014) are difficult to reconcile. Widely different outcomes regarding the interrelationships among language, attention, and reading might have been due to differences between investigations in the composition of their study samples, the particular scales used to assess ADHD symptoms (parent vs. teacher), or the ages of the participants.

Another possible mechanism that could link features of SLI to those of ADHD is the experience of chronic peer victimization. Both children with SLI and those with ADHD have been shown to be at elevated risk for physical bullying and other negative peer experiences (Conti-Ramsden & Botting, 2004; Humphrey, Storch, & Gefken, 2007; Knox & Conti-Ramsden, 2007; Lindsay, Dockrell, & Mackie, 2008; Weiner & Mak, 2009). One interpretation of these associations is that, for different reasons, both linguistic impairments and behavioral difficulties stigmatize children in ways that provoke negative peer regard. However, another possibility is that the direction of causality works in the other direction. For example, the results of one epidemiologically ascertained study sample of students with and

without ADHD suggest that, for at least some children, peer victimization represents a contributing factor to the development of ADHD symptoms rather than a consequence of their difficulties in inattention, impulsivity, or inattention. Holmberg and Hjern (2008) examined relationships between clinical measures of ADHD and student self-reports of peer victimization in 516 students collected at two time points: first and fourth grade. Results indicated that bullying levels at first grade were significantly associated with parent and teacher ratings of ADHD symptoms at fourth grade. However, there were no significant associations between informant ratings of ADHD symptoms at first grade and student's reports of being bullied in fourth grade. To accommodate for these results, Holmberg and Hjern (2008) suggested that the chronic stressors of insecurity, anxiety, and fear associated with being bullied on a regular basis may have been contributing factors to the establishment and/or aggravation of children's ADHD symptoms. These investigators drew parallels between the concentration difficulties and attention problems associated with individuals suffering from posttraumatic stress disorder and their participants who experienced chronic peer victimization. The pathway suggested by Homberg and Hjern (2008) shares a resemblance to the one suggested by Tomblin et al. (2000) for the link between language impairments and ADHD symptoms. In both cases, an external emotional stressor (peer victimization or reading disabilities and academic failure) is setting the stage for ADHD risk.

Redmond (2011) examined the relationships between 7- and 8-year-old students' language abilities, students' self-reports of physical and verbal bullying, and parent-reported levels of inattention and hyperactivity. The study sample consisted of the SLI, ADHD, and TD participants from Redmond et al. (2011). The results indicated that children with SLI reported the highest levels of physical bullying. Modest significant positive associations between hyperactivity ratings and reported levels of physical and verbal bullying were also found ( $r$  values were approximately .40) for the participants with SLI but not for the participants with ADHD. These results would be consistent with Holmberg and Hjern's (2008) victimization pathway to elevation of ADHD symptoms and suggest that there might be different sources for those difficulties when they appear in children with SLI than in children with ADHD. In other words, for children with SLI, the victimization pathway might amount to phenomimicry of ADHD. What is unavailable from this clinical case control sample, however, is crucial information about the order in which children with SLI experienced peer victimization relative to the emergence of their hyperactive symptoms.

## Working Conclusions and Future Directions

Variability across studies examining the links between LI and ADHD has been considerable, preventing straightforward answers to such basic questions as, "How often do ADHD and LI co-occur?" and "How does

comorbid ADHD+LI differ from SLI?” Encouraging results are available from a small number of new studies that suggest that psycholinguistic indices associated with the phenotype of SLI can be used to differentially diagnose SLI from ADHD in young elementary students. Furthermore, the evidence available suggests that children’s performances on measures of tense-marking, non-word repetition, and sentence recall are not detrimentally affected by the co-occurrence of ADHD. A comparable level of segregation appears to be possible with ADHD symptoms if practitioners and researchers make adjustments to standardized informant rating scales to accommodate for possible overlapping symptoms. Together, these results suggest separable phenotypes and that SLI and ADHD represent noninteractive disorders.

As a collection, these clinical metrics provide future investigations a space in which to examine further potential links between language impairments and ADHD that is relatively free of measurement artifacts associated with previous studies. I believe the path forward will involve three complimentary research strategies.

First, it is clear that additional epidemiological investigations of SLI are long overdue. Significant advances in our understanding of this common neurodevelopmental disorder have been made since the 1990s, and during this time, the clinical and educational climates have changed considerably. An approach that has yet to be used in this area is basing initial SLI case assignment on children’s performances on tense marking, nonword repetition, and sentence recall rather than basing them on potentially arbitrary standard score criteria from omnibus language tests. The advantage here would be better alignment in our prevalence and co-occurrence estimates with phenotypes of SLI currently being used in behavioral and molecular genetic investigations. Also, from this new vantage point, the extent to which comorbidity exceeds or simply reflects chance levels could be determined. Recall that co-occurrence rates of language impairment and ADHD currently include reported values that closely approximate general rates of ADHD diagnosis recently provided by the Centers for Disease Control and Prevention (Lindsay & Dockrell, 2008; Redmond & Rice, 2002; Rescorla, Ross, & McClure, 2007; Whitehouse et al., 2011; Willinger et al., 2003). The observation that co-occurring ADHD is prevalent within practitioner’s caseloads could turn out to be largely a function of referral and ascertainment biases. Another gap in the epidemiological record is the extent to which the prevalence and identification of SLI and the co-occurrence of ADHD+LI is affected by regional variations. Variation is commonplace with other neurodevelopmental disorders (e.g., the state of Utah has the highest rate of autism diagnoses in the United States but also one of the lowest prevalence rates of ADHD), and it is likely true that variation exists for SLI as well. Interactions among environmental, biological, and genetic risk factors could be uncovered through a careful analysis of geographical variation.

The second element needed to further clarify how links between these two common disorders can be established is

parallel longitudinal investigation of SLI and ADHD. At an individual level, neurodevelopmental diagnoses represent working hypotheses that practitioners should adjust as additional information accumulates. A cross-etiology comparison would provide crucial details that would be missed by following the growth of individuals affected by these disorders separately. For example, some children who start off with either an initial SLI or an ADHD profile might, over the course of development, drift toward a profile that aligns better with a comorbid ADHD+LI designation. Risk, as well as protective factors associated with these drifts, might be shared or be different for individuals from the initial groupings. There might also be a degree of permeability between criteria for these two common disorders such that, at different ages, some cases of SLI appear to grow into ADHD or vice versa, which could only be captured through a parallel longitudinal investigation. Individual changes in affected children will be especially important to track when they involve language or attention symptoms that are delayed in presentation or more difficult to identify. For children with SLI, this could involve apparent resolutions of their earlier expressive language deficits (at least under conversational contexts), which is offset by the ascendance of the functional impact that their underlying receptive language difficulties has on increasing academic demands. For children with ADHD as they grow older, these shifts could involve declines in their impulsivity and hyperactivity presentations that are accompanied by a rising prominence of the functional impact of their inattention symptoms. Of particular significance moving forward will be charting individual pathways from 7 to 12 years, which frames the age of customary identification of ADHD and the recently established upper age limits of onset of ADHD symptoms (American Psychiatric Association, 2013, p. 61).

In conclusion, the separation of SLI and ADHD symptoms provided by these clinical metrics allows for clearer evaluation of potential shared genetic liabilities. Rates of language impairment in first-degree relatives of probands with ADHD and rates of ADHD in first-degree relatives of probands with SLI can be used to evaluate different models of comorbidity (e.g., assortative mating, correlated additive risk, pleiotropy, and epistasis). An example of this method is provided by Bishop (2010b), in which several studies of the language abilities of parents and siblings of individuals with autism were used to test predictions based on different correlated risks models of SLI and autism. This analysis suggested that, rather than representing discrete clinical entities, SLI and autism might be better accounted for by dimensional views of language and social disorder. Without a doubt, it will take some time before the evidence base on the profiles of families of individuals with SLI and ADHD is suitably large enough for a similar synthesis. However, efforts to fill in this and the other gaps outlined in this review article will be worthwhile. The resulting improvements in our understanding brought in by these three research strategies will inform both theory and practice in ways that ultimately improve the lives of individuals affected by these two common disorders.

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