Early Childhood Research Quarterly 50 (2020) 114–128

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

Evaluating socioeconomic gaps in preschoolers' vocabulary, syntax and language process skills with the Quick Interactive Language Screener (QUILS)

Dani Levine[a,*], Amy Pace[b], Rufan Luo[c], Kathy Hirsh-Pasek[a], Roberta Michnick Golinkoff[d], Jill de Villiers[e], Aquiles Iglesias[d], Mary Sweig Wilson[f]

[a] Temple University, United States
[b] University of Washington, United States
[c] Rutgers University-Camden, United States
[d] University of Delaware, United States
[e] Smith College, United States
[f] Laureate Learning Systems, Inc., United States

ARTICLE INFO

Article history:
Received 27 February 2018
Received in revised form 6 November 2018
Accepted 12 November 2018
Available online 20 December 2018

Keywords:
Socioeconomic status (SES)
Language development
Preschoolers
Assessment
Quick Interactive Language Screener (QUILS)

ABSTRACT

Early language competence is a reliable and powerful predictor of children's success in school, and word gaps linked to socioeconomic status disparities have cascading effects on academic outcomes. While early research – such as the work of Hart and Risley (1995) – focused on gaps in vocabulary, growing evidence reveals wide gaps in syntax as well. Language is an interdependent developing system of vocabulary, syntax, and language processes, yet existing research has not evaluated how SES gaps compare for these language components or how these components are linked for children from lower- and higher-SES families. Such a profile is sorely needed to understand the course of language development in all children. A new language measure, the Quick Interactive Language Screener (QUILS), expands on other measures by evaluating preschoolers' vocabulary and syntax knowledge, along with their language-learning process skills. This screener was administered to a large, diverse sample of English-speaking children ages 3 through 5. Results indicated that the effect of SES was significant and comparable for all three language components, at all ages tested. Additionally, correlations among syntax, vocabulary and process were robust for low- and mid-SES children. These findings highlight the importance of looking beyond vocabulary to language syntax and process to better understand the SES gap in language.

1. Introduction

Children enter kindergarten with striking variation in language competence that reliably predicts academic performance (Catts, Fey, Tomblin, & Zhang, 2002; Einarsdóttir, Björnsdóttir, & Símonardóttir, 2016; Scarborough, 1990; Walker, Greenwood, Hart, & Carta, 1994) and that is linked to their socioeconomic status (SES), as defined by caregiver education level, income, or occupational prestige (Fernald, Marchman, & Weisleder, 2013; Hart & Risley, 1995; Hoff, 2003; Rowe, 2012; Rowe et al., 2012; Walker et al., 1994). Hart and Risley's (1995) research documented that by age three low-SES children hear 30 million fewer words than their higher-SES peers, and these inequities in experience are reflected in disparities in children's vocabularies. The *word gap* has spurred national programs and initiatives aimed at boosting the vocabularies of young children at risk for poor language and literacy outcomes due to socioeconomic disadvantage (Greenwood et al., 2017; Hindman, Wasik, & Snell, 2016). Yet, vocabulary is not acquired in a vacuum: for example, children's comprehension and production of complex syntax uniquely predicts children's academic outcomes (Durand, Loe, Yeatman, & Feldman, 2013; NICHD Early Child Care Research Network, 2005; Scarborough, 1990) and also differs by SES (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Vasilyeva, Waterfall, & Huttenlocher, 2008). Additionally, there are extensive individual differences in language-learning processes such as the *fast mapping* of word meanings (Bion, Borovsky, & Fernald, 2013) that could have significant implications for SES differences in language and academic outcomes.

* Corresponding author at: Temple University, 1701 North 13th Street, PA 19122, Philadelphia, United States.
E-mail address: dani.levine@temple.edu (D. Levine).

https://doi.org/10.1016/j.ecresq.2018.11.006
0885-2006/

Language develops as an integrated, emerging system of vocabulary, syntax, and language-learning processes (Bates & Goodman, 1997; Moyle, Weismer, Evans, & Lindstrom, 2007; Stolt, Haataja, Lapinleimu, & Lehtonen, 2009). Interventions will be unlikely to improve language skills if vocabulary is targeted without attention to the language system as a whole. Indeed, vocabulary-focused interventions are less effective for low-SES children than for higher-SES children (Marulis & Neuman, 2010, 2013). Addressing the SES gap in language will require a clear understanding of SES differences in the development of vocabulary, syntax, and language-learning processes. The focus of the current study is therefore to evaluate SES differences in each of these components and to examine how the integration of these components compares for children from low- and mid-SES families.

1.1. Vocabulary gaps

The SES gap in children's vocabularies revealed by Hart and Risley (1995) has been studied at length to evaluate the replicability, developmental time course, and the magnitude of this gap (see Suskind, 2015). By the time children enter preschool, the vocabularies of those from low-SES families trail the vocabularies of higher-SES children in the United States, with medium-to-large effect sizes (Dollaghan et al., 1999; Fernald et al., 2013; Hart & Risley, 1995; Hoff, 2003; Rowe, 2012; Rowe et al., 2012; Walker et al., 1994). SES differences in children's vocabulary size are also apparent in countries across the world including Australia (Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013), China (Zhang, Jin, Shen, Zhang, & Hoff, 2008), Chile (Coddington, Mistry, & Bailey, 2014), Estonia (Urm & Tulviste, 2016), the Netherlands (van Druten-Frietman, Denessen, Gijsel, & Verhoeven, 2015), the United Kingdom (Becker, 2011), and Turkey (Baydar & Akcinar, 2015). (One exception to this pattern is Sweden, where effects of SES on preschoolers' vocabulary do not emerge, likely because of the predominant homogeneity in middle income SES; Berglund, Eriksson, & Westerlund, 2005; Eriksson, 2017.) Clearly, the vocabulary gap is a widespread phenomenon that cuts across diverse cultures and languages.

But what is the magnitude of this gap? One study revealed an SES gap in vocabulary with a medium effect size (Hedges' $g = 0.61$)[1] as early as 16 months using a Computerized Comprehension Task, which tested children on pairs of vocabulary items using a touch sensitive screen (Deanda, Arias-Trejo, Poulin-Dubois, Zesiger, & Friend, 2016). In that study, SES was assessed using a median split of maternal education, with low-SES indicating an average of high school plus one year of post-high school education among mothers, and with mid-SES indicating an average of college completion (Deanda et al., 2016). Fernald et al. (2013) research further indicates that the SES gap, assessed using parent report of expressive vocabulary on the MacArthur-Bates Communicative Development Inventory (CDI), widens between 18 and 24 months. At 18 months, the gap between children from low-SES families, with an average maternal education of high school plus one year of education post-high school, and mid-SES families, with an average maternal education of college completion, was moderate (Hedges' $g = 0.56$), and by 24 months, children from low-SES families were 6 months behind their higher-SES peers (Hedges' $g = 0.93$; Fernald et al., 2013). Hart and Risley's (1995) research evaluating spoken vocabularies from at-home recordings suggests the vocabulary gap continues to widen between 24 and 36 months, with 36-month-olds from high-SES families knowing twice as many words as their peers from families on welfare. Additionally, Dollaghan et al. (1999) found a large effect when comparing the productive vocabularies of 3-year-olds whose mothers had at least a college degree with children whose mothers had less than a high school degree (Hedges' $g = 0.81$), and an even larger effect when comparing their receptive vocabularies, assessed with the Peabody Picture Vocabulary Test or PPVT (Hedges' $g = 1.30$).

While this research suggests a large and growing gap in vocabulary, other longitudinal research using growth curve modeling indicates stability in the gap. Huttenlocher et al. (2010), using at-home recordings to assess lexical diversity, found that the gap in vocabulary knowledge attributed to SES, measured as parental education or income, is constant from 26 to 46 months. Similarly, a study using a large, nationally representative longitudinal data set demonstrated that gaps on the PPVT attributed to SES, calculated as a composite of family education and poverty status, remain stable from age 3 to 13 years (although the stability of the SES gap from 36 to 60 months differed by race; Farkas & Beron, 2004). A large-scale longitudinal study in Australia also indicated a consistent income- and education-based gap in PPVT scores from ages 4 to 8 (Taylor et al., 2013). Together, this research suggests that the gap in vocabulary attributed to family SES initially widens from 16 months to approximately age 3, at which time the gap seems to stabilize, with comparable rates of vocabulary acquisition for low- and mid-SES children throughout all ages tested.

1.2. Syntax gaps

Research consistently reveals an SES gap in children's syntactic knowledge as well. For example, Arriaga, Fenson, Cronan, and Pethick (1998) compared 22- to 30-month-old children attending Head Start programs to a matched mid-SES sample on a parent-report measure of sentence complexity from the CDI, finding a significant gap of large effect size (Hedges' $g = 0.79$) comparable to the gap in CDI expressive vocabulary scores (Hedges' $g = 0.76$). Similarly, Dollaghan et al., 1999) found comparable large effect sizes for the SES difference in 3-year-olds' syntax, measured as the mean length of utterance (MLU) in a spontaneous speech sample, and vocabulary, measured as the number of different words from the speech sample (Hedges' $g = 0.76$ and 0.81, respectively; Dollaghan et al., 1999). Snow (1999) further showed that the MLUs of low-income 3- through 5-year-olds were over a year behind MLU norms, which were based on a middle-class sample. A few studies, including those conducted in China, have found no association between SES and grammatical development; however the SES variability in these studies was minimal, with either none of the children growing up in low-SES households (Hoff-Ginsberg, 1998; Hoff & Tian, 2005; Zhang et al., 2008) or with practically the full sample coming from low-SES backgrounds (Jackson & Roberts, 2001).

Beyond the broad measures of parent report and MLU, more precise assessments of syntax can provide a clearer picture of how SES may impact syntactic development. Vasilyeva et al. (2008) used primary caregiver education level as an indicator of SES and demonstrated that while there were no SES differences in children's production of sentences containing simple syntax (i.e., sentences with a single clause), there was an SES gap in the production of complex sentences (i.e., sentences containing two or more clauses) as early as 26 months, when the use of complex syntax emerges. Both the frequency with which children produced complex sentences and the number of types of complex sentences produced differed by SES from 26 to 42 months; additionally, the growth curves of SES groups suggested a possible widening from a 4-month gap at 30 months, separating children of caregivers with a high school degree and children of caregivers with a college or graduate degree,

[1] Here and throughout the Introduction, measures of effect size were included wherever it was possible to derive this information from the published studies. In all cases, we used Hedges' g as the measure of effect size because this measure provides the mean difference between two groups in standard deviation units and corrects for small sample sizes.

to an 8-month gap by 42 months (Vasilyeva et al., 2008). Similarly, Huttenlocher et al., (2010) showed that SES gaps in the diversity of syntactic clauses produced widened between 26 and 46 months (though SES gaps in the diversity of syntactic constituents produced remained constant during this period). However, research on the comprehension of complex syntax in preschoolers indicates that the SES gap is constant from 43 to 50 months; that is, the effect of SES, determined by the preschool in which children were enrolled, was large (Hedges' $g = 0.70$), but *growth* in syntax comprehension from 43 to 50 months was explained by teachers' use of complex syntax, not by SES (Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002). Thus, similar to the SES gap in vocabulary, the SES gap in syntax also seems to initially widen and subsequently stabilize — though confirmatory research is needed. In both cases, the gap is apparent as early as the emerging skill can be reliably measured (16 months for vocabulary and 26 months for complex syntax), and in both cases stabilization occurs during the third year.

While SES differences have been established in vocabulary and syntax (albeit with less evidence for the latter), much less is understood about the sources of this variation. Some of the differences in children's language products may be attributed to genetic factors; researchers have demonstrated effects of genetics on SES, especially as measured by educational attainment, and on the relation between parent education and measures of children's intelligence, which include tests of children's vocabulary knowledge (Trzaskowski et al., 2014). However, parental education also plays a role in moderating the effect of genetics on language and cognitive outcomes (Rowe, Jacobson, & Van den Oord, 1999; Turkheimer, Haley, Waldron, d'Onofrio, & Gottesman, 2003), though this effect may be unique to countries like the United States, which do not ensure access to high quality education and social welfare support for low-income families (Tucker-Drob & Bates, 2016). Nevertheless, the most critical factor contributing to SES differences in early language development is the early language environment (see Hoff, 2006; Pace et al., 2017, for reviews). Differences both between and within SES groups in children's lexical and grammatical development are robustly explained by the quality and quantity of parents' language use when interacting with their children (Hart & Risley, 1995; Hirsh-Pasek et al., 2015; Hoff, 2003; Huttenlocher et al., 2002, 2010; Rowe, 2012; Weisleder & Fernald, 2013). Moreover, high quality caregiver-child verbal interactions in child care serve as a buffer from poor language outcomes for children with lower quality language experiences at home (Vernon-Feagans, Bratsch-Hines, & FLP Key Investigators, 2013; see also Dickinson & Porche, 2011; Huttenlocher et al., 2002). Yet, other research also asks whether some of the observed SES differences in children's vocabulary and syntax might be artifacts of the assessment tools and testing environments employed; these may be insufficiently sensitive to the experiences of children who fall outside mainstream middle-SES (Campbell, Dollaghan, Needleman, & Janosky, 1997; de Villiers & de Villiers, 2010; Laing & Kamhi, 2003).

1.3. The role of process

One underexplored candidate for a less experience-dependent factor that reflects language potential and not simply prior language experience is children's language process skills (Pace et al., 2017). Process-dependent skills, which have been defined as "the mental operations required to manipulate linguistic units" (Campbell et al., 1997, p. 520) may be less impacted by SES than acquired linguistic knowledge. Several studies have shown minimal or no SES gaps in processing-dependent measures such as nonword repetition, as compared to knowledge-dependent measures such as vocabulary tests in preschoolers and school-age children (Balladares, Marshall, & Griffiths, 2016; Campbell et al., 1997). However, others have expressed concern that these measures "have stripped away the very essence of the linguistic code that is critical to assess," and simply measure domain-general abilities such as attention, memory, and executive function (Weismer & Evans, 2002). Indeed, processing measures that are more language-based, evaluating children's efficiency in real-time processing of known words and syntactic structures, reveal SES differences comparable to measures of vocabulary and syntax knowledge (Fernald et al., 2013; Huang, Leech, & Rowe, 2017; Leech, Rowe, & Huang, 2017).

Beyond linguistic and non-linguistic processing efficiency, there are process skills that enable children to acquire new linguistic items from language experience. The most widely studied of these process skills is *fast mapping*, through which children make a rapid inference about the likely meaning of a novel word based on the information available at the time of first exposure (Carey & Bartlett, 1978; Golinkoff et al., 1992; Spiegel & Halberda, 2011), and extend the label to other members of the referent category (Markman & Hutchinson, 1984). The skill of fast mapping leverages children's knowledge of *mutual exclusivity*, the learned principle that a given object or action typically has only one label (Markman, 1989). Zosh, Brinster, & Halberda, 2013 compared the retention of newly learned words given two types of word learning trials: one in which children were presented with a novel object and a familiar object, so that children had to infer that the novel word referred to the novel object; and a second trial type in which children were presented only with a novel object paired with the novel word. Trials which invoked the inferential processes involved in fast mapping actually led to significantly better retention of novel words than learning trials that were completely transparent, suggesting inferential processes may be critical components of lexical acquisition (Zosh et al., 2013). Moreover, as early as 17 months, infants who are trained to fast map novel nouns according to shape features experience gains in productive vocabulary size relative to an untrained control group (Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002).

Skills in disambiguating novel words' referents increase across development (Gray, 2006; Johnson & de Villiers, 2009; Mervis & Bertrand, 1994; Schmidt et al., 2016; Wilkinson & Mazzitelli, 2003). In theory, these process skills develop through and take advantage of existing vocabulary and syntax knowledge, but the research to date suggests that in contrast to the stark SES disparities in vocabulary and syntax products, language-learning processes may be available similarly for lower- and higher-SES children. Two studies to date with African American children, one with 2-year-olds and a second with kindergarteners, used composite SES measures (i.e., based on parental education and income or occupation) and found SES differences in vocabulary knowledge (Hedges' $g = 1.16$ and 1.13, respectively), but no SES differences in the ability to fast map novel nouns (Hedges' $g = 0.15$ and 0.18, respectively; Burton & Watkins, 2007; Horton-Ikard & Weismer, 2007). Process skills may be less directly affected by SES than acquired linguistic knowledge, although it is also possible that the small sample sizes and use of unstandardized measures of fast mapping obscured the effect of SES. More research is needed to understand SES differences in children's language-learning processes and how these might change over developmental time.

1.4. Language is an interdependent system

Studies of individual differences in language development and interventions primarily focus on a single aspect of language, and the aspect overwhelmingly studied is vocabulary. However, without the ability to comprehend and produce syntactic utterances, and without the ability to process language containing unfamiliar items, vocabulary knowledge serves little function. There is an extensive literature suggesting that the lexicon, syntax, and language processes emerge interdependently in a unified language

system (Bates & Goodman, 1997; Moyle et al., 2007; Stolt et al., 2009).

Dale (1991) found strong correlations ($r = 0.80$) between parent-reported vocabulary and syntax on the CDI at 24 months, and moderate correlations between 24-month child measures of a vocabulary test and MLU ($r = 0.53$). Similarly, Huttenlocher et al. (2010) found large correlations between preschoolers' lexical diversity and their syntactic diversity ($r = 0.70$ for correlation between lexical and constituent diversity; $r = 0.71$ for correlation between lexical and clausal diversity). Both studies were small and did not compare correlations for children from lower and higher SES backgrounds, though correlations are expected to be robust for all children.

What explains these robust links between vocabulary and syntax? On the one hand, there is evidence that the emergence of syntax depends on vocabulary size, with larger vocabularies enabling longer and more grammatically complex syntactic constructions (Bates & Goodman, 1997; Caselli, Casadio, & Bates, 1999; Stolt et al., 2009). Indeed, for English–Spanish bilingual toddlers, correlations between their vocabulary and syntax knowledge *within* each language were significantly stronger than correlations between vocabulary and syntax *across* languages, suggesting that syntactic development is tied to the growth of a language-specific lexicon (Marchman, Martínez-Sussmann, & Dale, 2004; but see Hoff, Quinn, & Giguere, 2018, for discussion that this finding may be explained by the common source of input).

On the other hand, children also leverage their knowledge of syntax to learn novel words. As early as 14 months, infants make use of their knowledge of grammatical forms (e.g., count nouns, adjectives) to interpret the meaning of novel words, recognizing that the statement 'These are blickets' refers to a novel object category, while the statement 'These are blickish' does not (Waxman & Booth, 2001). Simply hearing the word *the* preceding a noun (e.g., 'Can you see *the* ball?) elicits faster and more accurate orienting of toddlers to the visual target than hearing a nonsense or ungrammatical function word (e.g., "Can you see *and* ball?"), suggesting syntax is used to establish reference of nouns (Kedar, Casasola, & Lust, 2006). Moreover, learning verbs, which are considered 'hard words' because their referents are less concrete than nouns, theoretically relies even more heavily on syntactic knowledge (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). *Syntactic bootstrapping*, or the use of argument structure to guide interpretation of novel verbs, is used by children to map action labels differentially depending on whether the label is presented in a transitive frame (e.g., 'The duck is gorping the bunny') which implies a causative action, or in an intransitive frame (e.g., 'The duck and the bunny are gorping') which implies a non-causative action (Naigles, 1990).

Language-learning processes, including fast mapping and syntactic bootstrapping, are theoretically useful and perhaps essential for language acquisition to progress. And, importantly, the development and use of these process skills also theoretically depends on existing knowledge of syntax and vocabulary. Thus, it would be expected that children's process skills would be linked to both their vocabulary and syntactic knowledge.

Research examining the linkage between language products and processes have produced conflicting results, however. A study with 18- to 30-month-olds revealed a significant, albeit weak correlation between CDI vocabulary and the ability to fast map novel nouns ($r = 0.37$ controlling for age; Bion et al., 2013). Additionally, two studies with preschoolers indicated moderate correlations between children's PPVT scores and their performance on a test of fast mapping nouns (Gray, 2004; Wilkinson & Mazzitelli, 2003). Yet, a third study with preschoolers found no significant correlation between PPVT scores and fast mapping skills (Gray, 2006). In all of these studies, children were either from higher-SES backgrounds (Gray, 2004, 2006) or SES was not reported (Bion et al., 2013; Wilkinson & Mazzitelli, 2003), likely because the SES of the sample was homogenous and middle class.

Only one study to date examined the association between vocabulary knowledge and fast mapping skill in low-SES preschoolers, and this research did not find a significant correlation between PPVT scores and performance on a fast mapping task (Spencer & Schuele, 2012). It is possible that the link between language-learning process skills and vocabulary knowledge is weak or nonexistent for low-SES children – perhaps because individual differences in low-SES children's process skills are not capitalized on for vocabulary learning due to limited language exposure. However, it is difficult to draw conclusions from just one study, particularly because unlike the aforementioned studies with middle-SES children, which examined fast mapping of terms for whole objects, this study examined fast mapping of terms for object parts (Spencer & Schuele, 2012). Given these conflicting findings as well as the focus on links between vocabulary and fast mapping nouns to the exclusion of syntax and other language-learning processes, more research is needed to better understand the relation between language-learning processes and vocabulary and syntax products for children from different SES backgrounds.

1.5. The present study

The present study examines SES differences in vocabulary and syntax products as well as language-learning process in a cross-sectional, diverse sample of preschoolers ages 3 through 5. Children were assessed using the Quick Interactive Language Screener (Golinkoff, de Villiers, Hirsh-Pasek, Iglesias, & Wilson, 2017), a test designed to evaluate all three components of language based on research showing the importance of each component to the language system and based on the need for an assessment tool that improves the efficacy of language screenings for young children (de Villiers & de Villiers, 2010). We ask the following three questions:

1) Do children's vocabulary product, syntax product, and language-learning process scores differ by SES? We hypothesize that children from lower SES backgrounds will have lower scores than children from higher SES backgrounds on vocabulary and syntax products, but that their language-learning process scores will be less affected.
2) Does the effect of SES vary by age? Based on prior research, we predict SES gaps will be consistent throughout the preschool years. Specifically, we expect to find large SES differences in vocabulary and syntax at ages 3, 4, and 5 and smaller or no SES differences at these ages in language-learning process.
3) What is the relation between acquired vocabulary products, acquired syntax products, and language-learning processes for children from low- and mid-SES families? We predict that acquired vocabulary and syntax will be robustly correlated for low- and mid-SES children. However, we predict correlations between language products and processes will be stronger for mid-SES children than low-SES children, because the reduced language learning opportunities of low-SES children may limit these children from taking full advantage of their process skills in the acquisition of vocabulary and syntax knowledge.

2. Methods

2.1. Participants

Participants were 258 3- through 5-year-old children ($M = 52.7$ months; range = 37.5–71.0, 52.7% females). All participants were typically developing and were monolingual

Table 1
Demographic information on population, race/ethnicity, median income, poverty rate, and educational attainment in the research site.[a]

	Head Start centers			Private preschools		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Total population[b]	67,123	54,727	38,467	52,225	165,146	15,847
% Non-Hispanic White[c]	11.3%	1.5%	36.5%	66.0%	55.9%	79.7%
% Bachelor's degree or higher[c]	20.7%	12.5%	28.1%	52.5%	53.5%	60.6%
Median household income[c]	$42,385	$19,303	$37,473	$72,973	$83,349	$56,128
% Children below poverty[c,d]	35.1%	56.4%	34.3%	8.9%	17.1%	12.1%

[a] Source: U.S. Census Bureau, American Community Survey 2016 (https://factfinder.census.gov) for the locations from which participants were recruited.
[b] Total population at each site is inclusive of all zip codes in which children were recruited.
[c] Within each site, information for all zip codes in which children were recruited was averaged, weighted by the number of children tested in that location.
[d] 2016 Federal poverty level = $24,300 for family of four.

Table 2
Comparison of demographic characteristics for children from five SES backgrounds based on highest level of education attained by the primary caregiver.

Characteristic	<High school diploma (N = 17)	High school diploma (N = 64)	Trade/ associate's degree (N = 32)	Bachelor's degree (N = 52)	Graduate degree (N = 93)
Preschool status					
Head Start center	16 (94%)	54 (84%)	25 (78%)	9 (17%)	6 (6%)
Private preschool	1 (6%)	10 (16%)	7 (22%)	43 (83%)	87 (94%)
Gender					
Female	7 (41%)	33 (52%)	17 (53%)	30 (58%)	51 (55%)
Male	10 (59%)	31 (48%)	15 (47%)	22 (42%)	42 (45%)
Ethnicity					
Asian American	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (2%)
African American/Black	9 (53%)	31 (48%)	18 (56%)	9 (17%)	8 (9%)
Caucasian/White	1 (6%)	4 (6%)	6 (19%)	34 (65%)	59 (63%)
Hispanic	4 (23%)	11 (17%)	1 (3%)	4 (8%)	6 (6%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)
Multiple races	1 (6%)	4 (6%)	1 (3%)	3 (6%)	11 (12%)
Not reported	2 (12%)	14 (22%)	6 (19%)	2 (4%)	6 (6%)
Age (in months)	M = 51.5, SD = 8.8	M = 51.4, SD = 8.4	M = 52.2, SD = 9.5	M = 52.5, SD = 9.6	M = 54.1, SD = 8.7

English-speakers according to parent report. Recruitment and testing took place at Head Start centers and private preschools in the areas surrounding three university sites in Delaware, Pennsylvania, and Massachusetts. As shown in Table 1, the demographics of Head Start center locations and private preschool locations differed greatly in terms of race/ethnicity, poverty, and education, based on U.S. Census Bureau data. Relative to the population at private preschool locations, the population at Head Start center locations included a lower percentage of non-Hispanic whites, lower household incomes, higher percentage of children living below the federal poverty level, and lower percentage of adults with higher education (Table 1).

The sample in this study was a subset of the standardization sample for the QUILS (N = 674); participants from the larger sample were included in this subsample if questionnaire data from the children's primary caregiver were available. The highest level of education attained by the children's primary caregiver was used as a proxy for SES, because parental education has been shown to be the component of SES most closely linked to characteristics of caregiver speech (Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007) and most predictive of developmental outcomes (Hoff, 2013). Family income data were not collected; however, preschool status (i.e., private preschool vs. Head Start center) provides an indicator of income due to the high cost of private preschool and the low-income requirements of Head Start centers. Additionally, previous research has shown a very strong correlation between family income and preschool status (r = 0.91; Huang et al., 2017). Therefore, preschool status was used to support SES classification.

For the first research question, five SES levels were included: (1) primary caregiver did not complete high school (94.1% enrolled in Head Start centers), (2) primary caregiver graduated high school (84.4% enrolled in Head Start centers), (3) primary caregiver attended trade school or earned an associate's degree (78.1% enrolled in Head Start centers), (4) primary caregiver earned a bachelor's degree (17.3% enrolled in Head Start centers), and (5) primary caregiver earned a graduate degree (6.5% enrolled in Head Start centers). Table 2 presents the demographic characteristics of these five groups. There were no differences between these groups in terms of child gender ($\chi^2(4) = 1.57$, $p = 0.81$) or age ($F(4,257) = 0.98$, $p = 0.42$). However, there were significant differences between the groups in terms of preschool status ($\chi^2(4) = 143.92$, $p < 0.001$). There were also significant differences between the groups in terms of race/ethnicity when comparing the number of non-Hispanic white/Caucasian children to the number of children of other races ($\chi^2(4) = 71.41$, $p < 0.001$). Given that the census data indicated substantial racial/ethnic differences between Head Start center locations and private preschool locations, we also evaluated whether racial differences were significant across the 3 SES groups that primarily attended Head Start centers and across the 2 SES groups that primarily attended private preschools. Racial differences were not significant across the three lower SES groups primarily enrolled at Head Start centers ($\chi^2(2) = 4.16$, $p = 0.13$) or across the two higher SES groups primarily enrolled in private preschools ($\chi^2(1) = 0.04$, $p = 0.85$).

For the second research question, we were interested in comparing SES differences for different age groups (i.e., ages 3, 4, and 5), and for the third research question, we aimed to examine correlations between language components within SES groups. Both of these questions required larger samples, and we therefore collapsed the five SES groups into two SES groups based on the preschool status of the majority of children at each SES level. The low-SES group was comprised of children who predominantly attended Head Start centers and whose primary caregivers' highest education level ranged from less than a high school diploma to Trade School or an Asso-

Table 3
Comparison of demographic characteristics for children from low- and mid-SES backgrounds.

Characteristic	Low-SES ($N = 113$)	Mid-SES ($N = 145$)
Primary caregiver education		
Some high school	17 (15%)	
High school diploma	64 (57%)	
Trade School	24 (21%)	
Associate's degree	8 (7%)	
Bachelor's degree		52 (36%)
Graduate degree		93 (64%)
Preschool status		
Head Start center	95 (84%)	15 (10%)
Private preschool	18 (16%)	130 (90%)
Gender		
Female	55 (49%)	81 (56%)
Male	58 (51%)	64 (44%)
Ethnicity		
Asian American	0 (0%)	2 (1%)
African American/Black	56 (50%)	17 (12%)
Caucasian/White	12 (11%)	93 (64%)
Hispanic	16 (14%)	10 (7%)
Other	0 (0%)	1 (1%)
Multiple races	6 (5%)	14 (10%)
Not reported	23 (20%)	8 (5%)
Age (in months)	$M = 51.7$, $SD = 8.7$	$M = 53.5$, $SD = 9.0$
Age group		
3;0–3;11	46 (41%)	47 (32%)
4;0–4;11	40 (35%)	52 (36%)
5;0–5;11	27 (24%)	46 (32%)

ciate's Degree. The mid-SES group was comprised of children who primarily attended private preschools and whose primary caregivers had earned a Bachelor's Degree or greater.

Table 3 presents the demographic characteristics of these two SES groups. There were no differences between the groups in terms of child gender ($\chi^2(1) = 1.32$, $p = 0.25$). However, as in the 5-group SES comparison, here again there were significant differences between the SES groups in terms of preschool status ($\chi^2(1) = 141.14$, $p < 0.001$) and race/ethnicity ($\chi^2(1) = 75.37$, $p < 0.001$).

In terms of age, there was a trend for the mid-SES group to be older than the low-SES group ($F(1,256) = 2.73$, $p = 0.10$). Additionally, within each SES group, children were split into three age groups (i.e., 3;0–3;11, 4;0–4;11, and 5;0–5;11), and we tested whether there were SES differences in age for the three age groups. There were no age differences between mid-SES 3-year-olds ($M = 42.86$ months, $SD = 3.19$) and low-SES 3-year-olds ($M = 43.03$ months, $SD = 4.59$; $F(1,91) = 0.043$, $p = 0.84$), and there were no age differences between mid-SES 4-year-olds ($M = 53.91$ months, $SD = 3.45$) and low-SES 4-year-olds ($M = 54.14$ months, $SD = 3.63$; $F(1,90) = 0.091$, $p = 0.76$), but there was a trend for mid-SES 5-year-olds ($M = 63.95$ months, $SD = 2.73$) to be older than low-SES 5-year-olds ($M = 62.72$ months, $SD = 2.23$; $F(1,71) = 3.92$, $p = 0.052$).

2.2. Materials

The Quick Interactive Language Screener (QUILS) was constructed based on the research in language acquisition and its constructs were drawn from those measured empirically. Twelve subtests across three language components assess specific language constructs (Table 4). This instrument can be used by non-language specialists and is quick to administer, averaging 15 min for a full screening of the language comprehension of children 3 through 5 years. The QUILS was designed to be a dialect-neutral test, avoiding words or linguistic structures that might

Table 4
Subtests of the vocabulary product, syntax product, and language-learning process components of the QUILS.

Vocabulary product	Syntax product	Language-learning process
Nouns	WH-questions	Noun learning
Verbs	Past tense	Adjective learning
Prepositions	Prepositional phrases	Verb learning
Conjunctions	Embedded clauses	Converting active to passive

be biased against speakers of particular dialects. For example, morphology that is optional in African-American English grammar, such as 3rd person/s/, plural/s/, and present copula, was avoided. Some subtests required only illustration, while others required animation, based on prior research indicating that young children have difficulty interpreting pictorially represented action events (Cocking & McHale, 1981; Friedman & Stevenson, 1975). The voiceovers for all test items were recorded by a male with a regionally neutral American accent.

The Vocabulary Product component measures children's knowledge of two classes of words: open-class words (Nouns, Verbs), which refer to semantically meaningful content and to which new members are constantly being added, and closed-class words (Prepositions, Conjunctions), which perform grammatical operations and modulate the meaning of sentences. For example, an item from the Verbs subtest asks children, "Who is unlocking something?" while presenting pictures of three distinct actions: a girl inserting a key in a lock (target), a boy splashing water (foil), and a man stirring soup (foil) (Fig. 1).

The Syntax Product component assesses children's knowledge of different syntactic structures, including sentences referring to past actions and locations, sentences with multiple modifiers including prepositional phrases and adjectives, sentences with embedded clauses, and wh-questions. For example, an item from the Embedded Clauses subtest began by presenting the following scenario with corresponding animation: "Grandma asked Grandpa where Mia was and Grandpa said that Mia was getting mail from the mailbox. But look! Mia is playing in the pool instead." The audio then asks children, "Where did Grandpa tell Grandma that Mia was?" and presents four pictured location options: pool (foil), mailbox (target), garden (foil), and stairs (foil) (Fig. 2).

Unlike many current assessments, the QUILS also includes a language-learning process component that evaluates *how* children learn new words and generalize syntactic structures to newly learned words. These measures are derived from methods used to examine language learning in the research literature (Carey & Bartlett, 1978; Gertner & Fisher, 2012; Golinkoff, Jacquet, & Nandakumar, 1996; Landau, Smith, & Jones, 1988; Johnson & de Villiers, 2009). Specifically, the Noun Learning subtest evaluates children's skill at fast mapping and extending novel nouns to novel whole objects; the Adjective Learning subtest assesses children's skill at fast mapping and extending novel adjectives to novel properties of familiar objects; the Verb Learning subtest examines children's ability to infer the meaning of a novel verb from the syntax of a sentence and extend the verb to a novel exemplar of the action (i.e., syntactic bootstrapping); and the Converting Active to Passive subtest assesses children's skill at recognizing that novel verbs can be converted from one grammatical structure (i.e., active voice) to another (i.e., passive voice).

In an item from the Verb Learning subtest, for example, children view an animated scene in which a girl is performing a novel action with a basket, and a boy next to her is performing a novel movement (without an object). Children hear the following audio with this scene, "Look! Someone is 'praving' something! Hey! Someone is 'praving' something!" Then children are asked, "Can you find another one? Find 'someone is praving something'." The answer

Fig. 1. Sample test item from the Verbs subtest of the Vocabulary Product component. Children hear, "Who is unlocking something?".

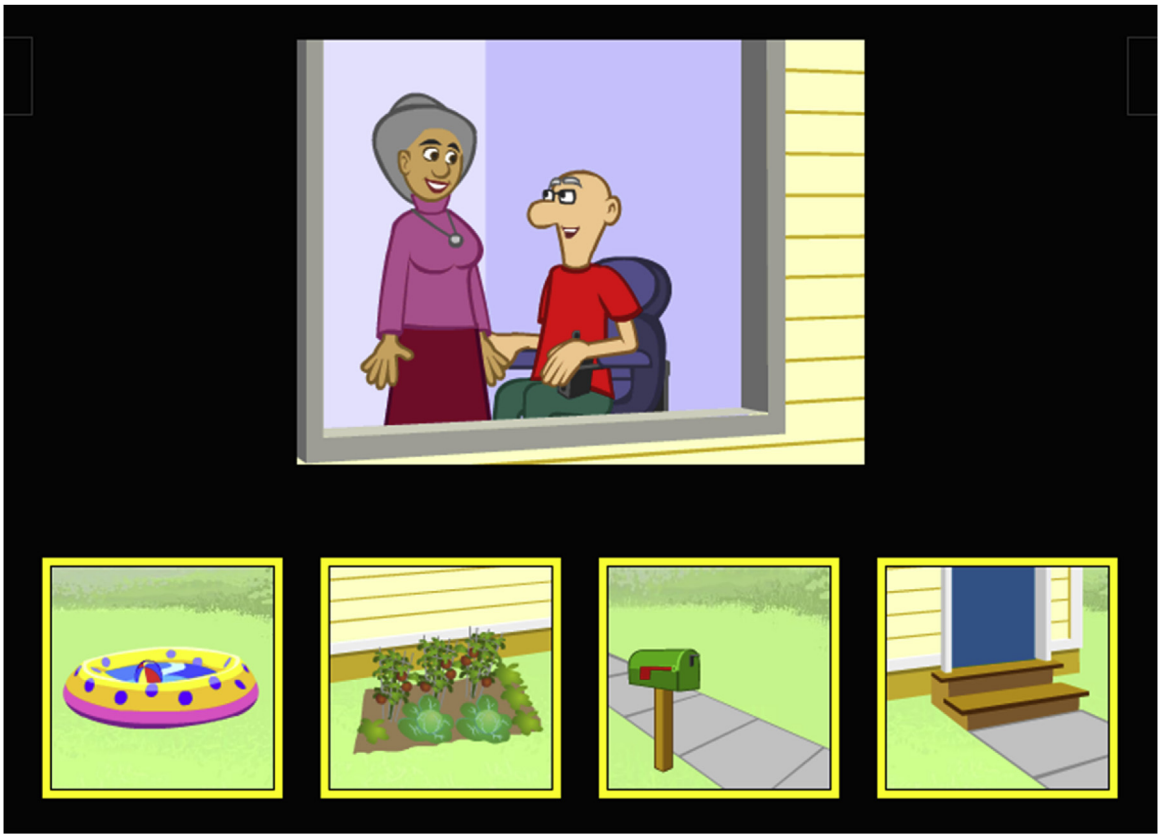

Fig. 2. Sample test item from the Embedded Clauses subtest of the Syntax Product component. First, children view an animation and hear the following: "Grandma asked Grandpa where Mia was and Grandpa said that Mia was getting mail from the mailbox. But look! Mia is playing in the pool instead." Then, children view the static demonstration presented in this figure and hear, "Where did Grandpa tell Grandma that Mia was?".

choices depicted include the same girl performing a different action with the basket (foil), a different girl performing the 'praving' action with a different object (target), and a different boy performing the same movement as the one enacted by the boy in the original scene (foil) (Fig. 3). For this item, children need to infer from the transitive syntax of the original sentence that the word 'praving' refers to the novel object-directed action of the girl rather than the novel movement of the boy, and need to extend this transitive verb to a novel exemplar of the object-directed action.

Across the Process subtests, novel words are used that: (a) have been used in previous research on fast mapping (Janse & Newman, 2013); (b) do not rhyme with any of the other words (within or across trials); (c) conform to the phonotactics of English (e.g., "merf" but not "chlurd" in English); and (d) begin with different phonemes compared to the foils in an item. Also across the Process subtests, the inclusion of familiar objects and known words is based on words known by most children by 30 months of age based on the CDI CLEX (Cross Linguistic Lexical Norm, Dale & Fenson, 1996).

The QUILS begins with three training items that provide familiarization with the touch screen computer and with the general format of the assessment. The test then commences with children viewing items one by one. After an item and its audio are presented, children respond to the question by touching one of the options on the screen. The software is configured so that children cannot respond until the audio is finished. A yellow border surrounds each option and when an option is selected, the border turns red, advancing the test to the next item. If a child does not select an option for 20 s following the completion of the auditory

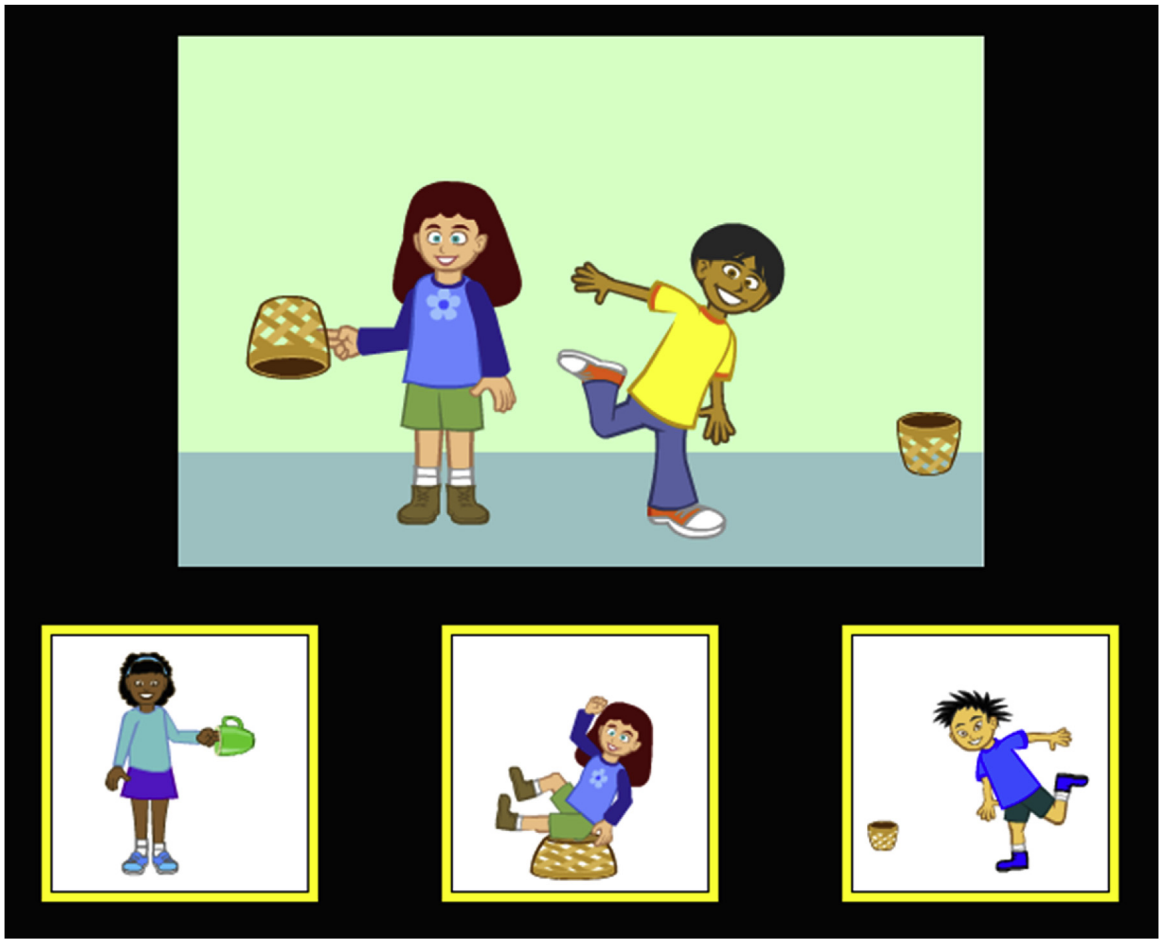

Fig. 3. Sample test item from the Verb Learning subtest of the Process component. First, children hear, "Look! Someone is 'praving' something! Hey! Someone is 'praving' something!" while viewing an animation of a girl performing a novel action with a basket and a boy performing a novel movement without an object. Then, children view the static demonstration presented in this figure and are asked, "Can you find another one? Find 'someone is praving something'.".

prompt, the prompt is repeated. If a child fails to select a response after an additional 15 s, the test advances to the next item. The test automatically moves through subtests and children view short, fun animated scenes throughout the assessment as a break from the tasks.

The standardization sample for the QUILS included 674 children from preschools and Head Start programs in Delaware, Pennsylvania, Massachusetts, Florida, and Nebraska. The QUILS has a high internal consistency reliability, with Cronbach's alpha coefficient of 0.93; Syntax Product and Vocabulary Product components each have reliability values of 0.79; and Process has a reliability of 0.87. Convergent validity was evaluated using the Preschool Language Scale 5th Edition, Auditory Comprehension subtest (PLS-5:AC; Zimmerman, Steiner, & Pond, 2011) and the Peabody Picture Vocabulary Test 4th Edition, Form A (PPVT-4; Dunn, Dunn, & Pearson Assessments, 2007), administered within two weeks of the initial QUILS test date for a subset of the standardization sample ($N = 112$ for PLS-5, $N = 116$ for PPVT-4). Overall QUILS scores correlate moderately with the PLS-5:AC ($r = 0.65$, $p < 0.001$), and with the PPVT-4 ($r = 0.67$, $p < 0.001$). Steiger's Z-test (Steiger, 1980) was utilized to determine whether the PPVT-4, a measure of vocabulary, correlated more strongly with the QUILS Vocabulary Product than with the other two QUILS components. The correlation between the PPVT-4 and the QUILS Vocabulary Product ($r = 0.67$) was significantly higher than the correlation between the PPVT-4 and the QUILS Syntax Product ($r = 0.54$; $Z = 2.06$, $p < 0.05$, one-tailed) and higher than the correlation between the PPVT-4 and QUILS Process ($r = 0.58$; $Z = 1.66$, $p < 0.05$, one-tailed), providing further evidence of convergent validity. In contrast, the PLS-5:AC is a measure of overall receptive language, and the correlation between this measure and QUILS Vocabulary Product ($r = 0.59$) was not significantly different from the correlation between this measure and QUILS Syntax Product ($r = 0.54$; $Z = 0.79$, *ns*) or QUILS Process ($r = 0.62$; $Z = 1.23$, *ns*), nor was the correlation between PLS-5:AC and QUILS Syntax Product different from the correlation between PLS-5:AC and QUILS Process ($Z = 1.18$, *ns*). Test-retest reliability was evaluated using a third subset of the standardization sample ($N = 75$), who were tested on QUILS on a second occasion 3- to 6-weeks after the initial test. The test-retest reliability coefficient for the overall QUILS scores is 0.83, and coefficients for the three language components range from 0.69 to 0.73, indicating reasonable stability across short time periods.

Normative scores were developed for each of the three QUILS components, for children in each of three age groups (Golinkoff et al., 2017). For Vocabulary, the average raw score (i.e., with a standard score of 100) for a 3-year-old is 37.5%, for a 4-year-old is 62.5%, and for a 5-year-old is 71.9%. For syntax, the average score for a 3-year-old is 37.5%, for a 4-year-old is 56.3%, and for a 5-year-old is 68.8%. For process, the average score for a 3-year-old is 25.0%, for a 4-year-old is 56.3%, and for a 5-year-old is 68.8%.

2.3. Procedure

Each child was tested individually in the child's school, seated at a table with a touchscreen monitor within reach (see Fig. 4 for

Fig. 4. Sample setup of QUILS administration.

sample setup). Test administrators had a minimum of a Bachelor's degree, and included lab coordinators, graduate students, and postdoctoral fellows. All test administrators participated in training sessions and communicated across sites to ensure that the QUILS was implemented uniformly in accordance with the user's manual (Golinkoff et al., 2017). The administrator of the test, sitting beside the child, asked the child to practice touching the screen prior to beginning the assessment, to ensure she knew the appropriate way to touch the screen such that responses would be properly registered. Once the training items began, the administrator did not provide any feedback; if the child asked the administrator questions about a test item or failed to select a response, the administrator provided encouragement to continue playing and take her best guess.

2.4. Coding

For the fast mapping nouns and fast mapping adjectives subtests, each test item contained two trials (i.e., fast mapping and extension), and children needed to answer both trials correctly to receive credit for the item. For the 10 other subtests, items contained a single trial. The percent of items answered correctly was determined for vocabulary product, syntax product, and language-learning process.

Preliminary analyses indicated no effect of gender on children's scores in any of the three language components of QUILS, and no interactions between gender and age or SES. The data were therefore collapsed across this variable for all analyses.

3. Results

3.1. Research question 1: Are there SES differences in children's vocabulary product, syntax product, and language-learning process scores?

The first question, whether there are SES differences in children's vocabulary product, syntax product, and language-learning process scores, was assessed in a 5 (SES) × 3 (language component) repeated measures analysis of covariance (ANCOVA), with age included as a covariate to control for variance attributable to age (see Fig. 5).

The ANCOVA revealed a significant covariate effect of age on QUILS scores ($F(1,252) = 160.16$, $p < 0.0001$, $\eta_p^2 = 0.39$) and a significant main effect of language component ($F(2,504) = 7.81$, $p < 0.0001$, $\eta_p^2 = 0.03$), with children performing better on Vocabulary Product ($M = 59.69\%$, $SE = 1.23$) than both Syntax Product ($M = 53.34\%$, $SE = 1.36$) and Process ($M = 51.82\%$, $SE = 1.67$) according to post-hoc comparisons ($ps < 0.001$; Fig. 5). The main effect of SES was also significant ($F(4,252) = 27.27$, $p < 0.0001$, $\eta_p^2 = 0.30$; Fig. 5). Post-hoc pairwise comparisons revealed that children whose primary caregivers had less than a high school diploma had lower QUILS scores ($M = 37.78\%$, $SE = 3.98$) than all other SES levels (all $ps < 0.05$). Additionally, children whose primary caregivers had earned a high school diploma had QUILS scores ($M = 50.85\%$, $SE = 2.06$) that were not significantly different from the scores of children whose primary caregivers had trade school education or an Associate's degree ($M = 50.18\%$, $SE = 2.90$; $p = 0.85$), but these two SES groups' scores were significantly lower than the scores of children whose primary caregivers had earned a Bachelor's degree ($M = 64.74\%$, $SE = 2.27$; $ps < 0.001$) or graduate degree ($M = 71.21\%$, $SE = 1.71$; $ps < 0.001$). Finally, the QUILS scores of children whose primary caregivers had earned a Bachelor's degree were significantly lower than the scores of children whose primary caregivers had earned a graduate degree ($p < 0.05$). The interaction between SES and language component was not significant ($F(8,504) = 1.61$, $p = 0.12$, $\eta_p^2 = 0.02$).

Effect sizes in Hedges' g (i.e., unbiased estimates of the mean difference in standard deviation units) were computed to assess the magnitude of the difference between the two lowest SES groups and the highest SES group for each language component. The difference in QUILS performance between children whose primary caregivers had a high school diploma and children whose primary caregivers had a graduate degree was large for Vocabulary Product (Hedges $g = 1.16$, 95% CI [0.82, 1.50]), Syntax Product (Hedges $g = 1.09$, 95% CI [0.75, 1.43]), and Process (Hedges $g = 0.95$, 95% CI [0.62, 1.29]). In comparison, the difference between children whose primary caregivers had less than a high school diploma and children whose primary caregivers had a graduate degree was approximately 1.5 times greater, for Vocabulary Product (Hedges $g = 2.07$, 95% CI [1.48, 2.65]), Syntax Product (Hedges $g = 1.75$, 95% CI [1.19, 2.32]), and Process (Hedges $g = 1.47$, 95% CI [0.92, 2.03]).

3.2. Research question 2: do SES differences in children's vocabulary product, syntax product, and language-learning process scores vary by age?

The second question, whether SES differences in children's vocabulary product, syntax product, and language-learning process scores vary by age, was assessed in a 3 (age) × 2 (SES) × 3 (language component) repeated measures analysis of variance (see Fig. 6).

There was a significant main effect of age ($F(2,252) = 79.18$, $p < 0.0001$, $\eta_p^2 = 0.39$), with 4-year-olds performing better on QUILS ($M = 65.43\%$, $SE = 1.74$) than 3-year-olds ($M = 41.63\%$, $SE = 1.74$), and 5-year-olds performing better ($M = 72.80\%$, $SE = 2.04$) than 4-year-olds, according to post-hoc pairwise comparisons ($ps < 0.01$; Fig. 6). Additionally, there was a main effect of language component ($F(2,504) = 29.31$, $p < 0.0001$, $\eta_p^2 = 0.10$), with children performing better on Vocabulary Product ($M = 64.94\%$, $SE = 1.10$) than both Syntax Product ($M = 58.14\%$, $SE = 1.18$) and Process ($M = 56.79\%$, $SE = 1.46$) according to post-hoc comparisons ($ps < 0.001$; Fig. 6). A significant interaction of age and language component ($F(4,504) = 2.89$, $p < 0.05$, $\eta_p^2 = 0.02$) was also produced. Post-hoc contrasts were conducted to determine whether the difference between children's language products and language process varied by age. The difference between language product (combining both vocabulary and syntax) and language process scores at age 5 was significantly smaller than the difference at age 3 ($t(255) = 2.53$, $p = 0.01$), while the difference at age 4 was not dissimilar from the difference at age 3 ($t(255) = 1.60$, ns) or age 5 ($t(255) = 1.03$, ns).

The main effect of SES was significant ($F(1,252) = 86.64$, $p < 0.0001$, $\eta_p^2 = 0.26$), with mid-SES children performing significantly better ($M = 69.92\%$, $SE = 1.40$) than low-SES children ($M = 49.99\%$, $SE = 1.62$; Fig. 6). However, there was no significant

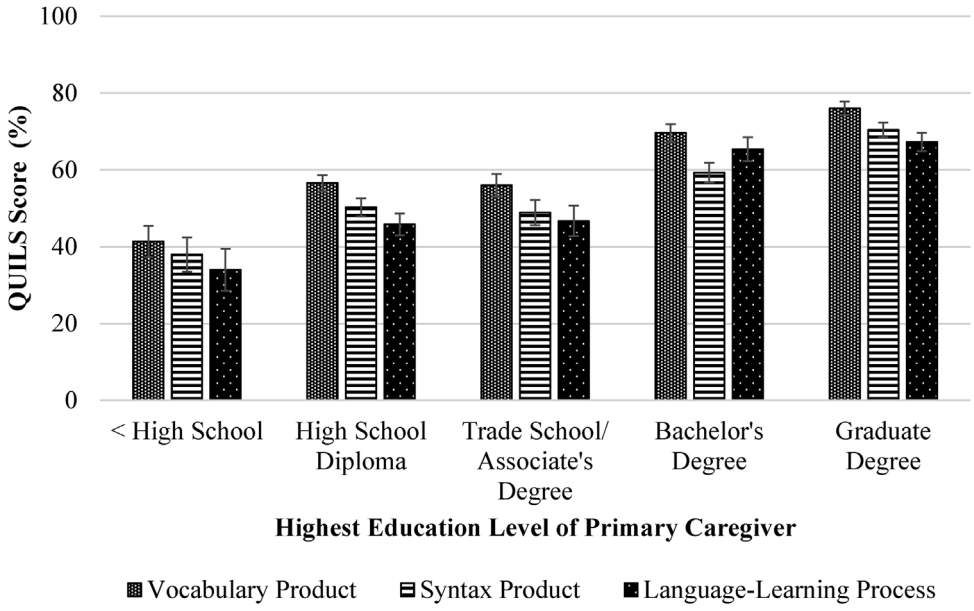

Fig. 5. Repeated measures analysis of covariance: effects of SES on QUILS vocabulary product, syntax product, and language-learning process scores.

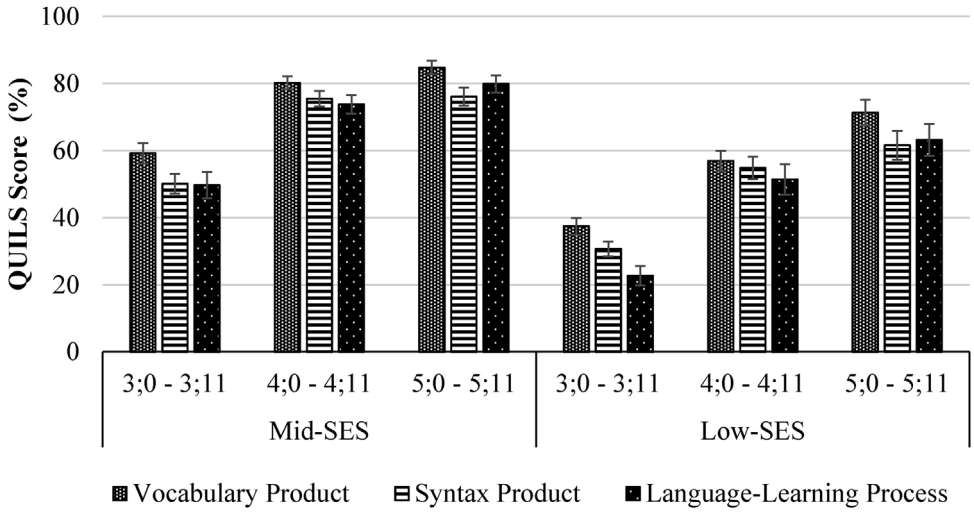

Fig. 6. Repeated measures analysis of variance: effects of SES and age on QUILS vocabulary product, syntax product, and language-learning process scores.

interaction between SES and age ($F(2,252) = 1.26$, $p = 0.29$, $\eta_p^2 = 0.01$) or between SES and language component ($F(2,504) = 1.47$, $p = 0.23$, $\eta_p^2 = 0.01$), and no significant 3-way interaction ($F(4,504) = 0.56$, $p = 0.69$, $\eta_p^2 < 0.01$).

The magnitude of the SES gap was quantified in two ways for each language component. First, effect size was calculated using Hedges g for Vocabulary Product (Hedges $g = 1.06$, 95% CI [0.80, 1.33]), Syntax Product (Hedges $g = 0.93$, 95% CI [0.67, 1.19]), and Process (Hedges $g = 0.94$, 95% CI [0.68, 1.20]). Second, the SES gap in years was estimated by comparing the QUILS component scores of low-SES 5-year-olds to the component scores of mid-SES children from the three age groups. On the Vocabulary product component, low-SES 5-year-olds' scores ($M = 71.30\%$, $SE = 3.85$) fell between the scores of mid-SES 3-year-olds ($M = 59.18\%$, $SE = 3.05$) and 4-year-olds ($M = 80.17\%$, $SE = 1.94$). On Syntax Product, low-SES 5-year-olds' scores ($M = 61.57\%$, $SE = 4.29$) also fell between the scores of mid-SES 3-year-olds ($M = 50.13\%$, $SE = 2.91$) and 4-year-olds ($M = 75.48\%$, $SE = 2.32$). Similarly, on Process, low-SES 5-year-olds' scores ($M = 63.19\%$, $SE = 4.73$) fell between the scores of mid-SES 3-year-olds ($M = 49.73\%$, $SE = 3.89$) and 4-year-olds ($M = 73.80\%$, $SE = 2.75$). Therefore, on all three language components, low-SES 5-year-olds were approximately 1- to 2-years behind their mid-SES peers.

3.3. Research question 3: what is the relation between vocabulary products, syntax products, and language-learning processes for children from low- and mid-SES families?

The third question explores the association between acquired vocabulary products, acquired syntax products, and language-learning processes for children from low- and mid-SES families. Partial correlations controlling for age are presented in Table 5. All partial correlations were significant (all $ps < 0.001$). To compare the strength of the three correlations across the two SES groups, the Fisher r-to-z transformation was utilized. The correlation between Vocabulary Product and Syntax Product was not significantly different for children from low-SES families ($r = 0.57$) and children from mid-SES families ($r = 0.57$; $z = -0.03$, $p = 0.98$). The correlation between Vocabulary Product and Process scores was also not significantly different for children from low-SES families ($r = 0.66$) and

Table 5
Partial correlations between QUILS vocabulary product, syntax product, and language-learning process scores for low-SES and mid-SES children.

Group and variable	1	2	3
Low-SES			
1. Vocabulary product	–	0.57***	0.66***
2. Syntax product		–	0.69***
3. Process			–
Mid-SES			
1. Vocabulary product	–	0.57***	0.59***
2. Syntax product		–	0.51***
3. Process			–

Note: N = 145 for mid-SES group, and N = 113 for low-SES group. All correlations control for age in months.
*** $p < 0.001$.

children from mid-SES families ($r = 0.59$; $z = 1.01$, $p = 0.31$). However, the correlation between Syntax Product and Process scores was significantly stronger for low-SES children ($r = 0.69$) than mid-SES children ($r = 0.51$; $z = 2.24$, $p = 0.03$).

4. Discussion

Three key findings emerged in this research. First, preschoolers from lower SES families performed significantly worse than preschoolers from higher SES families on all three language components – vocabulary product, syntax product, and language-learning process. Children whose primary caregivers had less than a high school diploma had the lowest scores on all three components, followed by children whose primary caregivers had a high school diploma or trade school/Associate's degree, followed by children whose primary caregivers had earned a Bachelor's degree, followed by children whose primary caregivers had earned a graduate degree. The magnitude of the difference between the lowest and highest SES groups was approximately 1.5–2 standard deviations across the three language components. Second, SES differences, assessed across combined low- and mid-SES groups, were comparable for 3-, 4-, and 5-year-olds across the three language components. In all three language areas, low-SES children's language skills by age 5 were 1- to 2-years behind the skills of their mid-SES peers. Finally, robust links were revealed between these three language components for low- and mid-SES children. This research broadens our understanding of the SES gap in vocabulary, by revealing a similar gap not only in syntax but also in language-learning processes. Further, these findings hint that the interplay between vocabulary, syntax and process may contribute to the persistent SES gap in language development and to the resistance of this gap to vocabulary-focused interventions. If children are lacking in their syntactic knowledge or cannot quickly engage their language-learning process skills, they may miss out on learning new words.

Replicating prior research, this study demonstrated a wide and consistent SES gap in vocabulary and syntax using a new rapid language screener, the QUILS, tested with a large, diverse sample of 3-, 4-, and 5-year-olds. This study also extends the SES gap to the study of language-learning processes, revealing that low-SES children's skills at learning novel words are reduced relative to mid-SES children. This finding of a process gap comparable to vocabulary and syntax gaps was unexpected. Two prior studies demonstrated SES differences in vocabulary but not in the ability to fast map novel nouns (Burton & Watkins, 2007; Horton-Ikard & Weismer, 2007). However, those studies may have been limited by small sample sizes and non-standardized measures of fast mapping, particularly given that patterns of performance in those studies suggested the possibility of SES differences, albeit without statistical significance (Burton & Watkins, 2007; Horton-Ikard & Weismer, 2007). Moreover, this research provides a stronger test of SES differences in process skills by examining a variety of language-learning processes, including fast mapping adjectives and syntactic bootstrapping.

4.1. The SES gap in language-learning process skills

This finding of a SES gap in language-learning process skills aligns with findings of SES gaps in language processing efficiency (Fernald et al., 2013; Huang et al., 2017; Leech et al., 2017). Although the measures are distinct, both assess how known language is leveraged, rather than simply evaluating the extent of the language children know. Tests of processing efficiency measure how quickly children can process known language in speech (Fernald et al., 2013), while the QUILS assesses the ability to use known language to learn novel language. The wide reach of the SES gap, impacting vocabulary sophistication, knowledge of syntactic constructions, language processing efficiency, and language-learning processes suggests that no aspect of language development is spared from the effects of SES.

Beyond the widespread SES gaps in various aspects of language development, we found robust correlations between these components. Associations between vocabulary and syntax were expected based on prior research (e.g., Dale, 1991; Huttenlocher et al., 2010), though this study is the first to demonstrate that these links are comparable for low-SES and mid-SES children. Moreover, correlations between language-learning process and vocabulary and syntax products were robust for children from mid-SES and low-SES backgrounds, and the correlation between process skills and syntax knowledge was even stronger for low-SES children than their mid-SES peers. Previous work indicated correlations between vocabulary knowledge and fast mapping skills for mid-SES children (Bion et al., 2013; Gray, 2004; Wilkinson & Mazzitelli, 2003, but see Gray, 2006), but the only study examining this relation within low-SES children failed to find a significant correlation (Spencer & Schuele, 2012). We had hypothesized that the correlation between language products and language process might be lower for low-SES children, due to their limited opportunities and the absence of language-rich environments to make use of their process skills to acquire language products. However, the SES gap in process and the high correlations between product and process together suggest that low-SES children's process skills may actually be constrained by their limited language products, particularly their knowledge of syntax. That is, SES differences in process may be a byproduct of disparities in language products.

4.2. Magnitude of SES differences in language product and process

While the SES differences found in this study were largely consistent with prior research, the magnitude of the gap across all three language components was stark in comparison with prior estimates. The 5-year-olds from low-SES backgrounds were 1–2 years behind their mid-SES peers on vocabulary, syntax, and language-learning process skills. Fernald et al. (2013) found that low-SES 24-month-olds were only 6 months behind their higher-SES peers in terms of vocabulary knowledge, and Vasilyeva et al. (2008) found that low-SES 42-month-olds were 8 months behind in their production of complex syntax. More comparable to the magnitude of SES gaps in this study is the finding that 3- through 5-year-old children from low-income backgrounds were over a year behind mid-SES-based norms on a measure of syntax production (Snow, 1999). Together, these findings suggest that the SES gap in language may widen substantially in the window between 24 months and age 3 through 5, though future research is needed to confirm this possibility.

The magnitude of the SES gap is especially concerning for the group of children from the lowest SES background, whose primary caregivers did not graduate high school. These children performed 1.5–2 standard deviations lower on the three language components than children from the highest SES group, comprised of children whose primary caregivers had earned a graduate degree. By comparison, the second lowest SES group, comprised of children whose primary caregivers had a high school diploma, were approximately 1 standard deviation away from the highest SES group. Most prior research of SES differences in vocabulary and syntax has led to estimates just under 1 standard deviation, though those studies tended to focus on younger children and children with less dissimilar SES backgrounds (e.g., Arriaga et al., 1998; Fernald et al., 2013; Huttenlocher et al., 2002). The comparisons between the highest and lowest SES groups in this study reveal troubling disparities at a level not previously documented.

4.3. Implications of these findings for practice, policy, and research

These findings have implications for practice, in terms of the language experiences that children need from caregivers and teachers to ameliorate SES differences in vocabulary, syntax, and language-learning process skills. While prior research on SES differences in language development has predominantly focused on gaps in vocabulary, we found large SES differences for children's vocabulary, syntax, and language-learning processes and, based on prior research, much of these differences can be attributed to differences in children's language experiences with caregivers (Hart & Risley, 1995; Hoff, 2003; Huttenlocher et al., 2010; Romeo et al., 2018; but see Sperry, Sperry, & Miller, 2018). What is it about these experiences that differs by SES and that is so critical for building children's language systems? Differences in the quality and quantity of language experiences, which exist both within SES groups and across these groups, are what seem to make a critical impact on children's developing language abilities (Cartmill et al., 2013; Golinkoff, Hoff, Rowe, Tamis-LeMonda, & Hirsh-Pasek, 2018; Hirsh-Pasek et al., 2015; Hoff, 2003; Huttenlocher et al., 2002, 2010; Pan, Rowe, Singer, & Snow, 2005; Rindermann & Baumeister, 2015; Romeo et al., 2018; Rowe, 2008, 2012; Weisleder & Fernald, 2013). In particular, the fluency and connectedness of communicative interactions, or the extent to which children experience back-and-forth exchanges in which the caregiver and child are equally active, is a strong predictor of language outcomes above and beyond quantity of speech (Hirsh-Pasek et al., 2015), and conversational turn-taking mediates the relation between parental education and language skill in children ages 4–6 (Romeo et al., 2018). Additionally, the diversity and complexity of vocabulary and syntax within communicative exchanges is a strong predictor of children's language products (Hurtado, Marchman, & Fernald, 2008; Huttenlocher et al., 2002, 2010; Pan et al., 2005; Rowe, 2008, 2012) that also mediates the relation between family SES and language outcomes (Hoff, 2003; Huttenlocher et al., 2010). Reanalysis of Hart and Risley's (1995) data also indicated that the proximal factor of parental behavior, including responsiveness and diversity of language, had a larger effect on children's vocabulary knowledge at age 3 than the more distal factor of SES (Rindermann & Baumeister, 2015). Further, these same characteristics of the input seem to support children's developing language processing efficiency (Hurtado et al., 2008; Weisleder & Fernald, 2013) and process skills such as syntactic bootstrapping (Naigles & Hoff-Ginsberg, 1998) and fast mapping (Cartmill et al., 2013). In sum, children's language systems must be nurtured through exposure to diverse language in the context of high quality back-and-forth interactions. Caregiver education regarding child development, and particularly regarding these key principles of child-directed communicative interactions, has the potential to transform children's language experiences (Rowe, 2008) and, in turn, to mitigate SES differences in children's language skills and school readiness.

Policy implications follow from this research as well, in terms of both *when* and *how* language interventions aimed at addressing the SES gap in language development should be implemented to maximize the efficacy of these programs. First, SES gaps in vocabulary, syntax, and process are present by age 3. Yet most interventions aim, mostly unsuccessfully, to mitigate the SES gap in language by targeting children between the ages of 4 and 6 (Marulis & Neuman, 2013). Language interventions may be more effective if they focus on younger children, prior to the stabilization of these gaps. Second, sparking adult-child conversation that is characterized by fluency and connectedness and that incorporates diverse vocabulary and syntax is essential in early childhood classrooms, where many teachers, particularly in low-SES neighborhoods, lack the training necessary to engage children in back-and-forth interactions infused with language. Meta-analyses of vocabulary interventions indicate that interventions are more effective when they go beyond mere exposure to words in book reading and actually incorporate novel words in discussion (Marulis & Neuman, 2010, 2013). Additionally, a longitudinal study of children's language experiences in preschool classrooms found that the quality and quantity of preschool teachers' language use predicted 4th grade reading comprehension, and this link was mediated by children's language skills in kindergarten (Dickinson & Porche, 2011). Teachers of early childhood programs have a crucial role to play, and better professional development around language learning is needed (Alper, Masek, Hirsh-Pasek, & Golinkoff, 2018) to enhance these programs with language-rich activities.

Finally, this study has implications for the use of more comprehensive language assessments in research and practice. The QUILS is a useful tool for answering basic research questions, such as the questions about SES differences addressed here, and questions that address how children with typical and atypical language product scores use process skills such as fast mapping to learn new words (Aravind et al., 2018). More broadly, the QUILS provides advantages to researchers and practitioners over other language measures that typically have an exclusive focus on vocabulary (e.g., the PPVT), providing limited information about language skill while still demanding extensive time and a skilled examiner for test administration. This is a problem for a wide range of research studies on child development that rely on vocabulary-only tests as indicators of language ability. The use of these existing measures also limits the capacity to screen children who may need targeted language intervention and to evaluate the efficacy of those interventions. The QUILS fills these gaps by integrating language acquisition theory and research into an assessment that provides a more informative profile of children's vocabulary and syntax knowledge and language-learning processes.

4.4. Limitations of these data

There are a number of limitations in our endeavor to evaluate SES differences in the developing language systems of preschoolers. First, the measure of language-learning process by necessity assumes some knowledge of vocabulary and syntax; this measure is therefore not knowledge-independent as might be desired in a pure measure of process. Efforts were made to ensure that the vocabulary that was incorporated into the process measure (e.g., *boy*, *table*) was largely known by 30 months based on established norms of children's early language development, in contrast to the sophisticated vocabulary assessed in the vocabulary product component of the QUILS (e.g., *doorknob*,

unlocking). However, our findings of SES differences in language-learning process skills assessed in the context of familiar words align with the findings of Fernald et al. (2013), which showed SES differences in children's processing efficiency for familiar words.

A second and related limitation is the limited validity data available for QUILS. While QUILS correlated with two standardized language measures, the PLS-5 and PPVT-4, the strength of the QUILS is that it assesses three distinct language dimensions. These language components are distinguished by the strength of the correlation between the PPVT (i.e., a vocabulary measure) and the Vocabulary Product component of QUILS relative to the correlation between the PPVT and the other two QUILS components. However, the limited availability or absence of standardized syntax and language-learning process measures precluded additional validity checks. Future validation of the distinctness of the three QUILS components would provide further support for the findings of SES differences in all three language areas. Moreover, a ripe avenue for future research is to explore specific strengths and weaknesses of individual children across the three language components, to create more targeted language interventions.

A third limitation is the confound of SES and race. SES in this study, as in many studies and in the Unites States more broadly, is unfortunately confounded with race, and it was not possible to tease apart these effects. However, SES differences in QUILS performance were found even when comparing the three lowest SES groups (i.e., primary caregiver education of less than high school, high school diploma, and Trade School/Associate's degree), which did not differ by race, and when comparing the two highest SES groups (i.e., Bachelor's degree and Graduate degree), which also did not differ by race. While this provides a hint that the SES differences in this study cannot be explained by race, the racial differences between the lower and higher SES groups in this sample necessitate caution in interpretation of these findings. Future research with more diverse samples, including more non-Hispanic Caucasian children from low-SES backgrounds and more African American and Hispanic children from mid-SES backgrounds would help to isolate the effects of SES on children's language development.

Another limitation of this sample is the age difference between the low- and mid-SES children. Specifically, low-SES 5-year-olds were approximately 1 month younger, on average, than mid-SES 5-year-olds, though this trend did not reach statistical significance. While this difference may have slightly exaggerated the SES disparities at age 5, low-SES 5-year-olds performed at levels between mid-SES 3- and 4-year-olds, suggesting that the 1 month gap in age did not have a substantial effect on the findings in this study.

A final and key limitation of the present findings is the use of cross-sectional, correlational methods rather than longitudinal or experimental designs. While this method enabled us to assess a large, diverse sample and to address questions about SES disparities in language components, it does not address questions about how SES differences in these language components change across development, nor does it address questions about how vocabulary, syntax, and language-learning process components may be causally related to one another. For example, it would be useful to know whether language-learning process skills are acquired over time as a function of learned vocabulary and syntax, or whether interventions aimed at boosting low-SES children's language-learning process skills could lead to improvements in children's language products. Future work is needed to examine these possibilities, to better inform intervention efforts that address the child's language system as a whole in the context of the child's unique language environment.

5. Conclusions

The wide and persistent SES gap in language development demands evidence-informed action. Academic standards are middle-SES academic standards, to which children from low-SES families are expected to conform despite substantial gaps in the very language skills which predict academic outcomes (Pace et al., 2017). The findings of this research indicate that children from low-SES families are limited by their knowledge of vocabulary and syntax and by their language-learning process skills by age 3 relative to their higher-SES peers. Interventions that consider the language system as a whole will likely be better equipped to mitigate these SES disparities in language skills and in the later academic outcomes which depend heavily on these early skills.

Acknowledgements

This research was supported by the Institute of Education Sciences [R305A110284, R324A160241]. We are grateful to the children who participated in this research and their parents, as well as the schools that facilitated data collection.

References

Alper, R. M., Masek, L. R., Hirsh-Pasek, K., & Golinkoff, R. (2018). Languagizing the early childhood classroom: Supporting children's language development. In C. T. Adger, C. E. Snow, & D. Christian (Eds.), *What teachers need to know about language*. Bristol, UK: Multilingual Matters.

Aravind, A., de Villiers, J., Pace, A., Valentine, H., Golinkoff, R., Hirsh-Pasek, K., . . . & Wilson, M. S. (2018). Fast mapping word meanings across trials: Young children forget all but their first guess. *Cognition*, *177*, 177–188.

Arriaga, R. I., Fenson, L., Cronan, T., & Pethick, S. J. (1998). Scores on the MacArthur Communicative Development Inventory of children from low- and middle-income families. *Applied Psycholinguistics*, *19*(2), 209–223.

Balladares, J., Marshall, C., & Griffiths, Y. (2016). Socio-economic status affects sentence repetition, but not non-word repetition, in Chilean preschoolers. *First Language*, *36*(3), 338–351.

Bates, E., & Goodman, J. (1997). On the inseparability of grammar and lexicon: Evidence from acquisition, aphasia, real time processing. *Language and Cognitive Processes*, *12*, 507–587.

Baydar, N., & Akcinar, B. (2015). Ramifications of socioeconomic differences for three year old children and their families in Turkey. *Early Childhood Research Quarterly*, *33*, 33–48.

Becker, B. (2011). Social disparities in children's vocabulary in early childhood. Does pre-school education help to close the gap? *The British Journal of Sociology*, *62*(1), 69–88.

Berglund, E. V. A., Eriksson, M., & Westerlund, M. (2005). Communicative skills in relation to gender, birth order, childcare and socioeconomic status in 18-month-old children. *Scandinavian Journal of Psychology*, *46*(6), 485–491.

Bion, R. A., Borovsky, A., & Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word–object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition*, *126*(1), 39–53.

Burton, V. J., & Watkins, R. V. (2007). Measuring word learning: Dynamic versus static assessment of kindergarten vocabulary. *Journal of Communication Disorders*, *40*(5), 335–356.

Campbell, T., Dollaghan, C., Needleman, H., & Janosky, J. (1997). Reducing bias in language assessment: Processing-dependent measures. *Journal of Speech, Language, and Hearing Research*, *40*(3), 519–525.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Proceedings of the Stanford Child Language Conference*, *15*, 17–29.

Cartmill, E. A., Armstrong, B. F., Gleitman, L. R., Goldin-Meadow, S., Medina, T. N., & Trueswell, J. C. (2013). Quality of early parent input predicts child vocabulary 3 years later. *Proceedings of the National Academy of Sciences*, *110*(28), 11278–11283.

Caselli, C., Casadio, P., & Bates, E. (1999). A comparison of the transition from first words to grammar in English and Italian. *Journal of Child Language*, *26*(1), 69–111.

Catts, H. W., Fey, M. E., Tomblin, J. B., & Zhang, X. (2002). A longitudinal investigation of reading outcomes in children with language impairments. *Journal of Speech, Language, and Hearing Research*, *45*(6), 1142–1157.

Cocking, R. R., & McHale, S. (1981). A comparative study of the use of pictures and objects in assessing children's receptive and productive language. *Journal of Child Language*, *8*(1), 1–13.

Coddington, C. H., Mistry, R. S., & Bailey, A. L. (2014). Socioeconomic status and receptive vocabulary development: Replication of the parental investment model with Chilean preschoolers and their families. *Early Childhood Research Quarterly*, *29*(4), 538–549.

Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavior Research Methods, Instruments & Computers*, *28*(1), 125–127.

Dale, P. S. (1991). The validity of a parent report measure of vocabulary and syntax at 24 months. *Journal of Speech, Language, and Hearing Research*, *34*(3), 565–571.
Deanda, S., Arias-Trejo, N., Poulin-Dubois, D., Zesiger, P., & Friend, M. (2016). Minimal second language exposure, SES, and early word comprehension: New evidence from a direct assessment. *Bilingualism: Language and Cognition*, *19*(1), 162–180.
Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. *Child Development*, *82*(3), 870–886.
Dollaghan, C. A., Campbell, T. F., Paradise, J. L., Feldman, H. M., Janosky, J. E., Pitcairn, D. N., & Kurs-Lasky, M. (1999). Maternal education and measures of early speech and language. *Journal of Speech, Language, and Hearing Research*, *42*(6), 1432–1443.
Dunn, L. M., Dunn, D. M., & Pearson Assessments. (2007). *PPVT-4: Peabody picture vocabulary test*. Minneapolis, MN: Pearson Assessments.
Durand, V. N., Loe, I. M., Yeatman, J. D., & Feldman, H. M. (2013). Effects of early language, speech, and cognition on later reading: A mediation analysis. *Frontiers in Psychology*, *4*, 586.
Einarsdóttir, J. T., Björnsdóttir, A., & Símonardóttir, I. (2016). The predictive value of preschool language assessments on academic achievement: A 10-year longitudinal study of Icelandic children. *American Journal of Speech-Language Pathology*, *25*(1), 67–79.
Eriksson, M. (2017). The Swedish Communicative Development Inventory III: Parent reports on language in preschool children. *International Journal of Behavioral Development*, *41*(5), 647–654.
Farkas, G., & Beron, K. (2004). The detailed age trajectory of oral vocabulary knowledge: Differences by class and race. *Social Science Research*, *33*(3), 464–497.
Fernald, A., Marchman, V. A., & Weisleder, A. (2013). SES differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science*, *16*(2), 234–248.
Friedman, S. L., & Stevenson, M. B. (1975). Developmental changes in the understanding of implied motion in two-dimensional pictures. *Child Development*, 773–778.
Gertner, Y., & Fisher, C. (2012). Predicted errors in children's early sentence comprehension. *Cognition*, *124*(1), 85–94.
Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J. C. (2005). Hard words. *Language Learning and Development*, *1*(1), 23–64.
Golinkoff, R. M., Hirsh-Pasek, K., Bailey, L. M., & Wenger, N. R. (1992). Young children and adults use lexical principles to learn new nouns. *Developmental Psychology*, *28*(1), 99–108.
Golinkoff, R. M., Jacquet, R. C., Hirsh-Pasek, K., & Nandakumar, R. (1996). Lexical principles may underlie the learning of verbs. *Child Development*, *67*(6), 3101–3119.
Golinkoff, R. M., de Villiers, J., Hirsh-Pasek, K., Iglesias, A., & Wilson, M. S. (2017). *User's manual for the Quick Interactive Language Screener (QUILS™): A measure of vocabulary, syntax, and language acquisition skills in young children*. Baltimore, MD: Paul H. Brookes.
Golinkoff, R. M., Hoff, E., Rowe, M. L., Tamis-LeMonda, C. S., & Hirsh-Pasek, K. (2018). Language matters: Denying the existence of the 30-million-word gap has serious consequences. *Child Development*, https://doi.org/10.1111/cdev.13128
Gray, S. (2004). Word learning by preschoolers with specific language impairment: Predictors and poor learners. *Journal of Speech, Language, and Hearing Research*, *47*(5), 1117–1132.
Gray, S. (2006). The relationship between phonological memory, receptive vocabulary, and fast mapping in young children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *49*(5), 955–969.
Greenwood, C. R., Carta, J. J., Walker, D., Watson-Thompson, J., Gilkerson, J., Larson, A. L., & Schnitz, A. (2017). Conceptualizing a public health prevention intervention for bridging the 30 million word gap. *Clinical Child and Family Psychology Review*, *20*(1), 3–24.
Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H. Brookes.
Hindman, A. H., Wasik, B. A., & Snell, E. K. (2016). Closing the 30 million word gap: Next steps in designing research to inform practice. *Child Development Perspectives*, *10*(2), 134–139.
Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., Pace, A., . . . & Suma, K. (2015). The contribution of early communication quality to low-income children's language success. *Psychological Science*, *26*(7), 1071–1083.
Hoff, E., & Tian, C. (2005). Socioeconomic status and cultural influences on language. *Journal of Communication Disorders*, *38*(4), 271–278.
Hoff, E., Quinn, J. M., & Giguere, D. (2018). What explains the correlation between growth in vocabulary and grammar? New evidence from latent change score analyses of simultaneous bilingual development. *Developmental Science*, *21*(2)
Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development*, *74*(5), 1368–1378.
Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, *26*(1), 55–88.
Hoff, E. (2013). Interpreting the early language trajectories of children from low-SES and language minority homes: Implications for closing achievement gaps. *Developmental Psychology*, *49*(1), 4–14.
Hoff-Ginsberg, E. (1998). The relation of birth order and socioeconomic status to children's language experience and language development. *Applied Psycholinguistics*, *19*(4), 603–629.
Horton-Ikard, R., & Weismer, S. E. (2007). A preliminary examination of vocabulary and word learning in African American toddlers from middle and low socioeconomic status homes. *American Journal of Speech-Language Pathology*, *16*(4), 381–392.
Huang, Y. T., Leech, K., & Rowe, M. L. (2017). Exploring socioeconomic differences in syntactic development through the lens of real-time processing. *Cognition*, *159*, 61–75.
Hurtado, N., Marchman, V. A., & Fernald, A. (2008). Does input influence uptake? Links between maternal talk, processing speed and vocabulary size in Spanish-learning children. *Developmental Science*, *11*(6), F31–F39.
Huttenlocher, J., Vasilyeva, M., Cymerman, E., & Levine, S. (2002). Language input and child syntax. *Cognitive Psychology*, *45*(3), 337–374.
Huttenlocher, J., Vasilyeva, M., Waterfall, H. R., Vevea, J. L., & Hedges, L. V. (2007). The varieties of speech to young children. *Developmental Psychology*, *43*(5), 1062.
Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*(4), 343–365.
Jackson, S. C., & Roberts, J. E. (2001). Complex syntax production of African American preschoolers. *Journal of Speech, Language, and Hearing Research*, *44*(5), 1083–1096.
Janse, E., & Newman, R. S. (2013). Identifying nonwords: Effects of lexical neighborhoods, phonotactic probability, and listener characteristics. *Language and Speech*, *56*(4), 421–441.
Johnson, V. E., & de Villiers, J. G. (2009). Syntactic frames in fast mapping verbs: Effect of age, dialect, and clinical status. *Journal of Speech, Language, and Hearing Research*, *52*(3), 610–622.
Kedar, Y., Casasola, M., & Lust, B. (2006). Getting there faster: 18- and 24-month-old infants' use of function words to determine reference. *Child Development*, *77*(2), 325–338.
Laing, S. P., & Kamhi, A. (2003). Alternative assessment of language and literacy in culturally and linguistically diverse populations. *Language, Speech, and Hearing Services in Schools*, *34*(1), 44–55.
Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development*, *3*(3), 299–321.
Leech, K. A., Rowe, M. L., & Huang, Y. T. (2017). Variations in the recruitment of syntactic knowledge contribute to SES differences in syntactic development. *Journal of Child Language*, *44*(4), 995–1009.
Marchman, V. A., Martínez-Sussmann, C., & Dale, P. S. (2004). The language-specific nature of grammatical development: Evidence from bilingual language learners. *Developmental Science*, *7*(2), 212–224.
Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, *16*(1), 1–27.
Markman, E. M. (1989). *Categorization and naming in children: Problems of induction*. Cambridge, MA: MIT Press.
Marulis, L. M., & Neuman, S. B. (2010). The effects of vocabulary intervention on young children's word learning: A meta-analysis. *Review of Educational Research*, *80*(3), 300–335.
Marulis, L. M., & Neuman, S. B. (2013). How vocabulary interventions affect young children at risk: A meta-analytic review. *Journal of Research on Educational Effectiveness*, *6*(3), 223–262.
Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name–nameless category (N3C) principle. *Child Development*, *65*(6), 1646–1662.
Moyle, M. J., Weismer, S. E., Evans, J. L., & Lindstrom, M. J. (2007). Longitudinal relationships between lexical and grammatical development in typical and late-talking children. *Journal of Speech, Language, and Hearing Research*, *50*(2), 508–528.
NICHD Early Child Care Research Network. (2005). Pathways to reading: The role of oral language in the transition to reading. *Developmental Psychology*, *41*(2), 428–442.
Naigles, L. R., & Hoff-Ginsberg, E. (1998). Why are some verbs learned before other verbs? Effects of input frequency and structure on children's early verb use. *Journal of Child Language*, *25*(1), 95–120.
Naigles, L. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, *17*(2), 357–374.
Pace, A., Luo, R., Hirsh-Pasek, K., & Golinkoff, R. M. (2017). Identifying pathways between socioeconomic status and language development. *Annual Review of Linguistics*, *3*, 285–308.
Pan, B. A., Rowe, M. L., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development*, *76*(4), 763–782.
Rindermann, H., & Baumeister, A. E. (2015). Parents' SES vs. parental educational behavior and children's development: A reanalysis of the Hart and Risley study. *Learning and Individual Differences*, *37*, 133–138.
Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. (2018). Beyond the 30 million word gap: Children's conversational exposure is associated with language-related brain function. *Psychological Science*, *29*(5), 700–710.
Rowe, D. C., Jacobson, K. C., & Van den Oord, E. J. (1999). Genetic and environmental influences on vocabulary IQ: Parental education level as moderator. *Child Development*, *70*(5), 1151–1162.

Rowe, M. L., Raudenbush, S. W., & Goldin-Meadow, S. (2012). The pace of vocabulary growth helps predict later vocabulary skill. *Child Development*, *83*(2), 508–525.
Rowe, M. L. (2008). Child-directed speech: Relation to socioeconomic status, knowledge of child development and child vocabulary skill. *Journal of Child Language*, *35*(1), 185–205.
Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*(5), 1762–1774.
Scarborough, H. S. (1990). Very early language deficits in dyslexic children. *Child Development*, *61*(6), 1728–1743.
Schmidt, A., de Oliveira Franco, M. G., dos Santos Lotério, L., & Gomes, G. F. (2016). Learning name–object relations after a single exclusion trial in 18- to 48-month-old children. *The Psychological Record*, *66*(1), 53–63.
Smith, L. B., Jones, S. S., Landau, B., Gershkoff-Stowe, L., & Samuelson, L. (2002). Object name learning provides on-the-job training for attention. *Psychological Science*, *13*(1), 13–19.
Snow, C. E. (1999). Social perspectives on the emergence of language. In B. MacWhinney (Ed.), *The emergence of language* (2nd edition, pp. 257–276). Mahwah, NJ: Erlbaum.
Spencer, E. J., & Schuele, C. M. (2012). An examination of fast mapping skills in preschool children from families with low socioeconomic status. *Clinical Linguistics & Phonetics*, *26*(10), 845–862.
Sperry, D. E., Sperry, L. L., & Miller, P. J. (2018). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development*, https://doi.org/10.1111/cdev.13072
Spiegel, C., & Halberda, J. (2011). Rapid fast-mapping abilities in 2-year-olds. *Journal of Experimental Child Psychology*, *109*(1), 132–140.
Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. *Psychological Bulletin*, *87*(2), 245–251.
Stolt, S., Haataja, L., Lapinleimu, H., & Lehtonen, L. (2009). Associations between lexicon and grammar at the end of the second year in Finnish children. *Journal of Child Language*, *36*(4), 779–806.
Suskind, D. (2015). *Thirty million words: Building a child's brain*. New York, NY: Dutton.
Taylor, C. L., Christensen, D., Lawrence, D., Mitrou, F., & Zubrick, S. R. (2013). Risk factors for children's receptive vocabulary development from four to eight years in the Longitudinal Study of Australian Children. *PLOS One*, *8*(9), e73046.
Trzaskowski, M., Harlaar, N., Arden, R., Krapohl, E., Rimfeld, K., McMillan, A., . . . & Plomin, R. (2014). Genetic influence on family socioeconomic status and children's intelligence. *Intelligence*, *42*, 83–88.
Tucker-Drob, E. M., & Bates, T. C. (2016). Large cross-national differences in gene × socioeconomic status interaction on intelligence. *Psychological Science*, *27*(2), 138–149.
Turkheimer, E., Haley, A., Waldron, M., d'Onofrio, B., & Gottesman, I. I. (2003). Socioeconomic status modifies heritability of IQ in young children. *Psychological Science*, *14*(6), 623–628.
Urm, A., & Tulviste, T. (2016). Sources of individual variation in Estonian toddlers' expressive vocabulary. *First Language*, *36*(6), 580–600.
Vasilyeva, M., Waterfall, H., & Huttenlocher, J. (2008). Emergence of syntax: Commonalities and differences across children. *Developmental Science*, *11*(1), 84–97.
Vernon-Feagans, L., Bratsch-Hines, M. E., & Family Life Project Key Investigators. (2013). Caregiver–child verbal interactions in child care: A buffer against poor language outcomes when maternal language input is less. *Early Childhood Research Quarterly*, *28*(4), 858–873.
Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development*, *65*(2), 606–621.
Waxman, S. R., & Booth, A. E. (2001). Seeing pink elephants: Fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology*, *43*(3), 217–242.
Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*(11), 2143–2152.
Weismer, S. E., & Evans, J. L. (2002). The role of processing limitations in early identification of specific language impairment. *Topics in Language Disorders*, *22*(3), 15–29.
Wilkinson, K. M., & Mazzitelli, K. (2003). The effect of 'missing' information on children's retention of fast-mapped labels. *Journal of Child Language*, *30*(1), 47–73.
Zhang, Y., Jin, X., Shen, X., Zhang, J., & Hoff, E. (2008). Correlates of early language development in Chinese children. *International Journal of Behavioral Development*, *32*(2), 145–151.
Zimmerman, I. L., Steiner, V. G., & Pond, R. E. (2011). *PLS-5: Preschool language scale-5*. San Antonio, TX: Psychological Corporation.
Zosh, J. M., Brinster, M., & Halberda, J. (2013). Optimal contrast: Competition between two referents improves word learning. *Applied Developmental Science*, *17*(1), 20–28.
de Villiers, P. A., & de Villiers, J. G. (2010). Assessment of language acquisition. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(2), 230–244.
van Druten-Frietman, L., Denessen, E., Gijsel, M., & Verhoeven, L. (2015). Child, home and institutional predictors of preschool vocabulary growth. *Learning and Individual Differences*, *43*, 92–99.