Dosage, Severity, Frequency, and Chronicity Effects of Adversity Exposure on Children's Grammar Abilities

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Abstract

Children exposed to adversity (e.g., chronic poverty, traumatic events, child maltreatment) are at increased risk for performing below age-expectations on norm-referenced language assessments, but it is unknown whether the risk is higher for specific language impairment. Previous research has not included samples with sufficient exclusionary criteria, assessments with sufficient diagnostic accuracy, nor comprehensive adversity measurement. Given hypothesized epigenetic mechanisms linking extrinsic factors (e.g., adversity exposure) with intrinsic predisposition (e.g., genetic risk), an increased prevalence of specific language impairment is expected. The current study investigated whether adversity exposure and which adversity features may increase risk for specific language impairment.

The syntax subtest of the Diagnostic Evaluation of Language Variation Norm-Referenced (DELV-NR) assessment was administered to 30 school-aged children with known histories of adversity exposure. Their primary caregiver also completed a comprehensive adversity exposure measure, which captured adverse event type, frequency, and severity. From the adversity exposure measure, the adversity feature predictors of dosage, frequency, chronicity, and severity were created. General linear models were conducted to examine whether the adversity feature predictors interacted with specific language impairment status to predict grammar performance.

Overall, the sample performed significantly lower on the DELV-NR syntax subtest (*M* = 8.07, *SD* = 1.96) than the expected population mean of 10, and a higher percentage of participants (20%) met diagnostic criteria for specific language impairment than the expected prevalence in the general population. The specific language impairment and typical language groups did not significantly differ in adversity dosage, frequency, chronicity, or severity; however, participants in the specific language impairment group were 1.46 times more likely to have experienced physical trauma than the participants in the typical language group. After accounting for maternal education and nonverbal cognition, specific language impairment status significantly predicted grammar performance on the DELV-NR syntax subtest, accounting for 66% of the sample variance, but adversity feature predictors did not.

Children with known histories of adversity exposure are at heightened risk for grammatical deficits and specific language impairment; however, the children with specific language impairment in this sample did not experience a higher dosage nor more frequent, chronic, or severe adversity. The only difference between groups was increased exposure to physical trauma (e.g., physical abuse, victimization) as compared to the typical language group. Future research is needed to investigate the prevalence of specific language impairment in this population and potential causal mechanisms linking adversity exposure to increased rates of specific language impairment.

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Introduction

Despite a documented association between adversity exposure and low language performance (Lum et al., 2015; Malarbi et al., 2017; Sylvestre et al., 2016), many questions remain regarding whether and how adversity exposure functions as a specific and unique risk factor for language disorder. Low language performance arises from multiple etiologies (Bishop et al., 2017; Rice, 2016) such as neurodevelopmental disorders (e.g., Intellectual Disability), cultural-linguistic variations (e.g., bi/multilingualism), or a genetic predisposition to a selective impairment in language. This last clinical profile, known as specific language impairment (SLI), comes from an intrinsic (i.e., genetic) disruption in language acquisition despite adequate hearing and nonverbal cognitive abilities (Leonard, 2014; National Institute on Deafness and Other Communication Disorders, 2019; Rice, 2012; Tomblin et al., 1997). Based on epidemiological data, approximately 7% of the general population has SLI (Norbury et al., 2016; Tomblin et al., 1997), and the disorder predisposes individuals to many long-term negative outcomes such as academic underachievement and limited occupational opportunities (Conti-Ramsden et al., 2018; Dubois et al., 2020).

While SLI is intrinsic to the child, adversity exposure is extrinsic and coincides with suboptimal environmental factors that interfere with child development. Adversity encompasses potentially traumatic events such as chronic poverty, neglect, physical or sexual abuse, and violence exposure, among others (Costello et al., 2002). This exposure is associated with potential epigenetic changes of the genome that regulate neural development, neural functioning, and behavioral outcomes such as learning and memory (Lupien et al., 2009; Roth & Sweatt, 2011). Through these mechanisms, adversity exposure may interact with a child’s genetic predisposition to SLI, possibly leading to a language impairment despite no genetic predisposition or to a more severe language impairment if a genetic disposition was already present.

Children exposed to adversity are at increased risk of scoring below age-expectations on language assessments (Lum et al., 2015; Malarbi et al., 2017; Smith et al., 2021; Sylvestre et al., 2016). For example, approximately 30% of children exposed to child maltreatment (Lum et al., 2018), approximately 33% of children living in poverty (Roy et al., 2013), and approximately 32% of children at risk for adversity exposure (Smith et al., 2021) perform below age-expectations, which is over four times the prevalence of SLI. Despite these findings, whether adversity exposure increases the rate of SLI is unclear since performing below age-expectations can stem from multiple etiologies if exclusionary criteria are not applied. In addition, few studies assess grammar, with most assessing overall language or vocabulary abilities, despite the diagnostic sensitivity of grammatical impairment for accurately identifying SLI (Rice & Wexler, 2001; Spaulding et al., 2006; Weiler & Schuele, 2021). Finally, comprehensive assessment of adversity exposure is needed to determine which features (e.g., dosage, frequency, severity, chronicity) relate to grammatical impairment and SLI. These adversity features have received little attention in studies of language acquisition in samples with various types of adversity exposure (e.g., Lum et al., 2015). Together, these methodological confounds interfere with understanding how adversity exposure may uniquely disrupt language acquisition rather than disrupting cognition, intelligence, or child development in general. This study addressed these limitations to advance understanding of which adversity features predict SLI in a sample of children exposed to adversity.

Exclusionary Criteria

Few studies in the adversity literature[1] have applied the exclusionary criteria needed to interpret low language performance as indicative of a language disorder or, in particular, SLI. For example, Smith and colleagues (2021) reported that 32% of the five-year-old children in their adversity sample (defined based on prenatal risk factors such as no household income) scored one standard deviation below the age-mean on a norm-referenced assessment of language. The authors used the term "language difficulties" to describe this proportion of the sample, likely because the criterion of scoring below a normative mean is insufficient to warrant the label of language disorder. Even with the broadest of diagnostic criteria (American Psychological Association, 2013; World Health Organization, 2016), a diagnosis of language disorder excludes sensory impairments (e.g., hearing loss), intellectual disability, and neurological disorders (e.g., epilepsy). In causal pathway research, researchers often use the stricter set of diagnostic criteria for SLI that exclude other neurodevelopmental disorders (e.g., Attention Deficit Hyperactivity Disorder), cultural-linguistic variations (e.g., bilingualism), and nonverbal cognitive impairment (Rice, 2016).

Without applying exclusionary criteria for SLI, the 32% of Smith and colleagues' (2021) sample scoring below the age-mean may include other etiologies that explain the notable prevalence of language difficulties. For example, children with Attention Deficit Hyperactivity Disorder may have language difficulties but, rather than SLI, these language difficulties stem from non-linguistic deficits in sustained attention, working memory, and other executive functions (Redmond, 2016). As another example, bilingual children produce language errors similar to children with SLI, but these language difficulties stem from the developmental

[1] In this study, unless otherwise noted, the term *adversity literature* refers to publications focused on children exposed to one or more potentially traumatic event types (e.g., poverty, child maltreatment, violence exposure).

complexity of mastering two different languages (Paradis, 2016). The language difficulties in both examples may contribute to the 32% prevalence, unless researchers apply exclusionary criteria. These other etiologies of language difficulties create confounds, which interfere with understanding whether and how adversity exposure increases the likelihood for SLI rather than intelligence or child development in general.

Applying exclusionary criteria also reduces measurement error to strengthen causal inferences between individual variation in adversity exposure and in language abilities. The adversity literature is rife with inconsistent findings and limited replicability. For example, in a meta-analysis examining the effects of child maltreatment exposure on language abilities (Lum et al., 2015), 53% of studies found no effect. Given that few studies in the child maltreatment and broader adversity literatures apply exclusionary criteria, the inconsistency of significant effects may coincide with the samples' vast heterogeneity. In Lum and colleagues' (2015) meta-analysis, the study with the largest standard mean difference between groups on a language assessment (i.e., *M*: 1.99, 95% confidence interval [1.23, 2.77]) also included a difference of 20 standard score points for IQ (Hoffman-Plotkin & Twentyman, 1984). When determining whether child maltreatment, or adversity more broadly, affects language acquisition, this type of confound interferes. Is the standard mean difference between groups because of individual variation in language or overall intelligence?

Some studies in the adversity literature have applied exclusionary criteria for certain neurodevelopmental disorders but not all consistent with the SLI criteria (e.g., Carvalho et al., 2017; Culp et al., 1991; De Bellis et al., 2009; De Bellis et al., 2013) while others have applied an exclusionary criterion for exposure to multiple languages (e.g., Culp et al., 1991; Julien et al., 2019; Vasilyeva et al., 2008). In these studies, the adversity groups still performed lower than the control groups on language measures, suggesting that adversity may indeed have a unique effect on or is associated with language abilities. However, without applying all exclusionary criteria consistent with SLI, other confounding sources (e.g., intellectual disability) remain in the sample that may explain the language difficulties in adversity groups. Given that no study has applied all exclusionary criteria consistent with SLI, one exploratory aim of this study was to assess the feasibility of identifying such a selective group of children in an adversity-exposed sample.

The Value of Grammar as an Outcome Measure

Most studies in the adversity literature have included an assessment of vocabulary or omnibus language (i.e., a measure of overall language ability) rather than grammar (Lum et al., 2015; Malarbi et al., 2017; Sylvestre et al., 2016). While all three constructs are sensitive to individual variation in language ability, grammar assessments are most sensitive for valid identification of SLI (Rice et al., 1995; Tager-Flusberg & Cooper, 1999). In contrast, vocabulary assessments may result in under-identification of SLI (i.e., false negatives) given that SLI groups score within one standard deviation of age-matched groups with typical language abilities (Spaulding et al., 2006). Vocabulary and grammar are also distinct dimensions of language based on confirmatory factor analyses in preschool (Language and Reading Research Consortium, 2015) and school-aged samples (Tomblin & Zhang, 2006). In all, grammar is a necessary dimension to include when assessing language abilities, especially when identifying SLI.

Grammar and SLI

For individuals with SLI, grammar deficits appear early in childhood and persist into adulthood (Rice, 2012). One grammar deficit, in particular—optional marking of obligatory tense and agreement (e.g., she walk<u>ed</u>)—functions as a clinical marker for SLI status in the general population (Rice & Wexler, 2001; Tager-Flusberg & Cooper, 1999; Weiler & Schuele,

2021) and in contexts where differential diagnosis is needed between SLI and cultural-linguistic variations or other neurodevelopmental disorders (e.g., Pruitt & Oetting, 2009; Redmond et al., 2011). In English, each clause within a sentence requires tense and agreement marking (e.g., past tense -ed, third person singular -s, copula BE, auxiliary BE, and auxiliary DO verbs). For example, in the sentence "She walked the dog", past tense -ed is the grammatical marker of interest. When children begin to learn tense and agreement marking, they optionally apply this obligatory grammatical marker, which is known as the optional infinitive phase (Wexler, 1998). Throughout the preschool years, the children begin marking tense and agreement more often until they no longer omit them in obligatory contexts, reflecting mastery of the adult grammar for this marker.

Children with SLI, however, experience an extended optional infinitive phase (Rice et al., 1995) where they optionally omit tense and agreement markers for a protracted period beyond age-matched typical language peers. In observational language samples, preschool- and early school-aged children with SLI continue to omit grammatical markings more often than their peers, and they produce shorter and less complex sentence structures (Hewitt et al., 2005; Rice et al., 2010; Rice et al., 1995). Over time, this gap slowly closes such that children with SLI begin applying grammatical markings more frequently, and their sentence length and complexity approach their typical language peers (Rice et al., 2010). During the school-aged years, grammar deficits still appear in other tasks such as elicitation and grammaticality judgment methods (Rice et al., 2009; Rice et al., 2004). In this last task, grammar deficits persist beyond adolescence.

Grammar, Socioeconomic Status, and Exposure to Varying Language Input

Not only are grammar deficits (e.g., tense and agreement marking) hallmark features of SLI (Rice et al., 1995; Tager-Flusberg & Cooper, 1999), but they are also less sensitive to variations in the language environment as compared to vocabulary and omnibus language measures (Pruitt & Oetting, 2009; Whitehurst, 1997). This distinction is crucial when research questions involve disentangling the unique contributions of intrinsic versus extrinsic risk factors affecting language acquisition. For example, in the seminal Hart and Risely study (1995), low socioeconomic status was an extrinsic risk factor associated with vocabulary growth. Children in high and middle socioeconomic status environments heard significantly more words than the children in low socioeconomic status environments. This extrinsic factor—the effect of socioeconomic status on language input—also predicts children's vocabulary knowledge later in development (Rowe, 2012). The causal inference is that reduced language input (i.e., hearing fewer words) causes delays in vocabulary acquisition.

This reduced language input is the underlying theory for much language acquisition research in adversity samples (e.g., Eigsti & Cicchetti, 2004; Hoff, 2013); however, newer studies do not confirm the findings of Hart and Risely. For example, in an attempt at replication, Sperry and colleagues (2019) found a weak association between socioeconomic status and how many words the children heard. Further, when the definition of language input expanded to include other speakers in the environment besides the parent, some children living in low socioeconomic status environments heard more words than the children living in middle socioeconomic status environments. The reduced language input theory also overlooks an important third variable—the intrinsic language abilities of both the parent and child (Dale et al., 2015). More talkative children and parents likely share a genetic proclivity for strong language. While the underlying mechanisms are complex and up for debate, the finding that children from low socioeconomic status environments perform below peers living in middle- or high-socioeconomic status environments on vocabulary assessments is robust (Abel et al., 2016; Hoff, 2013; Pace et al., 2017).

Observational studies of preschool-aged children living in poverty show that low socioeconomic status may also relate to spontaneous grammar production. Preschool-aged children living in poverty produce shorter and less complex sentences than peers living in higher socioeconomic status environments (Dollaghan et al., 1999; Hoff, 2013; Vasilyeva et al., 2008), in line with children who have SLI. The detailed results of Vasilyeva and colleague's (2008) study, however, indicated that socioeconomic status associated with productions of complex sentences (i.e., sentences with multiple clauses) but not simple sentences. Unlike the findings of vocabulary, this pattern of simple grammar productions is not consistent with the theory that poverty increases risk for SLI since children with SLI make grammatical errors even within simple sentences (i.e., extended optional infinitive stage; Rice et al., 1995). The reasoning for reduced grammatical complexity parallels that of vocabulary acquisition; children living in low socioeconomic status environments may hear fewer complex grammar structures in their language environment (Huttenlocher et al., 2002). Taken together, the reduction in complex sentence production may be a symptom of the language environment rather than indicative of SLI.

In school-aged observational studies, sentence length and complexity of children living in poverty does not significantly differ from peers living in middle socioeconomic status environments (Pruitt & Oetting, 2009; Whitehurst, 1997). This null finding, compared to significant findings during the preschool years, may stem from age effects on spontaneous language production; group differences between children with SLI and typical language peers also dampen throughout the school-aged years (Rice et al., 2010). For children with SLI, elicitation methods continue to reveal grammatical impairment during the school-aged and adolescent years, however (Rice et al., 2009; Rice et al., 2004). When elicitation methods were used in a school-aged sample of children living in poverty, no grammatical impairment appeared for tense and agreement marking. In a clever research design, Pruitt and Oetting (2009) recruited school-aged children living in poverty who performed below age-expectations on a receptive vocabulary measure. They compared the children's grammar performance to age-matched peers from middle socioeconomic status, who met age-expectations on the receptive vocabulary measure. Despite the intentional group difference in vocabulary performance, the two groups performed equivalently on an elicitation task of past tense -ed. While poverty may relate to vocabulary and spontaneous productions of complex sentences, poverty does not seem to associate with simple sentence production or the basic grammatical markings of tense and agreement.

Poverty does relate to complex grammatical structures in elicitation methods, however. In the same sample of children, Pruitt and Oetting (2011) found an effect of socioeconomic status for passive participles, which also uses the surface form of -ed but has a different underlying grammar. Using the verb "walk" as an example, sentence (1) includes a passive participle form while sentence (2) includes a past tense form.

1. The dog was walk<u>ed</u>.
2. She walk<u>ed</u> the dog.

While socioeconomic status did not relate to past tense -ed, children living in poverty marked passive participles at lower rates than middle-income controls and at lower rates than their own productions of past tense -ed. Further, passive participles, but not past tense -ed, correlated with maternal education and the children's vocabulary. In addition, school-aged children living in poverty have approximately a two-year delay in comprehension of wh- questions and complex sentences with multiple clauses (Pace et al., 2017).

In all, socioeconomic status-related variation in children's language environments may relate to vocabulary and complex grammar acquisition; however, basic grammar forms known to be difficult for children with SLI (i.e., tense and agreement marking) appear unrelated to effects of socioeconomic status, including poverty. When measuring grammar, researchers must consider the method (i.e., observational versus elicitation) based on the samples' age as well. Effects of socioeconomic status on sentence length and complexity appear in observational methods during the preschool years but not during the school-aged years. Elicitation methods during the school-aged years did reveal differential effects of low socioeconomic status on basic (i.e., past tense -ed) and complex grammar structures (i.e., sentences with multiple clauses, passive participles, wh-questions). The sensitivity to intrinsic individual variation in language abilities alongside insensitivity to extrinsic individual variation of the language environment positions basic grammar as a promising clinical marker in adversity samples when the research goal is to accurately identify SLI status.

Unique Effects of Adversity Features

Child clinical psychology researchers have called for more thorough measurement and statistical control in adversity samples (Brown et al., 2019; Jackson et al., 2019). Without thorough measurement and statistical control, adversity samples are either too broad or too narrow for meaningful interpretation. Broad adversity samples (i.e., inclusionary criterion of "yes" to any adversity exposure) are problematic because they conflate the unique contributions of specific adversity types. Narrow adversity samples (i.e., focus on only one adversity type such as neglect) are problematic because they ignore that many children experience more than one adversity type (Finkelhor et al., 2007; Saunders & Adams, 2014; Turner et al., 2010). In addition, adversity event features (e.g., severity, chronicity), and not always the total number or type of events, predict long-term outcomes such as mental health (e.g., Jackson et al., 2014). Thorough measurement of adversity dosage, severity, frequency, and chronicity will clarify how adversity exposure may create unique risk for disrupted grammar acquisition.

Adversity features such as dosage, frequency, severity, or chronicity (i.e., ongoing or repetitive adversity exposure) of the events may have greater explanatory power that adverse event types. Smith and Pollak (2021) reviewed that variation in severity or chronicity of adversity exposure can affect epigenetic changes, hypothalamic-pituitary-adrenal (HPA) axis dysregulation, and brain structure and function. These underlying biological systems are unaware of what specific adverse event type occurred; rather, these systems are prepared to respond in a non-specific manner when an individual faces a threat. From this perspective, what the child experienced may matter less than the amount, intensity, invasiveness, frequency, or regularity of the adversity exposure. More severe or chronic adversity exposure may lead to a dysregulated stress response system, potentially leading to epigenetic modifications of the genome and neural changes (Lupien et al., 2009; Roth & Sweatt, 2011). For example, the severity of community violence exposure is associated with adolescent emotional distress and problem behaviors but not always in intuitive ways (Goldner et al., 2015). Moderate, but not severe, victimization predicted anxiety and depression. For examples of chronicity effects, children exposed to chronic maltreatment performed poorer on working memory tasks than children exposed to maltreatment during only one developmental period (Cowell et al., 2015). The latter group's performance did not differ from the control group. Regarding poverty, rather than a child's poverty status at a single time point, chronicity of poverty better predicted executive functions, intelligence, academic success, and delinquent behaviors (Najman et al., 2010; Raver et al., 2013). Finally, chronic exposure to intimate partner violence is associated with increased odds of psychosocial problems as compared to a single exposure (Spilsbury et al., 2007).

Despite the potential effects of adversity features on neural development and behavioral outcomes, studies of grammar or language abilities in samples of children exposed to adversity have rarely included these features. Only one study of grammar included the adversity features of severity and frequency. Knolle and colleagues (2018) combined the two features into a single child maltreatment intensity predictor (i.e., severity times frequency); however, they found no effect on the children's grammar use. Although not a direct test of severity, Prasad and colleagues (2005) found that children who experienced severe physical abuse requiring hospitalization (e.g., non-accidental lacerations, fractures, burns) performed poorer on a general language assessment than a socioeconomically-matched control group recruited from the same hospitals[2]. This finding contrasts with the lack of correlation between physical abuse and language abilities in non-hospitalized samples who may have experienced less severe physical abuse (e.g., Culp et al., 1991; Nolin & Ethier, 2007; O'Hara et al., 2015), suggesting a possible influence of maltreatment severity. This study explored whether dosage, frequency, severity, or chronicity predicts grammar performance and SLI status.

Adversity Exposure Measurement

Multiple measurement methods for adversity exposure exist such as self-report, parent report, or, in the case of child maltreatment, child protective services case files (Cooley & Jackson, 2020). This study used the parent report method since the adversity exposure data came from a larger ongoing project (described in the Methods section), where participants entered the

[2] Prasad and colleagues (2005) did not report why the control participants were in the hospital.

project between the ages of three and five years. At that age, parent report is a preferred method since the children are too young for self-reporting.

Other Explanatory Mechanisms of Individual Variation of Language Abilities

Age Effects

Language abilities, relative to age peers, tend to remain stable across time, even in children with SLI after the initial delay in language acquisition onset (Conti-Ramsden et al., 2012; Johnson et al., 1999; Rice, 2012; Tomblin et al., 2003). That is, individual variation in language ability occurs across the population, but language growth trajectories are robustly similar. This may not be the case for children exposed to adversity based on longitudinal studies for specific adversity types. For children living in poverty, one study found a “lifting” effect on standardized language assessments such that 28 children who appeared to have SLI in kindergarten (n = 34) went on to score within the expected range in second grade (Fazio et al., 1996). The theory for improvement was that the children had increased experience with academic tasks and demands by second grade such that the low performance in kindergarten was a testing artifact. For children exposed to maltreatment, multiple growth trajectories are possible during the early childhood years, but overall language ability stabilizes during the school-aged years (Holmes et al., 2018). For some children exposed to maltreatment, their language abilities start high or low and remain stable across time, but, for others, their language abilities start high and decrease during early childhood or start low and increase during early childhood. Longitudinal studies of language in samples with broad adversity exposure or other specific adversity types (e.g., violence exposure) were not identified. Given that age at time of assessment is a factor to consider, this study focused on school-aged language abilities since trajectories are more stable during that time.

Sex Effects

The child's sex also affects language acquisition as well as adversity exposure. In early childhood, females outperform males on language tasks (Eriksson et al., 2012). However, for receptive vocabulary, this difference disappears during the school-aged years and then re-appears in the opposite direction during adolescence such that males end up outperforming females, although the magnitude is small (Rice & Hoffman, 2015). One study examined sex effects on language performance in a child maltreatment sample. The researchers reported that the females performed significantly lower than the males on spontaneous grammar production and receptive vocabulary at the age of 5 years in both the child maltreatment and socioeconomic-matched control group (Eigsti & Cicchetti, 2004). They theorized that socialization factors interacted with the reduced language input associated with child maltreatment and poverty. While both females and males receive reduced language input in the home, males may be more likely than females to interact with other adults in the community such as neighbors. In addition to sex effects on language acquisition, sex also associates with adversity exposure. As Gabrielli and colleagues (2017) reviewed, females are more likely to experience sexual abuse and less likely to experience physical abuse than males. Sex differences also appear for how child maltreatment affects neuroendocrine functioning and long-term outcomes. In all, sex is a factor to account for in studies examining adversity effects on language acquisition.

Nonverbal Cognitive Effects

Nonverbal cognition and language develop along separate causal pathways (Rice, 2016; Rice, 2020), as seen in the SLI profile where nonverbal cognition is intact alongside impaired language. Despite the separate causal pathways, nonverbal cognition contributes to language performance such that lower nonverbal cognitive abilities increase the likelihood of lower overall language (Johnson et al., 1999), vocabulary (Rice & Hoffman, 2015), and grammar performance (Rice et al., 2004). In the adversity literature, some studies included both nonverbal cognitive and language measures but did not control for the nonverbal cognitive contributions when examining language performance (e.g., Lum et al., 2018). This study controlled for nonverbal cognitive abilities to elucidate unique adversity effects on language abilities above and beyond more general cognitive impairment.

Dialect Effects

The participants in this study were recruited from a larger ongoing project. The recruited sample is likely to include speakers of the African American English dialect given the demographics of the larger project. The African American English dialect differs in grammar from the General American English dialect (Charity, 2008). For example, in the General American English dialect, each clause within a sentence must include tense and agreement marking. In the following sentences, past tense *-ed*, and third person singular *-s* mark the verb for tense and agreement:

1) She walk<u>ed</u>.
2) She walk<u>s</u>.
3) They walk<u>ed</u>.

To locate where the tense and agreement is happening in sentence 1, change the verb from past tense to third person singular as in sentence 2, or change the subject noun as in sentence 3. How children mark tense and agreement is informative for identifying SLI, as they do not always mark tense and agreement. For example, they may produce sentence 1 as “she walk” but with the intended meaning of past tense (Rice et al., 1995). In the General American English dialect, these productions are ungrammatical and flag potential SLI. In the African American English dialect, however, this same sentence (i.e., "She walk") is grammatical and, therefore, does not necessarily indicate SLI. Because of this grammatical difference between the two dialects, tense and agreement marking is considered a *contrastive feature*. When assessing individuals who speak the African American English dialect, the gold standard is to use assessments that focus on *non-contrastive features* (i.e., features that do not differ between dialects) but remain sensitive to SLI status. In this study, the grammar outcome measure was a dialect-neutral task that assessed these non-contrastive features.

Maternal Education Effects

To account for socioeconomic status effects on language variation, child language researchers commonly use maternal education as a proxy variable (Hoff, 2006). On norm-referenced measures of omnibus language and vocabulary, group means differ based on maternal education while standard deviations parallel the normal distribution, suggesting potential subsamples within the population (see for a review: Abel et al., 2016). In group comparison studies in adversity samples, researchers often use a socioeconomic-matched control group to account for such effects (Lum et al., 2015). In this study, maternal education was included in analyses as a covariate to determine how adversity features predict grammar above and beyond socioeconomic status influences.

Aims

The study was exploratory in nature given the limited reporting on the effects of adversity features (i.e., dose, frequency, severity, chronicity) in the language acquisition literature overall and scant literature focused on school-aged grammar acquisition in particular, especially in samples with exclusionary criteria for SLI. The goal of the present study was to identify whether specific adversity features (i.e., dose, frequency, severity, chronicity) interacted with SLI status to predict grammar abilities in a sample of school-aged children exposed to adversity while also controlling for confounding factors (e.g., intellectual disability, nonverbal cognitive abilities).

The hypotheses of the study were that: a significant portion of the sample would meet diagnostic criteria for SLI with a higher percentage than expected based on epidemiological prevalence, and adversity features would interact with SLI status to predict grammar performance. The analyses addressed the following research questions:

1. What percentage of participants meet diagnostic criteria for SLI, and is the percentage higher than expected based on the epidemiological prevalence of SLI?
2. How do adversity dosage, frequency, chronicity, and severity interact with SLI status to predict grammar performance beyond other explanatory mechanisms (i.e., maternal SES, dialect status, sex, nonverbal cognition)?

Methods

Participants

Participants and their primary caregiver were recruited from the Preschoolers' Adjustment and Intergenerational Risk (PAIR) project. The PAIR project is a "federally funded, five-year research project (2016-2021) aimed at understanding how specific features of adversity exposure in children and parents (i.e., chronic, acute), specific systems in the child (i.e., emotion regulation, cognitive skills), and parental responsiveness interact to predict developmental and mental health outcomes in young children" (Griffith et al., 2020, p. 2).

Exclusionary Criteria

The current study had three exclusionary criteria. First, the PAIR project sample was screened for participants who scored less than a standard score of 85 on a nonverbal working memory assessment at their last data collection time point. These participants were excluded from the current study such that all participants in this sample scored in the average or above average range on the nonverbal task.

Second, the author implemented a phone screening with the potential participants' primary caregiver and excluded any participants with a current or history of intellectual disorder, neurological impairment (e.g., traumatic brain injury, epilepsy), hearing loss, genetic syndromes (e.g., Down syndrome), or other neurodevelopmental disorder (e.g., speech sound disorder, Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder), per parent report. One potential participant was excluded due to parent report of an intellectual disability, and three potential participants were excluded due to parent report of Attention Deficit Hyperactivity Disorder.

Third, during the phone screening, the author assessed whether the potential participant had notable exposure to a second spoken language in the home, per parent report. This third criterion was less clear cut than the previous two and required case-by-case decision-making. The concern was that notable exposure to a second spoken language may influence grammatical development, introducing potential measurement error. One potential participant was excluded based on parent report that the child was fluent in Mandarin. Two other participants exposed to a second language were included, however. One participant was bilingual/modal in American Sign Language; this participant was included in the sample because the home used a total communication approach for another family member with a hearing loss. With a total communication approach, spoken and signed language often are used simultaneously, which the family confirmed. Thus, the use of American Sign Language in the home likely did not decrease the amount of spoken language that the participant heard. In addition, linguistic transfer effects from one modality to another (i.e., signed → spoken language) are nonverbal with differences in facial expressions, hand gestures, and spatial placement of body and signs (Emmorey & McCullough, 2009). These bimodal transfer effects are unlikely to affect spoken grammar development in ways that a second *spoken* language could, although no research exists to confirm this assertion. The second participant included in the study was exposed to Samoan in the home since birth; however, per parent report, the exposure was limited (i.e., less than 10% of the time) with almost all exposure being single words or phrases lacking grammatical features.

The final sample included 30 participants with average or above average nonverbal cognition, no reported developmental disorders, and no notable confounds of second language exposure.

Language Grouping

Performance on the Diagnostic Evaluation of Language Variation Norm-Referenced (DELV-NR; Seymour et al., 2018a) Syntax subtest determined participants' SLI status. Precedence exists in the research literature for using the DELV-NR Syntax subtest for SLI diagnostic classification in place of the entire assessment. First, the DELV-NR manual reports a large effect size when comparing children with SLI and typical language (TL) on the Syntax subtest (Cohen's d = 2.51; Seymour et al., 2018a). Second, other research studies using the DELV-NR Syntax subtest for diagnostic classification have reported even larger effect sizes (i.e., greater than 3) when comparing children with SLI and TL (e.g., Gregory & Oetting, 2018; McDonald et al., 2017). In this study, participants scoring one or more standard deviations below the age-referenced mean (i.e., scaled score less than 7) were assigned to the SLI group while those scoring within one standard deviation or above the age-referenced mean were assigned to the typical language group. Of the 30 participants, 6 met diagnostic criteria for SLI (20% of the sample) based on exclusionary criteria and performance on the DELV-NR Syntax subtest.

Demographics

Approximately half of the participants were female (53%) with most participants identifying as Black or African American (60%) followed by multiracial (20%), White or Caucasian (13%), Latino/Hispanic (3%), American Indian or Alaskan Native (3%), and Native Hawaiian or Pacific Islander (3%), as shown in Table 1. Visual analysis of the data did not suggest any meaningful differences between the SLI and typical language groups for sex, ethnicity, or race. The mean age of the sample was 6.93 years (SD = 1.08) with no significant difference between the SLI (M = 7.50, SD = 1.04) and typical language (M = 6.79, SD = 1.06) groups.

For almost all the participants, the primary caregiver and parent reporter for the study was their biological mother. A grandmother and an adoptive mother were primary caregivers for the remaining two participants. Most of the primary caregivers identified as Black or African American (70%) followed by White or Caucasian (20%), multiracial (7%), and Native Hawaiian or Pacific Islander (3%). Visual analysis of the data did not suggest any meaningful differences between the SLI and typical language groups for the primary caregiver's ethnicity or race. The mean age of the primary caregiver was 33.93 (*SD* = 5.99) with no significant difference between the SLI (*M* = 31.33, *SD* = 3.20) and typical language (*M* = 34.58, *SD* = 6.39) groups.

Table 1

Sample Demographic Characteristics Table

Characteristic	TL		SLI		Full Sample	
	n	%	n	%	n	%
Child Race & Ethnicity						
Latino/Hispanic	1	4.17%	0	0.00%	1	3.33%
Asian	0	0.00%	0	0.00%	0	0.00%
American Indian or Alaska Native	1	4.17%	0	0.00%	1	3.33%
Black or African American	14	58.33%	4	66.67%	18	60.00%
Native Hawaiian or Other Pacific Islander	1	4.17%	0	0.00%	1	3.33%
White or Caucasian	3	12.50%	1	16.67%	4	13.33%
Multiracial	5	20.83%	1	16.67%	6	20.00%
Other	0	0.00%	0	0.00%	0	0.00%
Child's Sex						
Female	13	54.17%	3	50.00%	16	53.33%
Male	11	45.83%	3	50.00%	14	46.67%
Reporter Relationship						
Biological Mother	22	91.67%	6	100.00%	28	93.33%
Grandmother	1	4.17%	0	0.00%	1	3.33%
Other	1	4.17%	0	0.00%	1	3.33%
Reporter Race & Ethnicity						
Latino/Hispanic	0	0.00%	0	0.00%	0	0.00%
Asian	0	0.00%	0	0.00%	0	0.00%
American Indian or Alaska Native	0	0.00%	0	0.00%	0	0.00%
Black or African American	16	66.67%	5	83.33%	21	70.00%
Native Hawaiian or Other Pacific Islander	1	4.17%	0	0.00%	1	3.33%
White or Caucasian	5	20.83%	1	16.67%	6	20.00%
Multiracial	2	8.33%	0	0.00%	2	6.67%
Other	0	0.00%	0	0.00%	0	0.00%

Note. N = 30. TL = Typical Language group (n=26); SLI = Specific Language Impairment group (n=6).

Procedures

Because data collection occurred during the 2019 novel coronavirus outbreak (COVID-19), all data collection was conducted remotely based on safety standards of the Institutional Review Board's (IRB) human subjects research under the pandemic conditions. Data collection included two parts: (1) a parent report measure via Qualtrics, and (2) direct assessment of the child via Zoom. If the family did not have adequate technology for Zoom (i.e., tablet or computer, Wi-Fi), a Chromebook and hot spot were provided via contactless drop-off and pick-up. Eight participants connected to the Zoom session via their smart phone, however. This occurred for various logistical reasons including: 1) (potential) exposure to COVID-19 so Chromebook drop-off was not possible per IRB requirements; 2) the hotspot had insufficient cellular coverage at their home; 3) significant drive time was required for drop-off/pick-up, which would have kept the parent and child from participating; or 4) the author was unaware the participant was on their phone until the end of session. All participants reported that they could see study materials on the smart phone sufficiently despite a smaller screen size. No participant made errors that suggested difficulty with seeing study materials. In addition, a preliminary analysis revealed no significant difference in performance on the grammar outcome measure between those who used their phones ($M = 8.50$, $SD = 1.69$) and those who used a device with a larger screen size ($M = 7.91$, $SD = 2.07$), $t(28) = -0.72$, $p = .476$.

During the scheduled Zoom session, the examiner provided the parent with brief instructions about what to expect, how to interact with the child during the direct assessments to ensure a standardized administration, and to encourage a quiet non-competing environment. All direct assessment measures were presented via a screenshared pdf file. Testing time for the child was approximately 20 minutes while the time for the parent to complete the parent report measure was approximately 30 to 40 minutes. For most sessions, the parent began working on the parent report measure while the child completed their tasks such that the total testing time ranged between 30 and 40 minutes on average.

Measures

Grammar Outcome Measure

The norm-referenced DELV-NR Syntax subtest (Seymour et al., 2018a) was administered as the grammar outcome measure. The DELV-NR is the only norm-referenced assessment available with a dialect-neutral design (i.e., assessment of non-contrastive language features) and with norms including speakers of dialects other than General American English. The DELV-NR Syntax subtest assessed the following non-contrastive features of English: wh-questions (10 items), passives (10 items), and articles (i.e., a, an, the; 8 items). These three features occur across English dialects and are also sensitive to language impairment status, making this subtest a valid grammar measure for speakers of the African American English dialect.

The DELV-NR Syntax subtest has adequate to excellent reliability and validity. Regarding reliability, test-retest (.76 to .84), Cronbach's alpha (.73 to .83), and split-half (.76 to .90) coefficients fall in the adequate to excellent range across age bands. Cronbach's alpha and split-half coefficients are similar or higher when split across typical language and language impairment. Two of the tasks in the DELV-NR Syntax subtest include some level of subjectivity in scoring—wh-questions and articles; however, interscorer reliability revealed excellent consistency (.99 to 1.00; Seymour et al., 2018a). Regarding validity, the DELV-NR Syntax subtest is based upon a strong theoretical framework of the contrastive/non-contrastive assessment model (Seymour & Seymour, 1977). Subtest intercorrelations revealed strong internal structure with the Syntax subtest correlating moderately with the semantics and pragmatics subtests and low correlation with the phonology subtest. Thus, the DELV-NR Syntax subtest taps into overall language ability, given moderate correlations, but also measures the unique dimension of syntax since correlations were not high. When compared to other language assessments, the DELV-NR Syntax subtest had moderate correlation with the DELV-Screening

Test Diagnostic Risk Status[3] (r = -.49; Seymour et al., 2018b) and the Clinical Evaluation of Language Fundamentals, 4th edition (CELF-4; Wiig et al., 2003) subtests (r = .33 to .40). The authors expected low to moderate correlations with the CELF-4 because the tests' underlying theoretical models differ. Further, the overall DELV-NR has excellent sensitivity (.95) and specificity (.93) when classifying language impairment status (Seymour et al., 2018a).

Adversity Feature Predictors of Grammar Outcome Measure

Adversity exposure was assessed via parent report. The PAIR project adversity exposure measure spans 55 different potentially traumatic events from previous measures with established reliability and validity (e.g., the ACEs questionnaire, Life Events Checklist, Juvenile Victimization Questionnaire; Griffith et al., 2020). The adversity exposure measure is comprehensive and encompasses a wide range of potentially traumatic event types such as poverty (e.g., insufficient food), child maltreatment (i.e., physical abuse, sexual abuse, psychological abuse, neglect), witnessing violence, victimization, household instability (e.g., household moves, new caregiver/parental figure), physical injury, and chronic illness, among others. The parent endorsed which potentially adverse events occurred in their child's life since birth. When the parent endorsed a potentially adverse event, adaptive questioning then presented them with follow-up questions. For every presented question, the caregiver was required to provide an answer; however, each question also included the answer choices of "I don't know the answer" or "I don't want to answer". The questions of interest to this study measured whether an event occurred, event frequency, and event severity to create the adversity feature predictors.

[3] Note the negative correlation is expected given that the DELV-Screening Test (Seymour et al., 2018a) calculates number of errors while the DELV-NR calculates the number of correct responses (Seymour et al., 2018b).

Adversity Dosage. Dosage represents the cumulative exposure of different event types. When presented with an event type, the caregiver endorsed whether the child experienced that event type at any time in their life. For example, when asked, “During your child's lifetime, has there been an instance where your child's caregivers have separated?” the parent selected either “yes” or “no”. An answer of “yes” represents a dose of one, and the dosage predictor variable was the sum of all “yes” responses across the different potentially adverse event types.

Frequency & Chronicity. Parents also reported how frequently the child experienced each event type across childhood (i.e., occurred 1 time (1), 2 times (2), 3-5 times (3), 6-10 times (4), 10 or more times (5)). The frequency rating provided additional information beyond dosage regarding the quantity of adversity exposure. As a hypothetical example, if a parent endorsed a particular event and rated that event as occurring one time, then the frequency score (i.e., 1) equaled the dose score (i.e., 1) for that event. If a parent endorsed a particular event and rated that event as occurring two times, then the frequency score (i.e., 2) was double the dose score (i.e., 1) for that event. If the parent did not endorse an event, the frequency rating was zero.

The frequency rating per event was used to calculate two adversity feature predictors: average frequency and chronicity. The average frequency variable was calculated by summing the frequency ratings across the event types and dividing by dosage. As a hypothetical example, a parent endorsed two events as occurring “6 to 10 times”, one event as occurring “2 times”, and one event as not occurring at all. The frequency score would then be 3.33 for that participant (i.e., (4 + 4 + 2 + 0) / 3), reflecting the average frequency across events regardless of dosage. In contrast, the chronicity variable captured both frequency and dosage to represent the regularity of adversity exposure. This variable was the sum of frequency ratings without dividing by dosage, which accumulated dosage with frequency. In the previous example, the participant would receive a chronicity score of 10.

Severity. Some event types included a question on severity when physical injury/harm was a possible consequence (e.g., abuse, car accident, victimization). These questions asked the parent whether the event caused physical injury and its severity (i.e., no injury (0); mild (1), moderate (2), serious (3), and serious with lasting physical effects (4)). In parallel to the frequency rating, severity provided additional information beyond dosage and was measured in two ways—average severity and overall severity. Average severity was calculated by summing the severity ratings across the event types and dividing by dosage. Not all events had a severity question, however, so dosage in this variable was the number of endorsed events where the caregiver had the opportunity to report severity (i.e., maximum of 17 event types). If the caregiver did not endorse the event type, then the participant received a severity rating score of zero. As a hypothetical example, a parent endorsed two events as being "serious", one event as being "mild", and one event as not occurring. The average severity score would then be 3.33 (i.e., (3 + 3 + 1 + 0) / 3), reflecting the average severity across events regardless of dosage. In contrast, the overall severity variable captured both severity and dosage to represent the accumulation of the two features. This variable was the sum of severity ratings without dividing by dosage. In the previous example, the participant would receive an overall severity score of 7.

Covariates

Nonverbal Cognition. Previously collected data from the PAIR Project was used for nonverbal cognition—the Working Memory Index of the Wechsler Preschool and Primary Scale of Intelligence, 4th edition (WPPSI-IV; Wechsler, 2012a). Each participant's last available WPPSI-IV data point was used in the current study. The Working Memory Index includes two subtests—Picture Memory and Zoo Locations. In the Picture Memory task, the participant views a page of pictures for five seconds, and then they select the matching pictures from a variety of options on the next page. In the Zoo Locations task, the participant views animal cards laid out in a pattern for five seconds, when the examiner removes the animal cards. Then, the participant lays the animal cards in the same pattern. The WPPSI-IV Working Memory Index has strong reliability (.88) and stability (.87) coefficients. In a confirmatory factor analysis, a five-factor model fit best with separate factors for the Verbal Comprehension and the Working Memory Indices. The Working Memory Index correlated strongly with the Nonverbal Index (.73) with a weaker correlation for the Verbal Comprehension Index (.48).

Although the Working Memory Index of the WPPSI-IV is not typically used as a nonverbal cognitive measure in studies of individuals with SLI, information from the manual as well as findings from the SLI literature suggest it is a sufficient measure. The WPPSI-IV Technical and Interpretative Manual Supplement (Wechsler, 2012b) reported low correlations between the Working Memory Index and grammar subtests of the Clinical Evaluation of Language Fundamentals Preschool, second edition (Semel et al., 2004) in a sample of children with receptive-expressive language disorder—0.27 for Sentence Structure and 0.34 for Word Structure. Note that the diagnostic criteria for receptive-expressive language disorder is broader than SLI such that the children in their sample may have had nonverbal cognitive abilities below age-expectations. Yet, low correlations appear. Further, children with SLI do not differ in performance from age-matched peers on these types of nonverbal tasks, which assess visual and visuospatial recall without an additional sequencing component (effect sizes ranging from 0.090 to 0.167; Baird et al., 2010; Petruccelli et al., 2012; Riccio et al., 2007). Thus, the previously collected WPPSI-IV Working Memory Index data provided independent information regarding nonverbal cognition beyond SLI status.

Dialect. The Diagnostic Evaluation of Language Variation-Screening Test's (Seymour et al., 2018b) Language Variation Status section identified the participant's degree of language variation from the General American English dialect. In this test, children imitate sentences, answer questions, and complete sentences based on cloze prompts. The target sound, word, or phrase is then scored based on whether General American English or non-General American English linguistic features are present. The resulting feature scores then classify the child as having strong, some, or no variation from the General American English dialect. Thus, the Language Variation Status section provides a categorical measure of dialect status.In a sample of children who primarily spoke the African American English dialect (*n* = 25), test-retest reliability of the Language Variation Status section was strong such that a pair of examiners classified 72% of children in the same dialect status group. Another 20% of children were classified as having variation from the General American English dialect but of differing degrees across the two examiners. Note that one examiner was African American, and the other examiner was White. In most cases, the race of the examiner did not affect the results; however, for two children (8%), the White examiner reported no variation while the African American examiner reported strong variation. Further investigation revealed that the children varied their language productions across examiners consistent with code-switching between dialects. Regarding the validity of the Language Variation Status section, the items and elicitation methods are well-supported by the research literature. In addition, the authors reported scores on the task based on a priori classification of dialect status. Children speaking the African American English dialect received higher scores for non-General American English dialect features than children speaking General

American English. In contrast, children speaking the General American English dialect received higher scores for General American English dialect features than children speaking the African American English dialect. These feature differences were consistent with the dialect classifications. Across each chronological age, children speaking the African American English dialect were mostly classified as speaking a variation (strong or some) while most children speaking General American English were classified as having no variation. In the current study, performance on the Language Variation Status of the DELV-Screening Test determined participants' dialect status. Participants scoring at or above the age-criterion for non-General American English features were placed in the "strong variation" group. Participants scoring below the age-criterion for non-General American English features and below the age-criterion for General American English features were placed in the "some variation" group. Participants scoring at or above the age-criterion for General American English features were placed in the GAE group.

Maternal Education. Maternal education was coded as (1) some grade school, (2) some high school, (3) high school graduate or GED, (4) trade school or community college graduate, (5) some college, (6) four-year degree college graduate, and (7) graduate or professional school. Preliminary analyses revealed a nonsignificant deviation from linearity when maternal education was added as a categorical variable ($p = 0.27$). Thus, maternal education was considered a continuous variable in further analyses.

Validity Considerations for Remote Data Collection

Although neither the DELV-Screening Test nor the DELV-NR have been assessed for validity in remote data collection, support for the approach was reported in another study with a language assessment of similar design. Children completed the CELF-4 (Wiig et al., 2003) in a face-to-face and remote administration. No differences in raw or scaled scores appeared across all subtests (Waite et al., 2010). In another study, scoring agreement between face-to-face and remote administration of the CELF-4 was between 97 and 100% (Eriks-Brophy et al., 2008).Lower agreement occurred for a speech sound assessment (i.e., 66 to 95%; Eriks-Brophy et al., 2008), which is relevant for the DELV-Screening Test. The authors noted that the remote condition presented some difficulty with interpreting specific speech sounds. Specifically, disagreements occurred more often on unvoiced phonemes (e.g., /p, t/), consonant clusters, and fricatives (e.g., /f, v/). These reliability issues were considered for the DELV-Screening Test Language Variation Status subscale, which includes word-level items with fricative sounds, some also unvoiced, within a sentence repetition task (all 5 items). Steps were taken to ensure the highest levels of scoring accuracy during remote data collection based on current best practices and this author's clinical experience with remote tasks. To the extent possible, the examiner and the examinee ensured a quiet and non-competing environment (e.g., limited background noise sources such as televisions) and spoke clearly with adequate volume. The examiner also encouraged the child to stay within the camera's view and to keep their hands away from their face. Having a clear view of the child's face helped the examiner with differentiating sounds given that visual cues benefit interpretation (Eriks-Brophy et al., 2008). The data collection session was also video-recorded such that this author could re-listen at a higher volume to ensure accurate scoring. Given that the primary concern was the sentence repetition task of the DELV-Screening Test Language Variation Status subscale, a correlation was conducted between those five items and the eight items in the same subscale assessing morphosyntax, which poses little concern for validity in the remote condition (Eriks-Brophy et al., 2008; Waite et al., 2010). The correlation was strong and positive, $r(28) = .745$, $p < .001$, suggesting consistency in the participants' use of General American English and non-General American English features across the two sections.

Data Analysis

RQ1: Percentage of SLI in the Sample

A binomial test was estimated to compare the sample frequencies in the SLI and typical language groups against the null hypothesis of matching the population distribution (i.e., 7.4% within the SLI group, 92.6% in the TL group). Cramer's *V* provided a measure of effect size with the interpretation that the effect size was considered large if greater than 0.5, medium if between 0.3 and 0.5, and small if between 0.1 and 0.3 (Cohen, 1988).

RQ2: Adversity Feature Predictors

Five separate and independent regression models were estimated to assess whether the adversity features interacted with language group status (i.e., SLI versus typical language) to predict grammar performance while controlling for other explanatory mechanisms (e.g., dialect status, maternal SES). All analyses were conducted using SAS PROC GLM. The dependent variable was the DELV-NR Syntax subtest scaled score. The predictors were language group status (i.e., SLI versus typical language), the adversity features, and an interaction effect between them. Covariates were sex, nonverbal cognition, dialect status, and maternal education.

The regression models were conducted stepwise so that changes in R^2 could be analyzed alongside the tests of significance. The following blocks were entered stepwise in this order: (1) covariates, (2) language group status predictor, (3) adversity predictor (e.g., dosage), and, finally, (4) the interaction terms of language group status by adversity predictor. For all analyzes, the significance criterion was set at 0.05.

The above process was applied across the five separate and independent general linear models to investigate the independent effects of adversity dosage, average frequency, chronicity, average severity, and overall severity. The covariates and language group status predictor did not change across the models, but how adversity was measured changed across the five analyses.

Power. Given the exploratory nature of this study and limited reporting on grammar performance in the adversity population, an a priori power analysis was not feasible (e.g., no available effect sizes or R^2 change in the literature). However, power was considered when interpreting study results given the small sample size. Post hoc power analyses are no longer considered best practice since they can only provide information on the observable effects of the study rather than true effects (Levine & Ensom, 2001; Zhang et al., 2019). In addition, a study's power is inherently linked with the *p*-value such that post hoc power analysis does not provide new meaningful information. Estimating the minimum detectable effect size and using the observable effects to provide guidance for future studies' designs remain useful (Colegrave & Ruxton, 2003). Estimating the minimum detectable effect size allows researchers to determine which specific test statistics in the study are under-powered while analyzing the observable effects (e.g., group mean difference, standard deviations) can inform future sample size selection. These two analyses were conducted to inform future research design.

Results

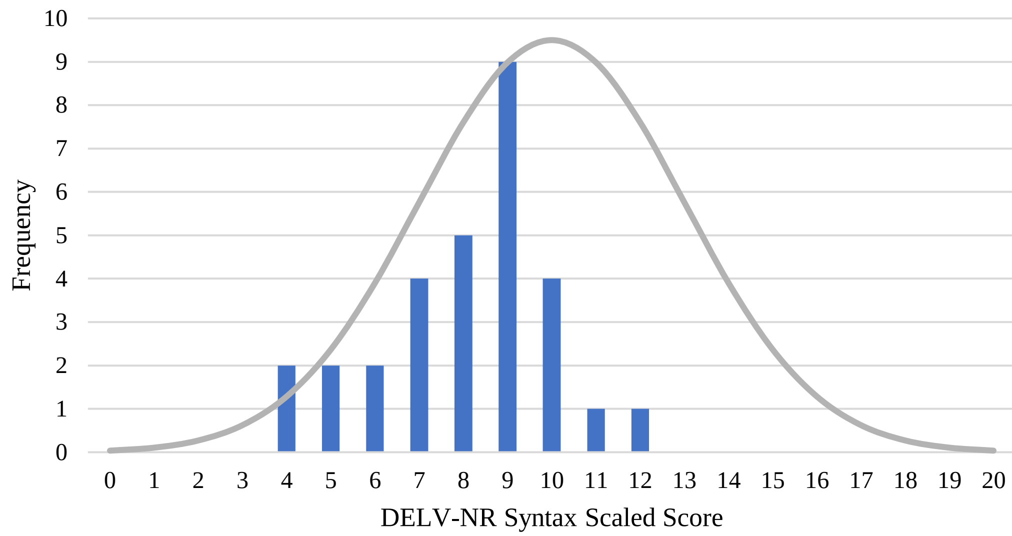
Sample Descriptives

Grammar Outcome Measure

Based on the Shapiro-Wilk test, the distribution of grammar outcome measure scores did not significantly deviate from normal; however, the distribution had a slight skew of -0.45, as shown in Figure 1. The grand mean on the DELV Syntax subtest was 8.07 (*SD* = 1.96). A one-sample t-test was conducted to determine whether the grand mean was significantly different than the population mean of 10. This sample's performance on the DELV Syntax subtest was significantly lower than the population mean, $t(29) = -5.29$, $p < .001$, Cohen's $d = -0.99$, 95% CI [-1.42, -0.54]. In addition, the SLI group scored significantly lower on the DELV Syntax subtest ($M = 5.00$, $SD = 0.89$) than the TL group ($M = 8.83$, $SD = 1.27$), $t(28) = -6.91$, $p < .001$, $d = 3.49$, 95% CI [2.70, 4.96]. No significant difference appeared based on the participant's sex (girls: $M = 8.31$, $SD = 2.06$; boys: $M = 7.79$, $SD = 1.89$).

Figure 1

DELV-NR Syntax Scaled Scores Compared to Normal Distribution



Adversity Feature Predictors

Table 2 presents descriptives at the level of individual event types. The table is ordered by level of endorsement for the entire sample with "new children entering the home" being the most often endorsed event type across the sample. Visual analysis of the data revealed group differences in how often the participant's caregiver endorsed specific event types. Caregivers in the typical language group endorsed the following event types more often than the SLI group: new children entering the home, child changing daycares, death of a pet, forced to move homes, child hospitalization, caregiver divorce, domestic violence, a caregiver with alcoholism, and someone attempting or completing suicide. In contrast, caregivers in the SLI group endorsed the following event types more often than the typical language group: caregiver hospitalization, moving to a new home, a caregiver having a mental illness, reduced standard of living, an incarcerated caregiver, physical abuse, hearing something terrible, car accident, living in an unsafe neighborhood, exposure to community violence, peers ignoring the child, being physically attacked by a child, and discrimination.

Table 2

Adverse Events Descriptives

Event Type	TL (n=24)			SLI (n=6)			Total (n=30)		
	%	Freq.	Sev.	%	Freq.	Sev.	%	Freq.	Sev.
New children in home	**50.00**	2.08	NA	**33.33**	3.00	NA	46.67	2.21	NA
Caregiver hospital	**37.50**	2.00	NA	**83.33**	1.20	NA	46.67	1.71	NA
Moving to new daycare	**45.83**	2.27	NA	**33.33**	2.00	NA	43.33	2.23	NA
Moving to new home	**37.50**	2.22	NA	**50.00**	2.33	NA	40.00	2.25	NA
Caregiver separation	33.33	1.00	NA	33.33	1.00	NA	33.33	1.00	NA
Death of pet	**33.33**	1.50	NA	**16.67**	1.00	NA	30.00	1.44	NA
Family member incarcerated	25.00	1.00	NA	33.33	1.50	NA	26.67	1.13	NA
Caregiver mental illness	**16.67**	1.25	NA	**50.00**	1.00	NA	23.33	1.14	NA
Chronic physical illness[a]	25.00	2.00	2.00	16.67	1.00	1.00	23.33	1.86	1.86
Reduced standard of living	**16.67**	2.50	NA	**33.33**	3.00	NA	20.00	2.67	NA
Caregiver arrest	**16.67**	2.25	NA	**33.33**	3.00	NA	20.00	2.50	NA
Death of a non-parental adult	20.83	2.20	NA	16.67	1.00	NA	20.00	2.00	NA
Physical abuse[a]	**16.67**	2.50	1.00	**33.33**	3.00	1.00	20.00	2.75	1.00
New parental figure	16.67	1.25	NA	16.67	1.00	NA	16.67	1.20	NA
Forced to move	**20.83**	1.40	NA	**0.00**	0.00	NA	16.67	1.40	NA
Child hospitalization[a]	**20.83**	1.40	NA	**0.00**	0.00	NA	16.67	1.40	NA
Heard something terrible	**12.50**	2.00	NA	**33.33**	3.50	NA	16.67	2.60	NA
Caregiver divorce	**16.67**	1.00	NA	**0.00**	0.00	NA	13.33	1.00	NA
Car accident[a]	**8.33**	1.00	0.00	**33.33**	1.00	0.00	13.33	1.00	0.00
Domestic violence	**12.50**	1.00	NA	**0.00**	0.00	NA	10.00	1.00	NA
Caregiver alcoholism	**12.50**	2.50	NA	**0.00**	0.00	NA	10.00	2.50	NA
Suicide	**12.50**	1.67	NA	**0.00**	0.00	NA	10.00	1.67	NA
Someone close to child moved	8.33	2.00	NA	0.00	0.00	NA	6.67	2.00	NA
Unsafe neighborhood	**4.17**	5.00	NA	**16.67**	1.00	NA	6.67	3.00	NA
Death of caregiver	8.33	1.00	NA	0.00	0.00	NA	6.67	1.00	NA
Death of sibling	8.33	1.00	NA	0.00	0.00	NA	6.67	1.00	NA
Physical illness[a]	8.33	4.00	2.00	0.00	0.00	0.00	6.67	4.00	2.00
Community violence	**4.17**	2.00	NA	**16.67**	2.00	NA	6.67	2.00	NA

Table 2 Continued

Event Type	TL (n=24)			SLI (n=6)			Total (n=30)		
	%	Freq.	Sev.	%	Freq.	Sev.	%	Freq.	Sev.
Burned[a]	4.17	2.00	0.00	0.00	0.00	0.00	3.33	2.00	0.00
Broken bones[a]	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Death of peer[a]	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Ignored by peers	**0.00**	0.00	NA	**16.67**	4.00	NA	3.33	4.00	NA
Saw something terrible	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Saw someone get hurt	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Physically attacked by child[a]	**0.00**	0.00	0.00	**16.67**	4.00	2.00	3.33	4.00	2.00
Removed - neglect	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Removed - physical abuse	4.17	1.00	NA	0.00	0.00	NA	3.33	1.00	NA
Discrimination	**0.00**	0.00	NA	**16.67**	3.00	NA	3.33	3.00	NA
Neglect	4.17	3.00	NA	0.00	0.00	NA	3.33	3.00	NA
Hit by car[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poisoned[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drowned[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serious fall[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Animal attack[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural disaster[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fire[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
War[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Robbed/mugged[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kidnapped	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	NA
Removed - sexual abuse	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	NA
Removed - emotional abuse	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	NA
New country	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sexual abuse[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neglect	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	NA
Emotional abuse	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	NA

Note. TL = Typical Language, SLI = Specific Language Impairment, Freq. = Frequency, Sev. = Severity, NA = Not Applicable.
Bolded numbers represent a difference between groups that is greater than or equal to 10%.
[a]Phsyical trauma items that included a severity rating question

All adversity feature predictors (i.e., dosage, frequency, chronicity, severity) significantly deviated from a normal distribution ($p < .001$) with positive skews (0.48 – 1.81), based on Shapiro-Wilk tests. Figure 2 depicts the dosage frequencies across the entire sample, and Table 3 includes the group and sample descriptives for each adversity feature predictor. Because of the non-normal distributions, independent t-tests could not be conducted; however, visual analysis of the data did not indicate notable differences between the SLI and typical language groups. On average, the participants experienced 5 to 6 potentially traumatic event types since birth with an average frequency of two times per event and an average severity of mild to moderate injury/harm per event.

Regarding severity, the caregiver indicated a severity rating only if they endorsed an event type with a potential consequence of physical injury or harm (i.e., physical trauma). Fifty-three percent of the sample did not endorse any of these event types, and caregivers in the SLI group were significantly more likely to endorse events with a potential consequence of physical injury or harm (83.33%) than the typical language group (37.50%), $X^2(1) = 4.05$, $p = .04$, RR = 1.46, 95% CI [0.97, 2.20]. Thus, the children with SLI in this sample were 1.46 times more likely to experience physical trauma (e.g., physical abuse, physical illness, car accident, physically attacked by another child) than the participants in the typical language group. Despite this group difference, the average severity per event and overall severity across events did not differ between groups.

Table 3

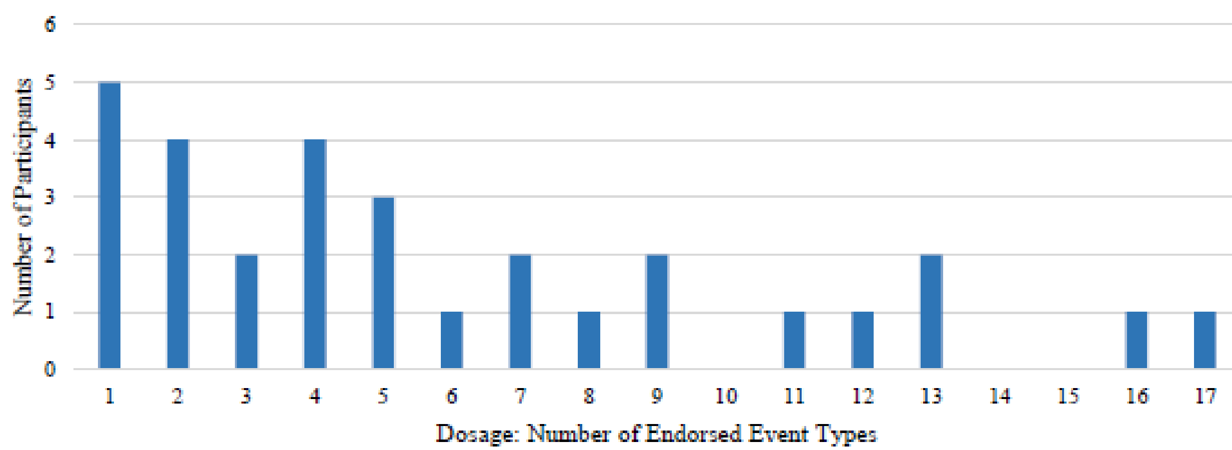
Adversity Feature Predictor Descriptives

	SLI				TL				Full Sample			
	M	*SD*	Min	Max	*M*	*SD*	Min	Max	*M*	*SD*	Min	Max
Adversity Dosage	6.33	4.08	1.00	13.00	5.83	4.87	1.00	17.00	5.93	4.66	1.00	17.00
Adversity Average Frequency	1.82	0.54	1.00	2.50	2.08	1.25	1.00	5.00	2.03	1.14	1.00	5.00
Adversity Chronicity	12.50	9.61	1.00	30.00	10.08	8.38	1.00	31.00	10.57	8.52	1.00	31.00
Adversity Average Severity	1.90	1.02	1.00	3.00	1.55	0.62	0.67	2.33	1.68	0.77	0.67	3.00
Adversity Overall Severity	2.20	1.10	1.00	3.00	2.67	2.00	1.00	7.00	2.50	1.70	1.00	7.00

Note. SLI = Specific Language Impairment; TL = Typical Language

Figure 2

Dosage Frequencies Across Full Sample



Covariates

The grand mean on the WPPSI Working Memory index was 108.63 (SD = 13.39). Based on the Shapiro-Wilk test, the distribution of scores significantly deviated from normal ($p = .02$) with a potential bimodal distribution based on the histogram. Most participants ($n = 21$) scored in the average range of 85 to 115 ($M = 100.90$, $SD = 6.32$, range 87 to 113) with the remaining nine participants scoring above 115 ($M = 126.67$, $SD = 5.24$, range 118 to 137). All individuals in the above average WPPSI Working Memory group were also in the typical language group. Because of the bimodal distribution, the WPPSI Working Memory index variable was dichotomized into an average and an above average group for further analyses.

Frequencies for dialect status and maternal education are shown in Table 4. Visual analysis of dialect status did not reveal any meaningful differences between the SLI and typical language groups. The continuous maternal education variable did not significantly deviate from a normal distribution based on the Shapiro-Wilk test. Caregivers in the SLI group reported the maternal education level of trade school or community college graduate more often than the typical language group. In contrast, caregivers in the typical language group reported the maternal education levels of some college and graduate or professional school more often than the SLI group.

Table 2

Dialect Status and Maternal Education Descriptives

Characteristic	TL		SLI		Full Sample	
	n	%	n	%	n	%
Dialect Status						
Strong variation from GAE	6	25.00%	1	16.67%	7	23.33%
Some variation from GAE	1	4.17%	1	16.67%	2	6.67%
GAE	17	70.83%	4	66.67%	21	70.00%
Maternal Education						
Some grade school	0	0.00%	0	0.00%	0	0.00%
Some high school	0	0.00%	1	16.67%	1	3.33%
High school graduate or GED	4	16.67%	0	0.00%	4	13.33%
Trade school or community college graduate	7	29.17%	3	50.00%	10	33.33%
Some college	9	37.50%	1	16.67%	10	33.33%
Four-year degree college graduate	2	8.33%	1	16.67%	3	10.00%
Graduate or professional school	2	8.33%	0	0.00%	2	6.67%

Note. $N = 30$. TL = Typical Language group (n=24); SLI = Specific Language Impairment group (n=6).

Correlations

Scores on the grammar outcome measure did not significantly correlate with any adversity feature predictors, as show in Table 3. Dosage positively correlated with chronicity and overall severity, and chronicity positively correlated with overall severity. In addition, average severity positively correlated with overall severity. These correlations are artifacts of how these adversity feature predictors were measured. Chronicity and overall severity both take dosage into account while average severity and overall severity both take severity into account.

Table 3

Correlations

	Grammar	Dosage	Avg Freq	Chronicity	Avg Sev	Overall Sev
Grammar	1.00					
Dosage	0.01	1.00				
Avg Freq	-0.05	-0.29	1.00			
Chronicity	-0.04	0.88*	0.04	1.00		
Avg Sev	-0.08	0.36	0.09	0.36	1.00	
Overall Sev	0.12	0.60*	0.22	0.65*	0.61*	1.00

Note. Avg Freq = Average Frequency; Avg Sev = Average Severity; Overall Sev = Overall Severity.

RQ1: Percentage of SLI in the sample

The first research question was whether the proportion of participants meeting diagnostic criteria for SLI differed from the expected prevalence in the general population (i.e., 7.4%; Tomblin et al, 1997). Twenty percent of the sample met diagnostic criteria for SLI, and a binomial test indicated that the proportion of participants in the SLI group was significantly higher than the expected prevalence in the general population, p = .002.

RQ2: Adversity Features Effects

Separate general linear models (i.e., regression) were conducted to examine whether adversity features interacted with SLI status to predict the grammar outcome measure. These general linear models were conducted stepwise to also examine change in R^2 across the following steps: 1) covariates, 2) SLI status, 3) adversity feature predictor, and 4) interaction between SLI status and adversity feature predictor. The first two steps were identical across the general linear models.

Baseline Model with Covariates and Language Status Group Predictor

In Step 1, the covariates of maternal education (continuous across 6 levels) and WPPSI Working Memory group (average versus above average) were entered into the model since these variables differed across the SLI and typical language groups. When added to the baseline model, the covariates were nonsignificant and, together, did not account for a significant amount of variance in the grammar outcome measure, $F(2,27) = 2.75$, $p = .08$, $R^2 = .169$, as shown Table 4. In Step 2, the language status group predictor (SLI versus typical language) was entered into the model, also shown in Table 4. At this step, the model accounted for a significant amount of variance in the grammar outcome measure, $F(3,26) = 16.83$, $p < .001$, $R^2 = .660$, with a significant main effect of language status group, $t(1) = -6.13$, $p < .001$, $\eta^2 = .491$. After accounting for maternal education and WPPSI Working Memory group, the grammar outcome measure was 3.58 scaled scores lower in the SLI group than in the typical language group.

Table 4

Results for Baseline Model Including Covariates and Language Group

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 1					0.17	0.17
Constant	6.59*	3.68	9.51	1.42		
Maternal Education	0.23	-0.43	0.89	0.32		
WPPSI Group	1.42	-0.23	3.07	0.8		
Step 2					0.66	0.49*
Constant	7.81*	5.87	9.76	0.95		
Maternal Education	0.18	-0.25	0.62	0.21		
WPPSI Group	0.45	-0.68	1.57	0.45		
Language Group	-3.58*	-4.78	-2.38	0.58		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
*$p < .001$.

Models with Adversity Feature Predictors

Building off the baseline model described in the previous section, the adversity feature predictors and their interactions with the language status group variable were entered into separate general linear models. That is, five separate general linear models were conducted, each with one adversity feature predictor: dosage, average frequency, chronicity, average severity, or overall severity. The results are presented in separate Tables with alpha suffixes (a-e) indicating the separate general linear models for Steps 3 and 4. See Table 5 through Table 9 for coefficient estimates, standard error, confidence intervals, and R^2 for each adversity feature predictor.

Overall, the adversity feature predictors of dosage, average frequency, chronicity, average severity, and overall severity did not significantly predict the grammar outcome measure after accounting for language group status (SLI versus typical language), maternal education, and WPPSI Working Memory group (average versus above average). In addition, these adversity feature predictors did not significantly interact with language group status nor contribute to a change in R^2 during Steps 3 and 4.

Table 5

Results for Adversity Dosage

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 3a					0.66	0.00
Constant	7.83*	5.80	9.85	0.98		
Maternal Education	0.19	-0.25	0.63	0.21		
WPPSI Group	0.46	-0.74	1.66	0.58		
Language Group	-3.57*	-4.82	-2.33	0.6		
Dosage	0.00	-0.11	0.10	0.05		
Step 4a					0.66	0.00
Constant	7.82*	5.75	9.89	1.00		
Maternal Education	0.19	-0.27	0.65	0.22		
WPPSI Group	0.46	-0.77	1.69	0.60		
Language Group	-3.64*	-5.91	-1.36	1.10		
Dosage	0.00	-0.13	0.11	0.06		
Language Group*Dosage	0.01	-0.3	0.32	0.15		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
*$p < .001$.

Table 6

Results for Adversity Average Frequency

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 3b					0.66	0.00
Constant	8.15*	5.89	10.42	1.10		
Maternal Education	0.18	-0.25	0.62	0.21		
WPPSI Group	0.32	-0.89	1.53	0.59		
Language Group	-3.66*	-4.91	-2.41	0.61		
Average Frequency	-0.14	-0.58	0.31	0.21		
Step 4b					0.66	0.00
Constant	8.18*	5.73	10.63	1.19		
Maternal Education	0.18	-0.29	0.64	0.23		
WPPSI Group	0.32	-0.92	1.56	0.60		
Language Group	-3.81*	-8.24	0.61	2.14		
Average Frequency	-0.14	-0.60	0.32	0.22		
Language Group*Average Frequency	0.08	-2.20	2.36	1.11		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
*$p < .001$.

Table 7

Results for Adversity Chronicity

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 3c					0.66	0.00
Constant	7.78*	5.77	9.79	0.97		
Maternal Education	0.18	-0.26	0.62	0.21		
WPPSI Group	0.43	-0.72	1.59	0.56		
Language Group	-3.60*	-4.84	-2.36	0.60		
Chronicity	0.01	-0.05	0.06	0.03		
Step 4c					0.66	0.00
Constant	7.77*	5.72	9.81	0.99		
Maternal Education	0.17	-0.28	0.62	0.22		
WPPSI Group	0.42	-0.76	1.60	0.57		
Language Group	-3.28*	-5.32	-1.23	0.99		
Chronicity	0.01	-0.05	0.08	0.03		
Language Group*Chronicity	-0.03	-0.16	0.11	0.07		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
*$p < .001$.

Table 8

Results for Adversity Severity (Average)

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 3d					0.66	0.00
Constant	7.80*	5.82	9.79	0.96		
Maternal Education	0.18	-0.26	0.62	0.21		
WPPSI Group	0.42	-0.74	1.58	0.56		
Language Group	-3.67*	-5.03	-2.30	0.66		
Average Severity	0.07	-0.45	0.60	0.26		
Step 4d					0.66	0.00
Constant	7.43*	5.33	9.52	1.02		
Maternal Education	0.29	-0.19	0.78	0.24		
WPPSI Group	0.40	-0.76	1.56	0.56		
Language Group	-4.48*	-6.50	-2.46	0.98		
Average Severity	-0.15	-0.82	0.52	0.32		
Language Group*Average Severity	0.68	-0.57	1.93	0.61		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
**p* < .001.

Table 9

Results for Adversity Overall Severity

	B	95% CI		*SE B*	R^2	ΔR^2
		LL	*UL*			
Step 3e					0.66	0.00
Constant	7.82*	5.83	9.81	0.97		
Maternal Education	0.19	-0.25	0.63	0.21		
WPPSI Group	0.45	-0.70	1.61	0.56		
Language Group	-3.56*	-4.82	-2.30	0.61		
Overall Severity	-0.02	-0.30	0.27	0.14		
Step 4e					0.66	0.00
Constant	7.65*	5.55	9.75	1.02		
Maternal Education	0.23	-0.24	0.70	0.23		
WPPSI Group	0.43	-0.75	1.61	0.57		
Language Group	-4.06*	-6.15	-1.97	1.01		
Overall Severity	-0.05	-0.37	0.26	0.15		
Language Group*Overall Severity	0.29	-0.68	1.27	0.47		

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; WPPSI = Wechsler Preschool & Primary Scale of Intelligence.
*$p < .001$.

Power

The null findings of the adversity feature predictors may stem from this studying being under-powered based on the small sample size, especially in the SLI group, and high variability around the group means. For example, with the dosage predictor, the minimum detectable effect size at an 80% power level in this study would be a Cohen's *d* of 1.32 (large effect size). The true effect may be smaller, however, than the detectable level in this study. If the true effect size is medium (Cohen's *d* of .5), then the sample size of this study would need to increase to 210 participants based on the observed group proportions (i.e., 20% of participants meeting diagnostic criteria for SLI) and pooled standard deviation. If the SLI group was oversampled to have balanced group sizes, then the sample size of this study would need to increase to 128 participants (64 in each group).

Discussion

The aims of this study were to determine the percentage of children with known adversity exposure who meet diagnostic criteria for SLI and to examine which adversity features interact with SLI status to predict grammar. The results of the study included three primary conclusions. First, adversity exposure is associated with reduced grammatical knowledge. Second, adversity exposure is a risk factor that may selectively affect language acquisition, resulting in a higher percentage of children with SLI than expected based on epidemiological prevalence. Third, for children with known adversity exposure, those with SLI may be more likely than their typical language peers to experience physical trauma but not increased adversity dosage, frequency, chronicity, or severity.

Reduced Grammar Knowledge and Higher Percentage of SLI

Grammar acquisition appears sensitive to adversity exposure. In this sample of children with known adversity exposure, the mean grammar score of 8.07 was significantly below the normative expectation of 10, suggesting reduced grammatical knowledge. The mean grammar score was also consistent with a previous report of over 300 five-year-old children at risk for adversity exposure (Smith et al., 2021), where the sample mean scores for the grammar subtests of Word Structure and Sentence Structure from the Clinical Evaluation of Language Fundamentals, Preschool—2nd edition (Semel et al., 2004) were 8.5 and 8.7, respectively.

In addition, the percentage of children in this study's sample meeting diagnostic criteria for SLI (i.e., 20%) was over double the expected prevalence of 7.4% in the general population (Norbury et al., 2016; Tomblin et al., 1997). This percentage is notably lower than Smith and colleagues (2021) at-risk sample, where 32% scored one or more standard deviations below the normative mean; however, they did not implement any exclusionary criteria, which may account for the discrepancy. Given the higher percentage of SLI in the current study's sample, a reduced sample mean on the grammar outcome measure would be expected. However, the typical language group remained below normative expectations (i.e., scaled score of 8.83), reflecting reduced grammar knowledge even when participants did not meet diagnostic criteria for SLI.

One possible explanation for these findings is that the adversity-exposed population represents a subsample in the normal distribution of grammar knowledge that is shifted toward the lower end. Subsamples within the normal distribution lead to distinct yet overlapping distributions with separate mean scores but similar standard deviations. Researchers have documented this phenomenon within the normal distribution for vocabulary and omnibus language based on socioeconomic status. When considering possible subsamples within the normal distribution, Qi and colleagues (2006; 2003) found that preschool children living in low socioeconomic status environments received mean scores one and a half standard deviations below the age-mean on norm-referenced assessments of vocabulary and omnibus language. In contrast, Abel and colleagues (2016) found that preschool children living in high socioeconomic status environments received mean scores one standard deviation above the age-mean. Taken together, children living in low socioeconomic status environments performed over two standard deviations below children living in high socioeconomic status environments. Qi (2006; 2003), Abel (2016), and colleagues suspected that the shifts in mean scores were due to cultural and linguistic bias in the assessments as well as access to resources (e.g., books), language learning experiences (e.g., trips to museums), and quality education, which can affect word learning. If this is the case, applying the same diagnostic threshold for SLI across both groups could over-identify children in the low socioeconomic status subsample and under-identify children in the high socioeconomic status subsample. Indeed, Qi and colleagues (2006; 2003) recommended a different diagnostic threshold for children living in low socioeconomic status environments—two standard deviations below the normative age-mean instead of one standard deviation. At this new diagnostic threshold, children scoring one standard deviation below the subsample mean, rather than the normative mean, would be classified as having SLI. Otherwise, children scoring at the subsample mean would be classified as having SLI since the subsample mean is the same as the original diagnostic threshold—one standard deviation below the normative mean. At this original diagnostic threshold, 52% of their sample would have met criteria for SLI. However, when Qi and colleagues (2003) applied the new diagnostic threshold, 10% of the sample presented as having SLI. This percentage remained higher than expected based on the normative sample and epidemiological prevalence, but the children scoring below this new diagnostic threshold also had coinciding deficits consistent with SLI such as reduced vocabulary knowledge, sentence length, and sentence complexity.

Adjusting the diagnostic threshold is one way of disentangling disorder from disadvantage. Roy and Chiat (2013) also argued for adjusting diagnostic practices for children living in poverty to avoid over-identification. In their sample, approximately a third of preschool-aged children scored below expectations on a norm-referenced language assessment. When the researchers added in other assessment tasks found to be free of socioeconomic status effects (i.e., nonword repetition, sentence imitation, novel word learning), that proportion reduced by a third. Thus, some children who performed below expectations on the language assessment may have had intact language-learning abilities. This group of children will introduce error into studies of causal pathways, especially studies of genetic and epigenetic effects, if an organic SLI is indeed not present. Proper classification of this group versus children with true SLI is also important for clinical service provision. The children performing below expectations on language assessments but with intact language-learning abilities may benefit from less restrictive services than speech-language pathology intervention (e.g., Head Start, response to intervention, multi-tiered systems of support). That is, these children will still benefit from enriched services since performance on language assessments is associated with academic achievement (e.g., Johnson et al., 1999). However, these same services will be insufficient for the children with true SLI, where language-learning abilities are impaired. The goal, therefore, is to properly distinguish low performance due to true SLI from low performance due to disadvantage in informing both causal pathway research and clinical practice (Roy & Chiat, 2013).

The subsample phenomenon based on non-linguistic factors such as socioeconomic status is important to consider for the findings of the current study. A lower sample mean score and higher percentage of children receiving scores below the normative diagnostic threshold (i.e., one standard deviation below the age-mean) may not be due to an increased prevalence of SLI but, rather, a distinct subsample with a score distribution shifted to the lower end. The participant demographics of the current study paralleled Qi and colleagues' (2003) study, so it is possible that the pattern of scores and percentage of children scoring below the SLI diagnostic threshold is a subsample artifact. That is, the socioeconomic status of the sample rather than the adversity exposure explains the reduced grammar knowledge.

The current study cannot disentangle a true increase in SLI prevalence in the adversity sample from an increase because of artifacts associated with a shifted distribution, but it lays the foundation for future research. A true increase in SLI prevalence in the adversity population is possible given that epigenetic mechanisms link environmental factors to changes in the genome, neural development, and cognitive outcomes (e.g., Lupien et al., 2009; Roth & Sweatt, 2011). To identify a true increased prevalence of SLI, basic grammar performance will be a key measure to assess in the adversity population.

Children living in poverty perform equal to their peers living in higher socioeconomic status environments on basic grammar structures (Pruitt & Oetting, 2009; Whitehurst, 1997) but differences emerge for complex grammar structures (Pace et al., 2017; Pruitt et al., 2011). The grammar outcome measure used in the current study included both basic and complex grammar structures. Future studies should consider differences between basic and complex grammar structures in the adversity population. Specifically, children living in low socioeconomic status or poverty environments perform as expected on certain basic grammar structures (Pruitt & Oetting, 2009; Weiler et al., 2021), which are known to be difficult for children with SLI (Rice & Wexler, 1996; Tager-Flusberg & Cooper, 1999)—finiteness marking (i.e., tense and agreement marking). If the shifted distribution of grammar knowledge in the current study is an artifact from the sample's socioeconomic status, then poor performance on finiteness marking would be unexpected. If the shifted distribution of grammar knowledge is because of a true increased prevalence of SLI, then poor performance in the SLI group but not the typical language groups would be expected on basic grammar structures in the adversity population. In addition, finiteness marking is a bimodally distributed skill for young children (Rice & Wexler, 2001; Weiler & Schuele, 2021), which will further clarify the potential underlying cause of a higher proportion of children scoring below the diagnostic threshold on norm-referenced assessments in this population. Bimodally distributed clinical markers, such as finiteness marking proficiency, remove the issue of arbitrary cut off scores on norm-referenced assessments and reduce the likelihood of false positives (Weiler & Schuele, 2021).

Evidence that children exposed to adversity make more errors with finiteness marking than expected would further support the theory that adversity exposure increases risk for SLI and improve diagnostic classification accuracy, which is crucial not only for causal pathway research but also clinical practice (Rice, 2020; Roy et al., 2013). It should be noted, however, that 30% of the sample in this study spoke a dialect other than the General American English dialect. Not all dialects require obligatory finiteness marking in the grammar. Researchers investigating SLI, grammar, and finiteness marking in the adversity population will need to consider that a notable proportion of their samples may speak dialects other than the General American English dialect and must account for this in study design, analysis, and interpretation.

Limited Effects of Adversity Feature Predictors

This was the first study in the child language research literature to have a sample of children with known adversity exposure across a broad range of adverse event types. This builds upon previous research focused on children at risk for, but not confirmed, adversity exposure and research focused on narrow types of adversity (e.g., poverty, child maltreatment). In addition, the caregiver-reported adversity exposure measure provided data with notable breadth and depth to characterize the children's adversity experiences. The mean age of the sample was almost seven-years-old, and the mean adversity dosage (i.e., number of different adverse event types) was approximately six. Thus, on average, the children in this sample experienced almost one different adverse event type per year since birth with a maximum report of 17 different adverse events before the age of 10. Building upon dosage, the chronicity feature accumulated the frequency of the different adverse events, providing a variable closer to the total experienced adversity amount across the child's lifetime. On average, the children in this sample experienced at least 10 total adverse events during their childhood with a maximum report of at least 31 adverse events before the age of 10 years. No child in this sample experienced zero adverse events during their lifetime.

Although this sample of children with confirmed adversity exposure had a higher percentage of participants meeting diagnostic criteria for SLI than expected, the features of the adversity exposure had little association with SLI status. The two groups experienced similar adversity dosage, frequency, chronicity, and severity across their childhoods. These features also did not significantly account for variation in the grammar outcome measure after accounting for maternal education, nonverbal cognition, and language status (i.e., SLI versus typical language).

The only significant difference between the SLI and typical language groups was exposure to physical trauma. The participants in the SLI group were 1.46 times more likely to report exposure to physical trauma than the typical language group (e.g., physical abuse, acute or chronic illness, car accident, injury). Despite the increased exposure to physical trauma, the SLI group did not experience more severe physical trauma than the typical language group, however. Increased exposure to physical trauma is consistent with some lines of research in the SLI literature. For example, children with SLI are more likely to be victimized by their peers (Knox & Conti-Ramsden, 2003; Redmond, 2011; van den Bedem et al., 2018), which includes physical bullying. In addition, children with SLI are likely to have parents with SLI since the disorder is hereditary with genetic underpinnings (e.g., Rice, 2012). Impaired language is associated with impaired health literacy, which is linked with poor physical health outcomes including accidents and illness (Berkman et al., 2011; Kindig et al., 2004). Through this mechanism, children (and adults) with SLI may be at elevated risk for more frequent accidents and illnesses.

The limited effect of adversity features on grammar ability and SLI status was surprising given they hold predictive power for other child developmental outcomes (Smith & Pollak, 2021). One possibility is that the true effects of adversity features are not large, and the current study was underpowered to identify them as significant. Alternatively, other aspects of the adversity construct may have more influence on grammar acquisition than features of the adverse events. Smith and Pollak (2021) proposed a topological approach to adversity exposure measurement, which also included features of the environment (e.g., predictability, safety) and features of the social context (e.g., support). The current study presented here did not measure nor account for environmental or social context features. Perhaps these features hold more explanatory power, or they may interact with features of the adverse events to affect grammar acquisition. A third possibility is *what* the child experiences may be less important than their *perception* of what they experience (Gusler et al., 2021), which is known as cognitive appraisal. If a child does not perceive an event to be adverse or traumatic, the body's physiological response may be attenuated compared to another child who experiences the same event but appraises it as upsetting or stressful. In adults, for example, cognitive appraisal accounts for psychopathology outcomes above and beyond adversity dosage (Martin et al., 2013). A fourth possibility is that the child's own adversity exposure is only one piece of a larger picture with intergenerational transmission of adversity also playing a role. Parental exposure to adversity can transmit to the child through prenatal and postnatal epigenetic mechanisms (e.g., Yehuda & Lehrner, 2018). Future studies should consider the parents' own adversity exposure, which may associate with the child's SLI status or account for additional variance in grammar acquisition. In all, adversity is a complex and multifactorial construct, and future research is needed to explore and identify which aspects of the adversity exposure are associated with grammar abilities and the higher-than-expected percentage of children with SLI.

Limitations and Future Directions

The primary limitation of this study was its small sample size, which may have affected statistical power and generalizability to other samples of children. As discussed in the Results section, this study was under-powered to identify small-, medium-, and some large-sized effects of the adversity feature predictors. This was due to the small sample size and notable variation of the group means. Future research should increase the sample size to determine whether adversity features do have true effects on grammar knowledge since the current study cannot determine whether the nonsignificant findings are indeed true effects or secondary to limited power. In addition, future research should consider oversampling participants with SLI so the groups are balanced.

The sample in this study was not nationally representative across race, ethnicity, nor socioeconomic status. Most participants in this study identified as Black/African American or multiracial, and most participants likely lived in low socioeconomic status environments, as measured by maternal education. In addition, the study was conducted in a Midwestern urban setting. The findings of this study may not generalize to all children with known histories of adversity, and the nature of the adversity experience may differ for children living in other geographic areas such as rural communities. Lastly, this study's exclusionary criteria were intentional based on the research questions; however, this limits generalizability of the findings to children with low nonverbal cognition, other co-occurring neurodevelopmental disorders, and bi/multilingual speakers.

Finally, this study did not include a control group given the exploratory nature of the study; however, without a control group, it is possible that some other unidentified factor besides adversity exposure led to the reduced grammar knowledge and higher rate of SLI. Future research should include a control group that is matched on key demographic variables, such as socioeconomic status, but without a history of adversity exposure.

Conclusion

Children with known histories of adversity exposure are at risk for reduced grammar knowledge and increased risk of meeting diagnostic criteria for SLI. Twenty percent of the sample met diagnostic criteria for SLI compared to approximately 7% in the general population (Norbury et al., 2016; Tomblin et al., 1997). However, adversity features did not associate with nor predict SLI status. Participants in the SLI group did not experience a higher adversity dosage nor more frequent, chronic, or severe adversity. Despite the limited effects of adversity features, the SLI group was 1.46 times more likely to experience physical trauma than the typical language group. Future research is needed to determine the prevalence of SLI in the adversity population and what causal pathways may account for an increased rate of SLI.

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