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Research Note

Longitudinal Associations Across Prematurity, Attention, and Language in School-Age Children

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Purpose: This research note explores the potential role of attention in mediating previously reported associations between language outcomes and prematurity.
Method: As a follow-up investigation to Mahurin Smith, DeThorne, Logan, Channell, and Petrill (2014), we employed multilevel modeling to analyze longitudinal data on language and attention collected when children were, on average, ages of 7, 8, and 10 years. The sample of 114 children taken from the Western Reserve Reading and Math Project was selected to oversample children with a history of prematurity while also controlling for differences in confounding influences such as age, gender, parental education, and race.
Results: As predicted, attention differentially predicted language outcomes based on form of measurement. Specifically, parent and examiner ratings of attention were significantly associated with standardized test performance at all 3 time points (R^2 = 15.2%–20%). Associations between attention and language sample measures were less consistent across home visits and tended to be smaller in effect size.
Conclusion: Attention abilities are associated with children's language performance even in the absence of an attention-deficit/hyperactivity disorder diagnosis. Clinical implications, particularly as related to assessment, are discussed.

Nearly 10% of babies born in the United States arrive prematurely or more than 3 weeks before their due dates (Hamilton, Martin, & Osterman, 2016). Prematurity can have far-reaching effects, ranging from a brain hemorrhage that affects mobility to subtler influences on neurocognitive domains like language. Despite the panoply of studies reporting language decrements for children born prematurely, few have taken into consideration difficulties in attention and executive function associated with this population (cf. Barre, Morgan, Doyle, & Anderson, 2011; van Noort-van der Spek, Franken, & Weisglas-Kuperus, 2012). Given that premature children often demonstrate difficulties in both language and attention, this population highlights the difficulty many speech-language pathologists face in interpreting whether depressed language scores reflect impairments in attention, language, or both.

In a prior study, Mahurin Smith et al. (2014) used longitudinal data from a twin study, the Western Reserve Reading and Math Project (WRRMP; Petrill, Deater-Deckard, Thompson, De Thorne, & Schatschneider, 2006), to compare language outcomes between 57 children born prematurely (< 1,500 g or ≤ 32 weeks) and 57 children born at full term with no reported complications. The two groups were matched for age, gender, race, and parental education. Comparisons at mean ages 7, 8, and 10 years revealed consistently significant differences between the two groups on standardized measures of language and cognition, with higher scores for children born at full term. Whereas previous studies focused primarily on standardized test results (e.g., Barre et al., 2011), this investigation also examined participants' use of sophisticated semantic and syntactic skills in conversation and narrative. Although there was a trend toward lower semantic and syntactic skills for premature children relative to the full-term children, between-group differences were relatively small and never reached statistical significance. This discrepancy between the standardized test results and the language sample results prompted the present follow-up investigation into the role of attention on language assessment; we hypothesized that between-group differences in attention abilities might be mediating the differential performance across standardized tests versus language sample measures. Three lines of evidence support this

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hypothesis: (a) the presence of attention difficulties in children born prematurely, (b) empirical reports of a link between language and attention, and (c) theoretical rationale for the differential role of attention across tasks.

First, prematurity has been linked to attention differences. In a meta-analysis, Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, and Oosterlaan (2009) evaluated academic performance, behavior problems (with a particular focus on attention concerns), and executive function among children born very preterm (VP; ≤ 32 weeks of gestation) and/or of very low birth weight (VLBW; weighing < 1,500 g at birth). They reviewed 35 studies that included 4,125 VP and/or VLBW children and 3,197 full-term controls. They reported that the VP/VLBW group scored significantly lower on math, reading, and spelling (0.48–0.76 *SD*). They were also more vulnerable to attention difficulties, scoring 0.59 *SD* higher on parent ratings and 0.43 *SD* higher on teacher ratings. In addition, executive function decrements ranging from 0.36 to 0.57 *SD* were reported. The authors relate these findings to potential disturbances in development of the cortex, augmented by additional perinatal complications in the most premature subset of the sample. In this set of studies, which evaluated children ranging in age from 5.0 to 22.3 years, effect sizes were stable across childhood and into young adulthood. It is noteworthy that the attention scale used in this investigation represents a continuum of attention skills. Although many of the available studies emphasize a binary criterion (participants with or without attention-deficit/hyperactivity disorder [ADHD]), this meta-analysis shows that premature children may face challenges related to attention and executive function in the absence of a formal ADHD diagnosis (see also Bhutta, Cleves, Casey, Cradock, & Anand, 2002).

Second, even apart from marked cases of prematurity, attention and language difficulties frequently co-occur: ADHD diagnoses are more common among children with language impairments than in the general population (Willinger et al., 2003), and language concerns have been reported among children diagnosed with attention deficits (Cohen et al., 2000). Although attentional concerns often present clinically as ADHD, the most common psychiatric diagnosis among school-age children (Visser et al., 2014), subclinical impairments also have the potential to create difficulties for children in the absence of a formal ADHD diagnosis. Even without an ADHD diagnosis, children with specific language impairment (SLI) may struggle with sustained attention (Finneran, Francis, & Leonard, 2009).

Within the field of communication sciences and disorders, studies have considered the interplay between attention and language difficulties (Finneran et al., 2009; Redmond, 2016), with a smaller number considering differential performance on standardized versus nonstandardized language tasks. These latter studies have described success in distinguishing between ADHD and SLI regardless of whether the measures are derived from standardized tests (cf. Redmond, Thompson, & Goldstein, 2011) or language sample analysis (Redmond, 2004). This body of work, however, has focused chiefly on clinically identified groups of children: Some have been identified as having ADHD, and some have been identified as having SLI, whereas all of them have IQ results above a specified cutoff. In clinical practice, however, clinicians are more apt to serve children with comorbid impairments across attention and language. For children born prematurely, cognitive/linguistic delay is a more usual pattern than SLI. One study, in fact, reported a lower incidence of SLI among children born prematurely than among children born at full term (Aram, Hack, Hawkins, Weissman, & Borawski-Clark, 1991). In summary, impairments in language and attention often co-occur, especially in children born prematurely, and clinicians are faced with the practical task of differentiating the effects of these two domains on children's performance.

The third form of support for the hypothesis that attention abilities might be mediating the differential performance across language tasks comes from theoretical frameworks of attention. Although a review of the differential theories of attention is beyond the scope of the present research note, several investigators have explored theoretical explanations for the relationship between attention and language (Leonard, Ellis Weismer, Weber-Fox, & Miller, 2014; Tomblin & Mueller, 2012). Multiple theoretical perspectives support the investigation of attention as a mediating variable among children born prematurely. One perspective that is particularly relevant for this study involves the importance of cognitive resource utilization on task performance. In a 2015 article, Archibald, Levee, and Olino (2015) concluded that tasks that required children to work above their storage capacity or memory span exerted a cumulative load on children's cognitive resources, with diminished language performance observed under high-load conditions. In a sample of 1,326 children born prematurely, Jaekel, Baumann, and Wolke (2013) found substantial performance decrements on standardized tests of cognition specifically under high-load conditions. Other relevant findings that support a mediating role for attention among children born prematurely have been reported in Sansavini et al. (2007) and Bayless and Stevenson (2007).

The potential influence of attention on language assessment raises practical issues for clinical service providers. Although a body of recent work in the field of communication sciences and disorders has focused on distinguishing difficulties related to SLI from difficulties related to ADHD, for a subset of children with nonspecific language impairment, including those born prematurely, these distinctions remain less clear. Children with more diffuse impairments experience deficits across multiple domains, including cognition, language, and attention, and may be at an increased risk for long-term challenges (Law, Rush, Schoon, & Parsons, 2009). Reliable identification of children's ability profiles is critical, both because families deserve accurate information about their children's abilities and because it improves the odds that children will receive the interventions and support they need. For example, would a child benefit most from increased time during

test-taking in a less distracting environment, or should he or she receive tests with simplified language? The impact of attention on measures intended to assess language and cognition is thus a question with the potential to steer providers toward more focused assessments and interventions/accommodations that better meet families' needs.

In this study, we returned to the data set described in our 2014 article with the goal of examining the associations across birth weight, attention, and language outcomes. We addressed the following research questions (RQs):

1. Does gestational age at birth predict parent and/or examiner measures of attention?
2. Do the children's attention ratings predict their performance on standardized tests of language and cognition?
3. Do their attention ratings predict their use of sophisticated semantic/syntactic skills in conversational and narrative language samples?

We hypothesized first that gestational age would predict measures of children's attention. Second, we predicted that attention would predict children's standardized test outcomes more reliably than their semantic/syntactic skills as assessed in conversational and storytelling contexts.

Method

Participants

To address these questions, we returned to the participant sample from Mahurin Smith et al. (2014), which consisted of 114 school-age twins from the WRRMP selected based on their birth history. Specifically, half of the sample met the criterion for prematurity (either < 1,500 g at birth or a gestational age ≤ 32 weeks), whereas half were born at full term with no perinatal complications. For the present analyses, the oversampling of children born prematurely helps ensure representation of children at risk for language and attention difficulties. To limit confounding influences, children with and without prematurity were matched for age, gender, race, and parental education. The 57 children born prematurely consisted of 28 twin pairs and a 29th child whose co-twin did not meet the birth weight criterion; this structure was also matched for the full-term children. Approximately 67% of the sample were girls (76/114); 89.5% were White, 7% were African American, and 3.5% were described as "other." All of the primary caregivers had completed high school, and 80.4% of them completed at least some college. At each visit, the children completed a battery of standardized tests.

Procedure

This follow-up analysis utilizes longitudinal data collected across home visits when children were 7, 8, and 10 years old, on average (see Mahurin Smith et al., 2014, for additional details). All assessments were administered by examiners who were blind to the children's history of prematurity and to the study questions underlying the present analyses.

Measures

At the mean age of 7 and 8 years, we specifically considered participant results from the Stanford–Binet Short Form (Thorndike, Hagen, & Sattler, 1986) and productive language sample measures taken from a 15-min conversation with a trained examiner (see De Thorne & Hart, 2009). Mean IQ at the age of 7 years was 97.8 (SD = 13.7) for children born prematurely and 105.4 (SD = 13.1) for children born at full term. At the later visit at the age of 10 years, we drew data from the four subtests of the Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4) administered to WRRMP participants[1] (Semel, Wiig, & Secord, 2003) and the Test of Narrative Language (Gillam & Pearson, 2004). The resulting transcripts from both the conversational samples and the narratives from the Test of Narrative Language were analyzed to yield a number of productive language measures, summarized in Table 1, designed to assess semantic and syntactic skills. Reliability checks, undertaken on approximately 10% of the transcripts, yielded average values above .90 (range = .80–1.00) for both grammatical morphemes and utterance boundaries. As described in our previous article (Mahurin Smith et al., 2014), language sample measures with frequency counts were converted to densities to limit confounding with sample length, and confirmatory factor analysis was used to generate factor loadings for each of the language sample measures and for all of the standardized tests. We then used the factor loadings to derive weighted sums for each participant: a productive semantic factor, a productive syntactic factor, and a formal factor derived from standardized test scores.

Whereas our prior article emphasized the role of prematurity as a predictor of school-age outcomes, this study looks explicitly at the predictive power of the children's attention skills. Although none of the WRRMP participants had a diagnosis of ADHD, their attention skills varied. Consistent with other twin research into attentional control at school age (Lemery-Chalfant, Doelger, & Goldsmith, 2008), we used elements of the Rothbart Child Behavior Questionnaire (Putnam & Rothbart, 2006) and the Bayley Behavior Rating Scale (Bayley, 1993) to obtain parent and examiner ratings of attention. As part of the WRRMP testing protocol, parents completed the short form of the Child Behavior Questionnaire, a measure that looks at a number of temperament traits, including attentional focus, the focus of this study. Parents rated children on a 1–7 Likert scale in which 7 reflects strong attentional focus. We had parent attention ratings for 88 of the 114 original participants, 44 full-term children and 44 children born prematurely. These ratings were obtained between Home Visits 2 and 3. Further information about this measure and its use

[1]Recalling Sentences, Word Classes (Expressive and Receptive), and Understanding Paragraphs

Table 1. Measures of semantic and syntactic skills.

Semantic measures
Adverb density
Metalinguistic verb density
Morphologically complex word density
Low-frequency word density
NDW
NTW
Syntactic measures
Conjunction density
Complex conjunction density
Elaborated noun phrase density
DSS
MLU

Note. NDW = number of different words; MLU = mean length of utterance; NTW = number of total words; DSS = developmental sentence scoring.

in the WRRMP cohort can be found in Mullineaux, Deater-Deckard, Petrill, Thompson, and DeThorne (2009). As a complement to the parent measure, examiners evaluated children's on-task behavior on a 5-point scale from the Bayley Infant Behavior Record, where the ratings ranged from *constantly off task* (1) through *typically off task* (2) and *off task half the time* (3) up to *typically attends* (4) and *constantly attends* (5). Examiner attention ratings were available for all of the children at the home visit at the age of 7 years; we removed one outlier from the data set before model fitting based on a score > 3 *SD*s from the mean.

Analyses

Because of the nesting inherent in a twin study, we used multilevel modeling to evaluate the relationships between our predictor variables and our outcome variables. For all models, individual children (Level 1) were grouped into families (Level 2). For RQ 1, we used the continuous variable of a child's gestational age at birth as a fixed factor to predict parent and examiner ratings of attention at school age. For RQs 2 and 3, our objective was to investigate the utility of attention ratings in predicting the variance observed in language measures across these 114 participants. To that end, we used parent and examiner ratings of attention as fixed factors to predict standardized test scores and sophisticated semantic/syntactic skills for all of the children in the sample. Exploratory models incorporating additional variables from the WRRMP data set did not alter the significance of sustained attention; in consequence, we describe the more parsimonious models below. Given the continuous nature of the variables under study, we combined premature and full-term children for all analyses to capitalize on the full range of variability. Analyses were completed using the nlme() package in R (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2016).

Results

To help address our first RQ on the association between gestational age and attention, we obtained descriptive statistics for parent and examiner ratings of child attention as a function of prematurity status. For the premature children, the mean parent rating of attention was 5.09 (SD = 1.04) on a 7-point scale, where 7 indicates the strongest attention skills; for the full-term children, it was 4.87 (SD = 0.77). For comparison, the population mean for the measure is 4.65 (SD = 0.67). The mean examiner rating of attention for children born prematurely was 4.4 (SD = 0.76) on a 5-point scale, where 5 indicates the most consistent attention to task; the mean examiner rating for the full-term children was 4.65 (SD = 0.67). Next, we looked directly at the relationship between gestational age and parent/examiner ratings of attention via multilevel modeling: Did gestational age predict attention ratings? In contrast to the existing literature on attention and prematurity (e.g., Bhutta et al., 2002), in this sample, there was no association between gestational age and parent attention ratings. For examiner ratings, however, there was a significant predictive relationship between gestational age at birth and off-task behavior (b = 0.04, p = .03). As one might infer from this contrast, parent and examiner ratings correlated poorly (r = .16), a finding in keeping with other studies that compare parent and examiner perspectives (see discussion in Redmond, 2016).

Next, we evaluated the impact of attention on standardized test scores versus language sample measures. Was there an association between parent and examiner assessments of children's ability to focus on a task and the children's performance on a standardized test? This relationship, assessed via multilevel modeling, was significant at all three home visits. Parent and examiner ratings served as effective predictors of standardized test scores in isolation; in a combined model that included both ratings, each of the variables retained its predictive power. This finding was observed for both general cognitive ability (measured via the Vocabulary and Pattern Analysis subtests of the Stanford–Binet at the age of 7 and 8 years) and language (measured via four subtests of the CELF-4 at the age of 10 years); results for the combined model, using both parent and examiner ratings as predictors, are shown in the top half of Table 2. The far right column of Table 2 shows the marginal R^2 value for each model, an estimate of the proportion of variance accounted for by attention (Nakagawa & Schielzeth, 2013). These range from 15.2% to 20.0%.

To address our third RQ, we also used multilevel modeling to evaluate the role of attention in these children's use of sophisticated semantic and syntactic skills within the context of a language sample. Parent ratings of attention were not significant predictors of children's semantic or syntactic skills in conversation or narrative at any of the three home visits under consideration. Examiner ratings, on the other hand, were significantly associated with semantic and syntactic skills at the age of 7 years and with syntactic skills at the age of 10 years; there were no significant associations for the conversational samples at the age of 8 years. As shown in the bottom half of Table 2, R^2 values ranged from 4.6% to 17.2%.

Table 2. Multilevel modeling results for standardized test scores and language sample measures, using parent and examiner attention ratings as the predictor variables.

Measure	Examiner rating slope (*SE*)	Parent rating slope (*SE*)	R^2
IQ, age = 7 years	0.49 (0.14)***	0.24 (0.08)**	.200
IQ, age = 8 years	0.35 (0.15)*	0.28 (0.11)*	.161
CELF-4, age = 10 years	0.39 (0.17)*	0.24 (0.09)*	.152
Semantics, age = 7 years	0.35 (0.14)*	*ns*	.055
Syntax, age = 7 years	0.32 (0.14)*	*ns*	.046
Semantics, age = 8 years	*ns*	*ns*	—
Syntax, age = 8 years	*ns*	*ns*	—
Semantics, age = 10 years	*ns*	*ns*	—
Syntax, age = 10 years	0.68 (0.16)***	*ns*	.172

Note. CELF-4 = Clinical Evaluation of Language Fundamentals–Fourth Edition; *ns* = not significant.
*$p < .05$. **$p < .01$. ***$p < .001$.

Discussion

Review of Findings

Our first RQ considered the relationship between gestational age and attention ratings (from both parents and examiners) in a combined sample of children with and without a marked history of prematurity. Although there was no association between gestational age and parent attention ratings, a finding discussed further in the Interpretations section, we found that lower gestational age did predict more off-task behaviors as rated by examiners.

Our second and third RQs considered the role of attention in mediating the previously established relationship between prematurity and language outcomes. At all three of the time points under consideration, attention ratings by parents and trained examiners proved to be effective predictors of performance on standardized tests of language and IQ, accounting for 15%–20% of the variance in children's scores. Parent ratings did not predict children's spontaneous use of sophisticated semantic and syntactic skills at any of the three time points under consideration. Examiner ratings of attention did predict language sample outcomes at the age of 7 years: Children who were less engaged in the task were less likely to deploy complex language skills. At the ages of 8 and 10 years, examiner ratings did not serve as consistent predictors for these outcomes, although a relationship was observed for syntactic skills at the age of 10 years. Our prior work on this data set indicates that this longitudinal change is unlikely to be explained by patterns of attrition (Mahurin Smith et al., 2014).

Interpretations

These findings help quantify a phenomenon familiar to many clinicians: A child who does not attend during testing is less likely to do well on the measure. They may also indicate that attention to task can exert a significant influence on test performance whether or not a child has ADHD. It is possible then for an instrument designed to evaluate a child's skills in a particular domain, such as language, to reflect other cognitive variables in addition to (or instead of) the targeted domain. Specifically, a highly structured task such as the CELF-4 relies on robust set-shifting abilities, as children must respond appropriately to rapidly changing stimuli in a way that is not likely required during conversational and narrative discourse. This specific aspect of executive function is known to be affected among children born prematurely, including those whose IQs fall in the normal range (Bayless & Stevenson, 2007). Given the importance of formal diagnoses and standardized tests in present-day clinical decision making and in the interpretation of research results, this is a finding that merits consideration; we will return to it in the Clinical Implications section.

This research note utilizes follow-up analyses of Mahurin-Smith et al. (2014) to extend the literature on attention and language by assessing the relationships between children's attentiveness and their use of sophisticated semantic/syntactic skills in conversation and narratives. Our models suggest that children's performance on language sample measures may be more robust in the presence of inattention than their standardized test performance. An explanation that merits consideration is that standardized testing and language sample tasks create different cognitive loads. One school of thought regarding the importance of attention and executive function for language tasks is that management of cognitive load is more difficult for some children than others (cf. Jaekel et al., 2013). A standardized testing context, in which an examiner must repeatedly find the ceiling of a child's ability, is an example of a high-load cognitive task.

One unexpected result of this study is the absence of any differences in parent ratings for children born prematurely. This may be related to unexpected differences in which parents completed the attention-rating task as a function of prematurity status. Despite the explicit effort to control parent education across children with or without a history of prematurity, only a subset of parents (88/114 families) completed the attention-rating task used in the present investigation. As it turned out, the more highly

educated parents were more apt to complete the parent rating task in the children born prematurely, whereas the reverse pattern was true in the children born at full term. The effect was to create a slight mismatch between educational levels within our analyses, specifically on the parent rating variable, with more highly educated parents among children born prematurely. Given that parental education is associated with better outcomes for premature children (Msall, Bier, LaGasse, Tremont, & Lester, 1998), it may play a role in explaining our null finding. Hence, it is possible that any effects of prematurity and parental education on child attention were "canceling each other out" in the present sample.

A second unexpected finding was the association between examiner attention ratings at the age of 7 years and syntactic skill at the age of 10 years, given the modest effects seen at the age of 7 years and the absence of other relationships between attention and language sample performance at the ages of 8 and 10 years. These findings were not explained by the presence of univariate or bivariate outliers. One possible explanation is that the sophisticated syntactic skills deployed in the narratives of some 10-year-olds require greater attentional focus; it might also be the case that the association is spurious. Further investigation is required to explain this result.

Our assertion that attention accounts for a significant proportion of the variance in standardized test scores raises questions in view of recent studies of ADHD and language impairment, which have not reported significant decrements in test performance among their participants with ADHD (Redmond, Ash, & Hogan, 2015). In studies of ADHD and cognition, however, it is not uncommon for investigators to report significantly lower scores for participants with ADHD (see Frazier, Demaree, & Youngstrom, 2004, for a meta-analysis). We suggest two explanations for this discrepancy: First, screening procedures that use standardized tests to assess for normal IQ will, by design, include only children able to tolerate standardized testing tasks reasonably well. Second, brief 3- to 5-min language assessment tasks (as in Redmond et al., 2011, 2015) are less likely to create difficulties for children who face challenges with sustained attention. Although these choices to ensure that IQ falls in the typical range and to limit the length of assessment tasks may improve a study's internal validity, they may also limit generalizability to a school setting, where children's cognitive profiles and tolerance for testing tasks can vary widely and where lengthy assessment batteries may be required by special education personnel. For this reason, we suggest that these findings may have important clinical implications.

Clinical Implications

We propose first that for service providers performing assessments among children with a history of prematurity, awareness of the relationship between attention and test performance is essential. Our findings indicate that multifaceted assessment strategies that allow children to demonstrate their abilities in naturalistic settings are more likely than standardized tests to highlight the complete profile of strengths and weaknesses in this population.

Second, we contend that a multifaceted assessment approach is helpful for parents and for children. If subclinical attention impairments can deflate standardized test scores, information based on those scores can lead to an inaccurate and unnecessarily grim prognosis and an incomplete picture of a child's abilities. If, on the other hand, children have true impairments across multiple domains, it is important for parents to be aware early on of the added risks associated with nonspecific language impairment (Law et al., 2009).

Finally, we suggest that the contexts in which attention concerns occur and their specific manifestations are important for service providers to consider. The *Diagnostic and Statistical Manual of Mental Disorders–Fifth Edition* (American Psychiatric Association, 2013) requires that children experience problems across more than one setting to receive an ADHD diagnosis. As previously noted, our results showed poor alignment between parent and examiner ratings, a finding consistent with other work in this area. Although a child who struggles with sustained attention primarily in a testing context would be unlikely to qualify for an ADHD diagnosis (or the academic supports that may accompany the diagnosis), in an era of high-stakes testing, that child may still face negative consequences for a focal attention deficit. Redmond et al. (2015) speculated that significant attention problems might have a counterintuitive protective effect, because they might trigger earlier identification and more intensive intervention. In contrast, children who have attention challenges, although they do not fit the criteria for ADHD (e.g., they have difficulty attending to task at school but not elsewhere, or their problem falls in the subclinical range), may fall in a diagnostic no-man's-land. Among premature children, the inattentive subtype of ADHD is most common (Hack et al., 2004); underidentification is a particular problem with this form of ADHD. Children who experience challenges with related cognitive skills—notably, working memory, a domain affected in many children born prematurely (Sansavini et al., 2007)—may face additional difficulties in a language-testing environment (Noonan, Redmond, & Archibald, 2014). Taken together, these factors suggest that service providers working with children born prematurely should consider carefully how their attention skills may influence their performance in other domains in hopes of mitigating the increased risks of academic challenges and poor self-concept observed in this population (Rickards, Kelly, Doyle, & Callanan, 2001).

Limitations

Two key factors limit the conclusions that can be drawn from the present analyses. First and foremost, multilevel modeling is based on correlational analyses that cannot provide causal evidence. Although we offer theoretical and empirical support for the influence of attention

on language assessment outcomes, it is also possible that children who are struggling with the language demands of a task may be more likely to disengage or, conversely, that unidentified variables explain the relationship between attention and language outcomes. Second, the generalizability of our findings is limited by the characteristics of the sample, which underrepresents families of color, parents without a high school diploma, and children with extreme prematurity (born before 28 weeks). On a related note, given the lengthy and repeated demands of the testing protocol, it is less likely that parents of children with significant attention challenges would elect to participate. Further research is needed to address this complex web of variables.

Summary and Conclusion

Many studies of premature children have confirmed that they are more vulnerable to ADHD and subclinical attention problems; many others have reported that they score significantly lower on standardized tests of cognition and language. This research note extends those findings by measuring the association between attention and gestational age as well as potential influence of attention on language outcomes across both standardized test scores and productive language measures. For clinicians working with children whose history includes prematurity and whose present includes complex and uncertain blends of academic, behavioral, and language challenges, these findings indicate that a multifaceted assessment strategy may permit these children to show their skills to best advantage.

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