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Early word-learning skills: A missing link in understanding the vocabulary gap?

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Abstract

Socioeconomic status (SES) has been repeatedly linked to the developmental trajectory of vocabulary acquisition in young children. However, the nature of this relationship remains underspecified. In particular, despite an extensive literature documenting young children's reliance on a host of skills and strategies to learn new words, little attention has been paid to whether and how these skills relate to measures of SES and vocabulary acquisition. To evaluate these relationships, we conducted two studies. In Study 1, 205 2.5- to 3.5-year-old children from widely varying socioeconomic backgrounds were tested on a broad range of word-learning skills that tap their ability to resolve cases of ambiguous reference and to extend words appropriately. Children's executive functioning and phonological memory skills were also assessed. In Study 2, 77 of those children returned for a follow-up session several months later, at which time two additional measures of vocabulary were obtained. Using Structural Equation Modeling (SEM) and multivariate regression, we provide evidence of the mediating role of word-learning skills on the relationship between SES and vocabulary skill over the course of early development.

KEYWORDS

early development, SEM, SES, vocabulary development, vocabulary gap, word-learning skills

1 | INTRODUCTION

Social disparities in children's academic achievement emerge early in the United States, with some estimates indicating that fewer than half of children from socioeconomically disadvantaged families begin school at grade level (Isaacs, 2012). Although these disparities are evident across a wide range of disciplines (e.g., Jordan & Levine, 2009; Ransdell, 2012), vocabulary knowledge provides a particularly striking example. In their foundational work, Hart and Risley (1995) describe how a "vocabulary gap" of as many as 3000 words characterizes children at the poles of the socioeconomic (SES) spectrum at 3 years of age. Limitations to this initial investigation have been duly noted (e.g., Johnson, 2015; Purpura, 2019; Sperry, Miller, & Sperry, 2018), and it is important not to lose sight of the fact that both parent input and children's vocabulary growth vary substantially within socioeconomic strata (e.g., Pan, Rowe, Singer, & Snow, 2005). However, evidence strongly suggests that poverty and discrimination, along with poor quality healthcare and education, can introduce challenges that affect the home language environment and children's development (e.g., Perkins, Finegood, & Swain, 2013). Differences in language input and development across the SES spectrum have been observed consistently across a number of studies (see Schwab & Lew-Williams, 2016 for a review), and as Golinkoff and colleagues (2019) have argued, denying their existence may have harmful implications for policy and practice. Indeed, a better understanding of differences in the early trajectory of vocabulary development is essential to developing best practices for promoting the success of all children as they enter school.

While the precise origins of SES-related variability in vocabulary acquisition remain uncertain, some aspects of early socio-linguistic experience have been highlighted repeatedly (e.g., Hoff, 2006; Ramírez-Esparza, García-Sierra, & Kuhl, 2014; Rodriguez &

Tamis-LeMonda, 2011). In particular, the amount of speech directed to children by their caregivers has received considerable attention (e.g., Hart & Risley, 1995; Weisleder & Fernald, 2013). Evidence suggests, however, that the variability, complexity, and quality of that speech is likely of even greater import (e.g., Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Pan et al., 2005; Rowe, 2012). Regardless, there is broad consensus that parent input supports vocabulary acquisition by boosting children's exposure to words, along with their underlying phonological structure and meaning, thereby increasing processing efficiency and opportunities for learning (e.g., Weisleder & Fernald, 2013).

Unfortunately, once disparities in vocabulary knowledge have taken hold, they do not narrow appreciably over time and can have cascading effects on developmental trajectories (Leffel & Suskind, 2013). Vocabulary in kindergarten is highly predictive of vocabulary throughout the primary, and even into the secondary, school years (Dickinson & Tabors, 2001; Walker, Greenwood, Hart, & Carta, 1994). Early vocabulary also has implications for the development of reading, particularly with respect to comprehension (Cunningham & Stanovich, 1997; Suggate, Schaughency, McAnally, & Reese, 2018), and has also been associated with broader measures of behavioral functioning and academic achievement (Marchman & Fernald, 2008; Morgan et al., 2015).

Although the vocabulary gap has received much empirical attention, in some respects our understanding of this phenomenon remains limited. For example, how, if at all, does it connect to all we know about the skills young children use in learning new words? When faced with a novel word, we know that children apply a number of strategies to hone-in on the intended referent among myriad viable alternatives. And once a child has identified the intended referent, we know that they rely on still other strategies to determine what else can (and cannot) be accurately labeled with that same word (Bloom, 2002; Woodward & Markman, 1998). Although it is widely assumed that children's successful application of these strategies supports real-world vocabulary acquisition, and should by implication play some role in explaining the individual variability in growth that contributes to the vocabulary gap, there has been little discussion of this possibility.

In one notable exception, Henderson and Sabbagh (2013) argue that key contributors to early differences in children's accumulated vocabulary (i.e., quantity and quality of linguistic input) might also impact the repertoire of skills and strategies available to children for further word learning. This idea is consistent with socio-pragmatic and other learning-based theories arguing that variability in early experiences with language and communication influences children's opportunities for abstracting general expectations regarding the ways in which speakers indicate communicative intentions, as well as the patterns of generalization that are appropriate for newly encountered words (e.g., Gogate & Hollich, 2010; Golinkoff et al., 2000; Houston-Price & Law, 2013; Namy, 2012). For example, variability in the degree to which parents facilitate joint attention when introducing new words might predict their children's sensitivity to the gestural cues typically used in these contexts (i.e., eye gaze and pointing). And the more experience children accumulate with unambiguous labeling episodes, the more likely they might be to detect regularities underlying the expectation that new words map to referents with previously unknown names (i.e., the mutual exclusivity assumption), as well as correlations between the syntactic frames in which words are introduced and their meaning. Variability in the degree to which parents facilitate the identification of multiple exemplars of any given word might also predict children's privileging shape over other dimensions in extending newly learned words (i.e., the shape bias; Smith, 2000). Thus, traditional explanations of the association between SES and vocabulary that hinge solely on language exposure, and resulting opportunities to build associations between individual words and their referents, might not be capturing the full story. Instead, this direct route between early experience and vocabulary (path c in Figure 1) might be supplemented by an indirect route mediated by children's word-learning skills (path ab in Figure 1; see Henderson & Sabbagh, 2013).

Research Highlights

- Maternal education correlated with vocabulary scores measured both contemporaneously and several months later, replicating prior research on the "vocabulary gap."
- Maternal education also predicted variation in children's word-learning skills.
- Word-learning skills correlated with vocabulary scores measured both contemporaneously and several months later.
- Word-learning skills partially mediate the well-established relationship between socioeconomic status and vocabulary, thus, highlighting a missing link in prior conceptions of the vocabulary gap.

Seemingly contrary to this possibility, some researchers have found no differences between low- and middle-SES toddlers in their ability to "fast-map" novel words onto objects (Horton-Ikard & Weismer, 2007). However, learning words generally requires more

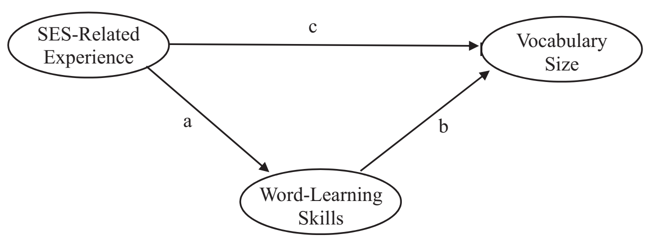

FIGURE 1 Proposed model. SES, Socioeconomic Status. Path (c) depicts the direct effect of SES on vocabulary, and path (ab) depicts its indirect effect through word-learning skills. Adapted from Henderson, A. M., & Sabbagh, M. A. (2013). Learning words from experience: An integrated framework. In *Theoretical and computational models of word learning*: *Trends in psychology and artificial intelligence* (pp. 109–131): IGI Global

than the basic information processing skills (i.e., attention, memory, and associative learning) that underlie fast mapping in unambiguous naming contexts like those used in this study. Indeed, word learning typically requires identifying intended referents from numerous alternatives and determining appropriate extensions thereafter. These tasks present unique challenges that young children overcome in a variety of ways, ranging from intrinsic attentional and conceptual biases, to sensitivities to linguistic and socio-pragmatic cues. Recent work by Levine et al. (2020) suggests that these more complex processes (measured in the context of a mutual exclusivity task) are as strongly associated with SES as are vocabulary and syntactic knowledge in 3- to 5-year-olds.

Here, we present two studies exploring relationships among socioeconomic status (SES), word-learning skills, and accumulated vocabulary – first contemporaneously (Study 1), and then across time (Study 2). We specifically test three central components of Henderson and Sabbagh's (2013) model. First, we evaluate path (a) in Figure 1 by considering whether measures of socioeconomic status correlate with early word-learning skills. As already noted, there are compelling reasons to predict that this relationship should hold. Critically, however, this does not obviate the need for empirical inquiry. Although many believe that word-learning skills and strategies emerge gradually through social-communicative exchange, it is possible that development in this area is quite robust across a wide range of early experiences. Second, we evaluate path (b) in Figure 1 by considering whether early word-learning skills correlate with vocabulary knowledge. Although research and theory strongly suggest that this relationship should also hold (e.g., Smith, 2000; Tomasello, 1992; Waxman, 1998), little systematic evaluation of this possibility has been conducted in the age range targeted here. Third, if these relationships are evident, we will directly evaluate the possibility that early word-learning skills mediate the already well-documented relationship between SES and vocabulary.

2 | STUDY 1

We began by gathering information regarding children's socioeconomic background, accumulated vocabulary, and word-learning skills as they were entering preschool. Due to constraints on the length and frequency of testing sessions that could be reasonably demanded of participants, we could not exhaustively test all skills and strategies potentially used by young children learning new words. We targeted four specific skills that were well documented in the literature and could confidently be tested within the target age range: following a speaker's gaze/pointing gestures to intended referents, capitalizing on mutual exclusivity, using object shape to define referential scope, and using syntactic information to map adjectives to properties. Our goal was to test the viability of Henderson and Sabbagh's (2013) model by establishing whether early word-learning skills are related to (1) socioeconomic indicators of early experience and (2) the size of children's vocabulary. Moreover, we explicitly test the possibility that the well-established relationship between socioeconomic status and vocabulary might be explained by an indirect effect through early word-learning skills.

2.1 | Method

2.1.1 | Participants

Our sample included 205 two- to three-years-old children (118 females) from Austin, Texas area (M = 2.88, SD = 0.29, range =2.40–3.52). Children had no diagnosed developmental disorders or hearing impairments and were exposed to at least 50% English at home (and/or their parent rated them as understanding English "well" or "very well"). An additional 9 children were excluded due to behavioral noncompliance. They did not vary systematically from the full sample in terms of race, ethnicity, or maternal education.

Based on parent report, 11.7% of participating children were Black or African American, 82% were White, and 5.9% identified as multiple races or "other." In addition, 33.2% of these children were identified by their parents as Latino. Years of maternal education ranged from 7 to 23 (M = 15.7, SD = 2.9). More specifically, 5.9% had not completed high school, 15.3% had a high school diploma or GED, 14.4% had some college (or Associate's degree), 27.2% had a college degree, and 37.2% had some graduate education.

2.1.2 | General procedure

Over the course of three sessions, children completed one standardized test of vocabulary, one behavioral and one parent-report measure of executive functioning, one behavioral measure of phonological working memory, and four experimental tests of word-learning skills. All sessions were scheduled within a 3-month window to minimize developmental effects on performance across tasks, while preventing families from becoming overburdened with too many visits within a short period of time.

Before participating, parents provided informed consent on behalf of their child (who also provided verbal assent). Children were tested in a quiet room by a female experimenter, and parents were asked to silently fill out paperwork or observe during the session. The four word-learning tasks all involved asking children to choose referents of novel words (e.g., *noop*) from a small array of novel items (e.g., a potato masher) based on specific cues.

2.1.3 | Measuring word-learning skills

Novel words conformed to the phonological rules of American English and were within the productive capabilities of typically developing 2-year-olds (Dyson, 1988; Stoel-Gammon, 1987, 1991). Whenever familiar items were required for a task, their names could be produced by over 90% of 30-month-olds according to the LEX database (Dale & Fenson, 1993).

Gaze and point following

It is well established that young children use social cues like pointing and eye gaze to infer the intended referents of novel words (Baldwin & Tomasello, 1998; Hollich et al., 2000). Although this ability begins to emerge in the second year (e.g., Baldwin, 1991; Hennon, Chung, & Brown, 2000; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006), it continues to develop for some time thereafter (Baldwin, 1993; Booth, McGregor, & Rohlfing, 2008; Brand, 2000; Woodward, 2004). Moreover, several reports indicate that children's sensitivity to referential social cues is related to the size of their vocabulary (e.g., Brooks & Meltzoff, 2005; Carpenter, Nagell, & Tomasello, 1998; Mundy & Gomes, 1998).

We assessed sensitivity to a speaker's eye gaze and pointing as cues to reference using a procedure modeled after Booth et al. (2008). The experimenter began by saying "Today I'm going to show you some special toys from my treasure boxes. You have never seen these things before, but they are really cool!" She then took three novel objects out of the first treasure box, let the child play with them briefly, and then lined them up on the table out of the child's reach. In order to minimize demands on inhibition of attention toward objects of particular interest to the child, the experimenter first drew the child's attention to a neutral location at her chest with a squeaker toy. While looking intently at one of the objects, the experimenter labeled it three times (e.g., "Look, it's a *goot*! It's called a *goot*! Wow, what a cool *goot!*"). She then put the objects in a clear rectangular container, reminded the child to "remember which one the *goot* is!", and shook the container to mix up the objects. She then handed the container to the child and asked for the target object ("Can you hand me the *goot*?"). This procedure was repeated for each of the eight treasure boxes (see Figure 2). The target labels and locations were presented in a fixed order, and the location of the target object (right, center, left) was fixed but counterbalanced across the eight trials. In the first four trials, the experimenter only used eye gaze as a cue. In the latter four, the experimenter also pointed to the novel item while naming. Performance on this task was quantified using the proportion of trials on which the correct referent was chosen.

The mutual exclusivity assumption

Young children tend to map new words onto referents for which they do not already know a name (Markman, Wasow, & Hansen, 2003; Mervis & Bertrand, 1993). This *Mutual Exclusivity Assumption* (Markman & Wachtel, 1988), also instantiated in related forms as the *Principle of Contrast* (Clark, 1987) and the *Novel Name Nameless Category Assumption* (Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992), allows children to rule out potential referents in a naming context that are already represented in their vocabulary. The Mutual Exclusivity Assumption has been observed in children from 16 months to 4 years of age (see Markman et al., 2003) and has been shown to relate to accumulated vocabulary as assessed by the MacArthur-Bates Communicative Development Inventory (e.g., Graham, Poulin-Dubois, & Baker, 1998; Mervis & Bertrand, 1994).

We assessed adherence to the Mutual Exclusivity Assumption by introducing children to 12 "treasure boxes" (see Golinkoff et al., 1992). The first box familiarized the child with the protocol and contained four familiar objects (toy hat, elephant, cheese, and crayon). The experimenter opened the box, allowed the child to play with the objects briefly, and then lined them up before asking the child to hand her a familiar object (e.g., the elephant). She then repeated with another one of the items in the same set (e.g., the hat) to ensure the child understood. The remaining 11 trials unfolded in the same manner except that no further coaching was provided, and the four objects revealed in each box included three that had a name known to most children of this age, and a fourth drawn from a novel category (see Figure 3). On eight test trials, the Experimenter asked for the novel item (e.g., "Where is the *hux*?"), while on three control trials (occurring in second, fifth, and eighth position) she asked for one of the known items as a check on whether children were perseveratively choosing the novel object across trials. The treasure boxes were presented in a fixed order, but objects were lined up in random arrangement. Performance on this task was quantified using the proportion of unfamiliar name trials on which the novel object was selected.

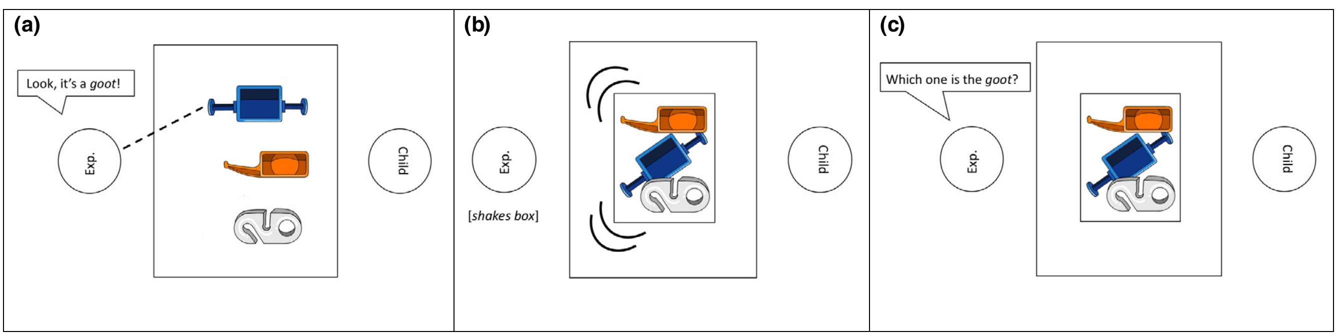

FIGURE 2 Schematic of the Gaze-and-Point task. On each of 8 trials, the experimenter would label the novel object while directing her gaze at the target object (a). In half of the trials she also pointed at the object while naming it. She then returned the target and distractor objects to a box to mix them up (b) and, finally, asked the child to select the target object (c)

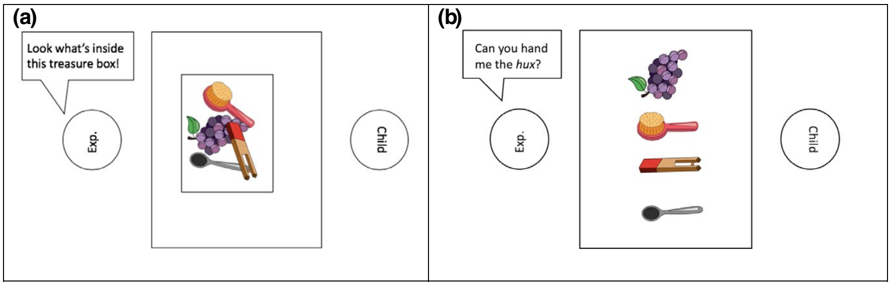

FIGURE 3 Schematic of the Mutual Exclusivity task. For each of 8 test trials, the experimenter would open each "treasure box" containing three known objects and one unknown object (a). After lining the objects up, she asked the child for the novel object by using a novel label (c). On three additional three control trials she asked for one of the known items instead

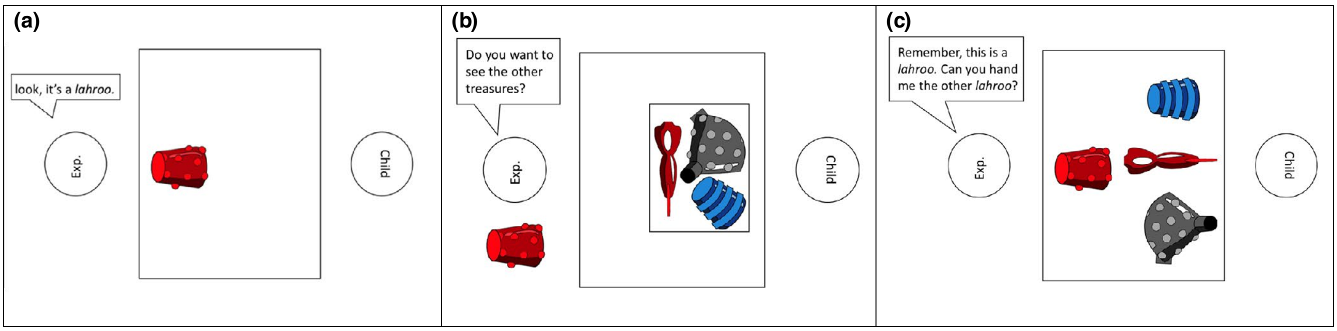

FIGURE 4 Schematic of the Shape Bias task. On each of 8 trials, the experimenter would present a novel object and label it with a novel word (a). She would then present the child three new novel objects: a shape match, a color match, and a texture match (b). She then held up the original object and asked the child to find another one (c)

The shape bias

Young children are biased to extend words on the basis of shape, rather than other object properties such as color (e.g., Jones, Smith, & Landau, 1991). This strategy is useful for identifying the appropriate extension for count nouns in particular because, for the most part, the categories they reference are organized around shape similarity (Jones & Smith, 2002). The *Shape Bias* has been observed before 2 years of age (Booth, Waxman, & Huang, 2005), but becomes more robust as children enter preschool (e.g., Landau, Smith, & Jones, 1988; Samuelson, Horst, Schutte, & Dobbertin, 2008).

We assessed children's reliance on the Shape Bias using procedures similar to those used in Ware and Booth (2010). The experimenter introduced eight treasure boxes, one at a time. For each of the boxes, the experimenter pulled out the target object, labeled it, and allowed the child to play with it briefly. She then took it back and labeled it again. She then put away the target object and handed the child the remaining three objects from the box: one matching the target in shape (but differing in texture and color), one matching in texture (but differing in shape and color), and one matching in color (but differing in shape and texture). After the child played briefly with these new objects, the experimenter lined them up in front of the child, and then held up the original object, saying "Remember, this is a *lahroo*. Can you hand me another *lahroo*?" This was repeated for each of the eight treasure boxes (see Figure 4). Placement of objects was fixed across participants with the shape-match appearing in different positions on consecutive trials. Performance on this task was quantified using the proportion of shape-match selections.

Adjective mapping

Evidence suggests that children utilize the syntactic frames in which novel words are heard to determine their appropriate range of extension (Booth & Waxman, 2003; Waxman & Klibanoff, 2000). As a group, infants first develop a clear expectation for words presented in count noun syntactic frames (e.g., "It is a _____."), mapping them onto object categories by around their first birthday (Booth & Waxman, 2009; Waxman & Booth, 2001). Expectations linking words presented in adjectival frames (e.g., "This one is very ____-ish.") onto object properties develop later – emerging gradually over the next 2 to 3 years (e.g., Klibanoff & Waxman, 2000).

As a measure of children's sensitivity to these syntactic cues, we originally planned to use a novel noun/adjective disambiguation task, but piloting revealed insufficient variability in response for it to serve as a viable measure of individual differences. Instead, we chose to focus on adjective-mapping specifically. To measure this skill, we adopted a procedure similar to Waxman and Markow (1998). The experimenter introduced the first trial by placing a card depicting a novel object on the table in front of the child, saying "Wow! Look at this one! This one is very *yaddish*. Can you say *yaddish*?" She then repeated the label (e.g., "I like this *yaddish* one") and handed the child the picture card. The experimenter then introduced a test card picturing three novel items. Although all of these items differed from the labeled target in category membership, one (appearing equally often in the left, right, and middle position across trials) matched its distinctive color and patterning. At this time, the experimenter said "Remember, that one [pointing to the target] is a *yaddish* one. Now, look at these [pointing to the test card]. Can you find another one that is very *yaddish*?" This procedure was repeated for each of the eight trials (see Figure 5), which were presented in a fixed order. Performance on this task was quantified using the proportion of test trials on which correct property-based extensions were made.

2.1.4 | Measuring socioeconomic status

While no clear consensus exists regarding which factors best index socioeconomic status (Bradley & Corwyn, 2003; Ensminger, Fothergill, Bornstein, & Bradley, 2003), we collected information regarding two leading indicators, income-to-needs ratio, and maternal education, through interviews with mothers (Angel et al., 1999). Income-to-needs ratio was calculated as the total reported annual household income divided by the 2017 poverty threshold for a given family size. Maternal education corresponded to the total self-reported years of education completed.

2.1.5 | Measuring accumulated vocabulary

We utilized the Peabody Picture Vocabulary Test – Fourth Edition (PPVT; Dunn & Dunn, 2007) to assess children's receptive vocabulary. The PPVT is designed for use with children as young as 2.5 years of age and takes 10 to 20 minutes to administer. This test was extensively evaluated to minimize item bias and was normed on a large and diverse sample (Dunn & Dunn, 2007).

2.1.6 | Measuring attention and executive functioning

Although we paid careful attention to minimizing the task demands of our measures of early word learning, we nevertheless felt it was important to evaluate the potential influence of attentional factors on performance. We therefore used digital recordings of each task session to quantify children's overall level of engagement (on a 5-point scale) based on clues like facial expressions, fidgeting, and looks to mother or the exit. A score of less than 3 indicated insufficient engagement to support a meaningful interpretation of performance and was considered grounds for discarding the data for that task. However, this was a rare occurrence, applying to less than 5% of task sessions. Agreement between coders on whether attention was deemed "acceptable" (3–5 rating) or "unacceptable" (1–2 rating) averaged 95% across the four word-learning tasks.

Even if children were uniformly engaged in our tasks, it remains possible that their executive functioning (EF) skills might have impacted their performance. Therefore, we included both a behavioral and a parent-report measure of children's EF. The Minnesota Executive Function Scale (MEFS; Carlson & Zelazo, 2014) is a measure of cool executive function, tapping working memory, inhibitory control, and set shifting. This task was adapted from the Dimensional Change Card Sort Task (Zelazo, 2006) and is administered as a computerized tablet game. The Behavior Rating Inventory of Executive Functioning – Preschool (BRIEF-P; Gioia, Espy, & Isquith, 2003) is a parent questionnaire that evaluates eight aspects of executive functioning. Because phonological processing has been found to predict vocabulary growth in toddlers (Fernald & Marchman, 2012), we also included a more specific measure of phonological working memory. The Preschool Repetition Test from the Early Repetition Battery (PSRep; Seeff-Gabriel, Chiat, & Roy, 2008) requires children to repeat back 18 words and 18 non-words varying from one to three syllables in length.

2.1.7 | Coding

Participant data were managed using Research Electronic Data Capture (REDCap; Harris et al., 2009), a secure, web-based application. Experimenters initially recorded children's responses on paper and added them to REDCap after each session. Video-recordings were also used to check the reliability of these records, to code level of engagement, and to assess the fidelity of protocol

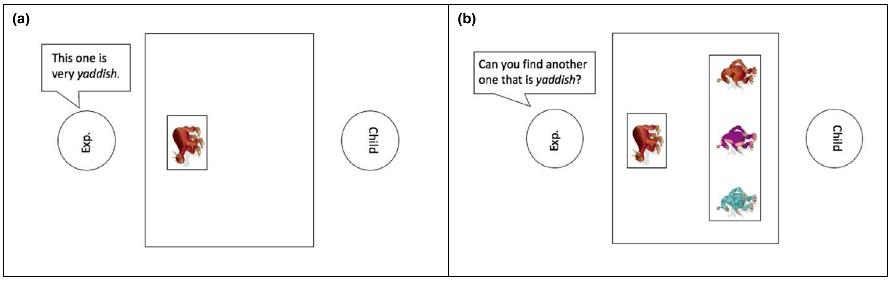

FIGURE 5 Schematic of the Adjective-Mapping task. For each of eight trials, the experimenter would place a picture card (depicting a target object) in front of the child, and describe it with a novel adjective (a). She then introduced a test card picturing three novel items, asking the child to point out another one (b). Although all of the test items differed from the labeled target in category membership, only one matched its distinctive color and patterning

implementation. For each of the word-learning tasks, at least 20% of the videos were coded by a second coder. Averaged across the four tasks, the inter-rater correlation was .98.

2.2 | Results

Due to the multiple sessions required, and the age of children tested, data were missing on at least one task for more than half of our participants due to: low task attention (n = 58), failure to respond correctly on familiar catch trials in the mutual exclusivity task (n = 2), experimenter error (n = 16), and attrition or extended delay between sessions (n = 97). Little's (1988) test was not significant, $\chi^2(412, N = 205) = 381.74$, $p = .855$, suggesting that the data were missing completely at random (MCAR) and therefore free of systematic bias. The following analyses are therefore based on multiply imputed estimates of missing values (see Table 1). Specifically, we ran 10 iterations based on the average percent of missing data across key variables and calculated pooled statistics across imputations (White, Royston, & Wood, 2011).

As a reminder, our primary goal was to test the hypothesis that early word-learning skills might mediate the relationship between SES and vocabulary. An initial review of bivariate correlations (see Table 2) reveals significant associations between PPVT scores and both maternal education ($r = .43$, $p < .01$) and income-to-needs ratio ($r = .37$, $p < .01$), thereby providing confirmatory evidence of a relationship between SES and vocabulary. We used Structural Equation Modeling (SEM) to test the hypothesis that this well-documented relationship might be best understood by consideration of a second, indirect path through word-learning skills (see Figure 6). We performed this analysis with LISREL 8.80 (Jöreskog & Sörbom, 2006), and our hypothesized model fit the data well; $\chi^2(12, N = 205) = 13.32$ ($p = 0.346$), CFI = 0.995, TLI = 0.991; and RMSEA = 0.025 (95% CI = 0.00, 0.08).

TABLE 1 Percent of missing data for study 1 measures

Measure	% Missing
Age	1.95
Maternal education	1.46
Income to needs	15.12
MEFS	20.00
BRIEF-P	13.17
PSRep	19.02
Gaze & point following	20.98
Mutual exclusivity	11.71
Shape bias	9.27
Adjective mapping	14.15
PPVT	8.78

Abbreviations: MEFS, minnesota executive function scale; BRIEF-P, behavior rating inventory of executive functioning–preschool; PSRep, preschool repetition test; PPVT, peabody picture vocabulary test.

In line with previous research on the vocabulary gap, the direct effect between SES and vocabulary was significant, $B = 0.41$ ($SE = 0.12$), $p < .05$. And, as hypothesized, the model suggests that environmental factors are related to children's word-learning skills, as variation in socioeconomic status was predictive thereof, $B = 0.40$ ($SE = 0.09$), $p < .05$. Also as expected, the model confirms that those word-learning skills are then predictive of children's vocabulary scores, $B = 0.57$ ($SE = 0.18$), $p < .05$. See Figure 6 for standardized parameter estimates.

Given these relationships between word-learning skills and both our broad indicators of SES *and* vocabulary size, it is important to assess the proposed indirect path from SES, through word-learning skills, to vocabulary size. While our SEM provided an estimate for the indirect path ($B = 0.23$), it is unable to directly test the significance of the indirect effect. Although a true mediation analysis is precluded here by the fact that our mediator and outcome variables were measured contemporaneously (see Baron & Kenny, 1986), to test the viability of our proposed indirect effect, we used Selig and Preacher's interactive tool (2008) to conduct a Monte Carlo simulation (with 20,000 repetitions) in R. The resulting 95% confidence interval around our indirect path (ab path) of 0.23 was [0.09, 0.37]. All values contained in this interval are nonzero, so the indirect effect is considered significant.

2.2.1 | Additional analyses

As mentioned earlier, even if children were generally engaged and attentive in our word-learning tasks, it remains possible that their executive functioning (EF) skills might have impacted their performance. Additionally, as is the case with early vocabulary, EF skills have been found to correlate with SES (e.g., Shonkoff, 2011). Thus, it may be the case that individual differences in EF could help explain variation in our other measures. In particular, we predicted that SES would predict variation in EF, which would, in turn, predict performance on our other two constructs (WRDLRN and VOCAB). To test this possibility, we ran an additional SEM analysis, adding an EF construct (comprised of MEFS, BRIEF, and PSRep) into our model as another indirect effect variable (between SES and WRDLRN in Figure 6). However, this model would not converge. This poor model fit is consistent with the bivariate correlations (see Table 2) that foreshadowed this conclusion – only one component measure of our EF construct (MEFS) correlated with any of our word-learning measures, and it did so inconsistently.

2.3 | Discussion

In Study 1, we (1) conceptually replicated the relationship between socioeconomic status and vocabulary that constitutes the heart of the vocabulary gap, (2) confirmed that early word-learning skills are associated with vocabulary knowledge, and (3) demonstrated that those early word-learning skills are also associated with

TABLE 2 Summary of intercorrelations, means, and standard deviations for study 1 measures

Measure		1	2	3	4	5	6	7	8	9	10	11	12	*M*	*SD*
1.	Age	–												2.88	0.29
2.	Ethnicity†	0.03	–												
3.	Maternal education	0.00	−0.40**	–										15.73	2.94
4.	Income-to-needs	−0.05	−0.32**	0.37**	–									3.38	2.83
5.	MEFS	0.04	−0.07	0.24**	0.20*	–								48.29	23.04
6.	BRIEF-P	0.04	0.15*	−0.27**	−0.15	−0.10	–							93.82	17.07
7.	PSRep	0.10	−0.20*	0.17*	0.14	0.10	−0.21**	–						0.83	0.21
8.	Gaze & point following	0.11	−0.07	0.18**	0.09	0.18	−0.11	0.14	–					0.63	0.63
9.	Mutual exclusivity	0.12	−0.17*	0.24**	0.20**	0.35**	−0.11	0.17	0.23**	–				0.23	0.23
10.	Shape bias	0.16*	−0.08	0.21**	0.17*	0.27**	−0.14	0.08	0.18*	0.37**	–			0.61	0.61
11.	Adjective mapping	0.02	−0.08	0.17*	0.17*	0.04	0.01	0.14	0.15	0.15	0.22**	–		0.28	0.28
12.	PPVT	0.25**	−0.21**	0.43**	0.35**	0.42**	−0.15*	0.23*	0.10	0.47**	0.33**	.16	–	44.67	20.78

Abbreviations: MEFS, minnesota executive function scale; BRIEF-P, behavior rating inventory of executive functioning–preschool; PSRep, preschool repetition test; PPVT, peabody picture vocabulary test.

†Ethnicity was a dichotomous variable (whether the participant was Hispanic) and, therefore, does not have a mean or standard deviation value.

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

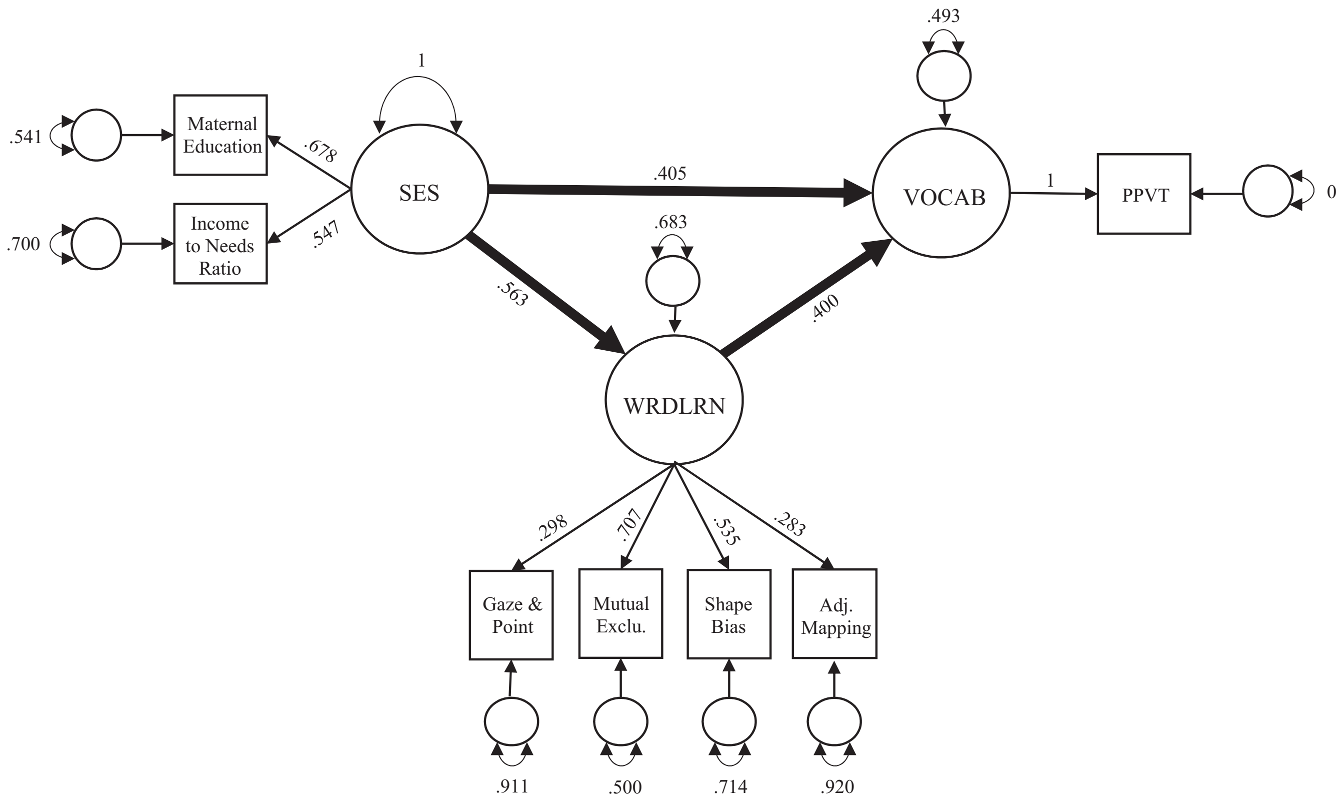

FIGURE 6 Structural Equation Model (SEM) of relationship among socioeconomic status (SES), word-learning skills (WRDLRN), and accumulated vocabulary (VOCAB). PPVT =Peabody Picture Vocabulary Test. For ease of differentiation, narrow lines represent measurement components while bold lines represent structural (i.e., theory-driven) components. Circles represent latent variables, and rectangles represent measured variables (empty circles are error terms). All parameter estimates provided are standardized completely and $p < .05$

socioeconomic status. Furthermore, we provided evidence that SES and vocabulary are related not only directly but also indirectly through word-learning skills.

3 | STUDY 2

Although Study 1 provides evidence consistent with Henderson and Sabbagh's (2013) model of the vocabulary gap, it is limited by the fact that all measurements were collected contemporaneously. As a result, the directionality of effects remains unclear. Although neither children's word-learning skills nor their accumulated vocabulary could possibly shape SES, it is entirely possible that the size of a child's vocabulary influences the development of their word-learning skills. Indeed, this possibility has been explicitly articulated with respect to the shape bias and mutual exclusivity assumption, as well as children's sensitivity to socio-pragmatic cues (e.g., Frank, Goodman, & Tenenbaum, 2009; Houston-Price & Law, 2013; Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002). While we find this possibility compelling, in the current study we were particularly interested in testing the potential influence of word-learning skills on vocabulary acquisition specified in Henderson and Sabbagh's (2013) model. One way to address the directionality of this effect is to assess whether word-learning skills predict *subsequent* vocabulary knowledge in a longitudinal design. In Study 2, we followed up with a subset of Study 1 participants several months later in order to again test their vocabulary knowledge and evaluate its relationship to earlier word-learning skills.

3.1 | Method

3.1.1 | Participants

Although the ideal circumstances would have been to invite all Study 1 participants back for follow-up testing, at the time that the decision was made to pursue this second study, several had aged beyond the 18-month delay we had selected as our maximum. The caregivers of 77 qualifying children (46 female) were successfully contacted and agreed to participate. Children were 3- to 4-years-old at the time of their follow-up session (M = 3.71, SD = 0.35, range =3.07–4.70). Based on parent report, 6.5% of participating children were Black or African American, 87% were White, and 6.5% identified as multiple races or "other." In addition, 36.4% of these children were also identified as Latino. Maternal education ranged from 7 to 21 years, with an average of 15.99 years (*SD* = 2.86). More specifically, 7.8% had not completed high school, 7.8% had a high school diploma or GED, 14.3% had some college (or an associate degree), 33.8% had a college degree, and 36.4% had some amount of graduate education.

3.1.2 | General procedure

Children returned to our laboratory 4.5–18 months after participating in the first session of Study 1 to again complete the PPVT (Form B). In order to strengthen our assessment, children also completed the Test of Preschool Early Literacy (TOPEL; Lonigan, Wagner, Torgesen, & Rashotte, 2007). In the Definitional Vocabulary subtest, which was of particular interest here, children are shown individual pictures and asked to not only name the item but to describe one of its important features. All general study procedures were the same as in Study 1.

3.2 | Results

We again began by using multiple imputations to account for missing data, as 22 children were missing follow-up PPVT scores and eight were missing TOPEL scores (due to experimenter error). The following analyses were computed with the pooled results from 10 iterations of this imputation procedure.

Given our goal of revisiting the indirect effects observed in Study 1 within a true mediation model (now licensed by the temporal separation of our measures), our ideal approach here would have been to precisely replicate the SEM analyses utilized in that study. However, due to our significantly attenuated sample size, we no longer had sufficient power to confidently do so and therefore opted to use analyses based on linear regression instead. This alternative approach precluded loading our multiple indicators of word-learning skills onto a single construct (as we had done in our Study 1 SEM), but in order to preserve power, it also required that we keep the number of factors under consideration to a minimum (especially intrinsically related ones, to reduce multicollinearity of predictors). In order to confirm that our four word-learning measures could be reasonably combined into a single factor, we used LISREL to perform a confirmatory factor analysis using the pooled data from Study 1 (with all 205 participants). Correlations, means, and standard deviations are shown in Table 3, and our theoretical model is presented in Figure 7. The minimum fit function chi-square test, as well as other indices, suggest a good fit between our one-factor model and the observed data; χ^2 (2, N = 205) = 2.05 (p = 0.358), CFI = 0.999, TLI = .997, and RMSEA < 0.001 (95% CI = 0.0, 0.14). Based on this analysis, we created a composite measure of word-learning skills (WLS) by averaging the four word-learning measures collected at the time of Study 1 (i.e., gaze and point following, mutual exclusivity, shape bias, and adjective mapping).

In order to further reduce the number of factors under consideration in our analysis, we included maternal education as our sole indicator of SES. Not only was this the only variable that correlated with both our key predictor (word-learning skills) and outcome (receptive vocabulary) variables in Study 1, but it is also the most theoretically motivated factor given the strength and consistency of its previous association with parent–child interaction and language-related child outcomes (e.g., Davis-Kean, 2005; Magnuson, Sexton, Davis-Kean, & Huston, 2009; Yarosz & Barnett, 2001).

Having narrowed the scope of unique factors to be considered, we believed that a next important step was to confirm that there was still a relationship between SES (maternal education) and vocabulary (now including both TOPEL-Def and PPVT-B) to potentially be mediated by our composite word-learning skills measure, especially given that we were now evaluating this relationship over time. Similarly, we felt it was important to confirm that our composite word-learning skills measure would predict vocabulary over this newly imposed delay, especially given our addition of a productive measure of vocabulary (TOPEL-Def). In the absence of either of these relationships, we reasoned that our mediation model would be untenable.

To confirm these foundational relationships, we ran a multivariate regression (Model 1), with maternal education and our word-learning skills composite (WLS) predicting both follow-up measures of vocabulary (PPVT-B and TOPEL-Def). Given that the length of delay

TABLE 3 Summary of intercorrelations, means, and standard deviations for study 2 measures

Measure	1	2	3	4	5	6	*M*	*SD*
Baseline (Time 1)								
1. Word-learning skills composite	–						0.69	0.15
2. Maternal education	.26*	–					15.99	2.86
3. PPVT-A	.43**	.43**	–				48.88	22.05
Follow-Up (Time 2)								
4. Age	.28*	−.09	.23*	–			3.71	0.36
5. PPVT-B	.55**	.39**	.70**	.33**	–		72.88	22.19
6. TOPEL-Def	.51**	.31**	.43**	.25*	.62**	–	66.05	23.82

Abbreviations: PPVT-A, peabody picture vocabulary test (Baseline); PPVT-B, peabody picture vocabulary test (Follow-up); TOPEL-Def, test of preschool early literacy–definitional vocabulary subtest.

** p < .01. * p < .05.

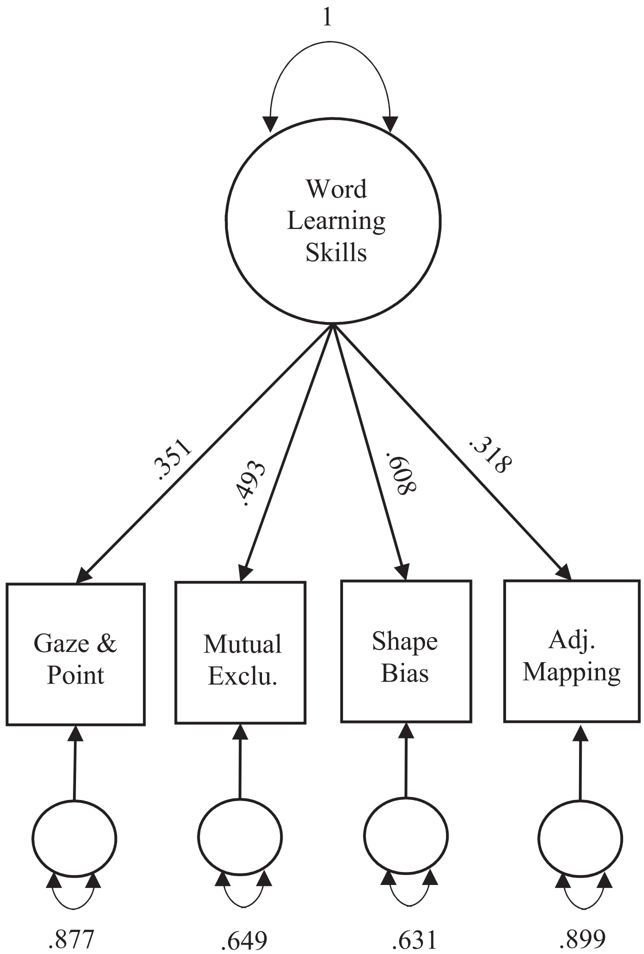

FIGURE 7 Confirmatory factor analysis (CFA). All parameter estimates are standardized completely and $p < .05$

varied substantially across individual participants, resulting in children being tested at similarly varying ages, we also controlled for age at the time of follow-up in this analysis. The resulting regression equation for PPVT-B was significant with a moderate effect size (F (3,73) = 11.31, p < 0.001; R^2 = 0.32), as was that for TOPEL-Def (F (3,73) = 18.10, p < 0.001; R^2 = 0.42). Maternal education, WLS, and age were all significant predictors of PPVT-B (p = 0.002, <0.001, and .017, respectively). Maternal education and WLS were also significant predictors of TOPEL-Def (p = 0.030 and <0.001, respectively), but age was not (p = 0.136). See Table 4.

Having confirmed these key relationships with the new longitudinal data, we were ready to conduct our planned mediation analysis. As in Study 1, we hypothesized that the relationship between SES (maternal education) and vocabulary (PPVT-B and TOPEL-Def) was mediated by word-learning skills (WLS). To test the significance of this relationship, we used the PROCESS macro (Hayes, 2017) in SPSS to complete a test of mediation using bootstrapping. In our analysis of follow-up PPVT-B scores, the direct effect (path c in our theoretical model, Figure 1) was significant: maternal education was directly predictive of later vocabulary, p = .010. As all values contained in the confidence interval around our indirect path (ab path) are non-zero (95% CI = 0.19, 2.02), we have evidence that the relation between SES and vocabulary is also partially mediated by our measures of word-learning skills.

A similar pattern of results was revealed when using our productive vocabulary measure (TOPEL-Def) as the outcome vocabulary measure (instead of our receptive vocabulary measure, PPVT-B). While the direct effect (path c) between maternal education and TOPEL-Def was now marginal (p = .059), all values contained in the confidence interval around our indirect path were non-zero (95% CI = 0.12, 1.28), thus, lending further support to the conclusion that the relation between SES and vocabulary is at least partially mediated by word-learning skills. See Table 5.

3.2.1 | Additional analyses

As we now had two time-separated scores on the PPVT, we were able to expand our analysis a step further to look at receptive vocabulary at follow-up while controlling for baseline scores. In other words, we were able to look at whether our variables predicted not just vocabulary size, but vocabulary *change*. Therefore, we ran a

TABLE 4 Parameter Estimates from Multivariate Regression Analysis Predicting Vocabulary Size (Model 1)

		Unstandardized		Standardized			95% CI	
Outcome	**Predictor**	***B***	***SE***	**β**	***t***	***p***	***LL***	***UL***
PPVT-B	(Intercept)	−62.07	25.83	0.00	−2.40	.016	−112.76	−11.37
	Age at follow-up	15.36	6.39	0.25	2.41	.017	2.80	27.91
	Maternal education	2.39	0.76	0.31	3.16	.002	0.91	3.88
	WLS	57.36	15.70	0.40	3.65	<.001	26.40	88.31
TOPEL-Def	(Intercept)	−22.39	17.23	0.00	−1.30	.194	−56.16	11.38
	Age at follow-up	6.19	4.15	0.16	1.49	.136	−1.95	14.33
	Maternal education	1.09	0.50	0.22	2.17	.030	0.10	2.07
	WLS	37.09	9.69	0.41	3.83	<.001	18.11	56.07

Abbreviations: CI, confidence interval; *LL*, lower limit, *UL*, upper limit; PPVT-B, peabody picture vocabulary test (at Follow-up); TOPEL-Def, test of preschool early literacy–definitional vocabulary subtest; WLS, word learning skills (composite score).

TABLE 5 Parameter estimates for (Separate) Mediation Analyses with different Measures of Vocabulary

		Unstandardized		Standardized	
Measure used	Effect pathway	*B*	*SE*	β	*p*[*]
PPVT-B	(Total)	3.03	0.83	0.39	<.001
	Direct (c)	2.06	0.74	0.27	.010
	Indirect (ab)	0.97	0.47	0.12	<.05
TOPEL-Def	(Total)	1.54	0.54	0.31	.006
	Direct (c)	0.95	.50	0.19	.060
	Indirect (ab)	0.59	0.30	0.12	<0.05

Abbreviations: PPVT-B, peabody picture vocabulary test at follow-up; TOPEL-Def, definitional vocabulary subtest of the test of preschool early literacy.

* Indicates whether a path coefficient is significantly different from 0.

second multivariate regression (Model 2), adding PPVT scores gathered at Study 1 (PPVT-A) as a predictor in the otherwise same multivariate regression as Model 1. The resulting regression equation for PPVT-B was significant with a moderate effect size (F (4,72) = 9.32, p < .001; R^2 = 0.34) as was that for TOPEL-Def (F (4,72) = 27.02, p < 0.001; R^2 = 0.60). In Model 2, WLS and PPVT-A were significant predictors of PPVT-B (p = 0.014 and < .001, respectively), but maternal education and age were not (p = 0.195 and 0.092, respectively). Additionally, WLS was a significant predictor of TOPEL-Def (p = 0.001), while maternal education, age, and PPVT-A were not (all *ps* > 0.112). See Table 6. Because maternal education no longer predicted vocabulary at follow-up (Study 2) after controlling for initial vocabulary (Study 1), there was no relationship for word-learning skills to mediate, and further analysis was therefore not warranted.

3.3 | Discussion

The temporal separation of measurements achieved in Study 2 represents a significant advance over Study 1, allowing us to clarify the directionality of the relationship between word-learning skills and accumulated vocabulary. Specifically, the data confirm that word-learning skills predict *subsequent* receptive and productive vocabulary. Moreover, because word-learning skills accounted for unique variance in follow-up vocabulary after controlling for baseline scores, it is clear that these skills predict vocabulary *change* over time. Finally, the results from Study 2 provide unique insight into the nature of the 'vocabulary gap,' revealing that word-learning skills mediate the well-established relationship between SES and vocabulary acquisition.

4 | GENERAL DISCUSSION

Decades of research have documented differences in the developmental trajectory of vocabulary acquisition across socioeconomic strata. Although the extent and origins of these differences remain under considerable scrutiny, a large number of studies replicating disparities in the number of words known by children highlights the need for a better understanding of this concerning phenomenon. In order to advance this goal, the current investigation attempts to leverage our knowledge of early word learning to articulate a more nuanced

TABLE 6 Parameter estimates from multivariate regression analysis predicting vocabulary change (Model 2)

		Unstandardized		Standardized			95% CI	
Outcome	Predictor	*B*	*SE*	β	*t*	*p*	*LL*	*UL*
PPVT-B	(Intercept)	−28.27	23.66	0.00	−1.20	.233	−74.83	18.30
	Age at follow-up	9.55	5.64	0.15	1.69	.092	−1.56	20.66
	Maternal Education	0.94	0.72	0.12	1.30	.195	−0.48	2.35
	WLS	37.56	14.96	0.26	2.51	.014	7.81	67.31
	PPVT-A	0.51	0.11	0.50	4.75	< .001	0.30	0.72
TOPEL-Def	(Intercept)	−14.45	17.85	0.00	−0.81	.418	−49.44	20.54
	Age at follow-up	4.83	4.21	0.12	1.15	.251	−3.42	13.08
	Maternal Education	0.75	0.54	0.15	1.38	.168	−0.31	1.80
	WLS	32.43	10.04	0.36	3.23	.001	12.76	52.11
	PPVT-A	0.12	0.08	0.19	1.59	.112	−0.03	0.27

Abbreviations: CI, confidence interval; *LL*, lower limit, *UL*, upper limit; PPVT-A, peabody picture vocabulary test (Baseline), PPVT-B, peabody picture vocabulary test (Follow-up); TOPEL-Def, test of preschool early literacy–definitional vocabulary subtest; WLS, word learning skills (composite score).

model of the vocabulary gap. In doing so, we move beyond the assessment of the size of children's vocabulary alone to focus on variability in children's repertoire of skills and strategies for acquiring new words. Results from Study 1 and Study 2 suggest that word learning at least partially mediates socioeconomic variability in vocabulary. We will discuss the four key findings undergirding this conclusion in turn.

First, our results add to the considerable evidence linking SES to the size of children's vocabulary. Specifically, maternal education correlated with vocabulary scores measured both contemporaneously (Study 1) and several months later (Study 2). This relationship has now been observed using a variety of measures of both expressive and receptive vocabulary – from standardized tests, to parental report, to natural language samples (e.g., Bornstein, Haynes, & Painter, 1998; Hoff, 2003) – and across race and ethnicity (e.g., Magnuson & Duncan, 2006; Restrepo et al., 2006). Interestingly, however, maternal education did not explain any unique variance in vocabulary *change* above and beyond word-learning skills in Study 2, suggesting that the effects of SES-related experience have already exerted their impact by our first measurement time point at 2 to 3 years of age, launching children on a developmental trajectory that unfolds with relative independence thereafter.

Second, our results confirm that the vocabulary gap is not characterized by differences in accumulated vocabulary alone, but instead extends to the skills and strategies available to children for building that vocabulary. This finding is consistent with the recent work of Levine and colleagues (2020) in which they reported an association between SES and performance on a contrastive fast-mapping task requiring the application of mutual exclusivity. The current evidence extends this association with a broader composite of word-learning skills, including not only mutual exclusivity but also application of the shape bias, and sensitivity to social and syntactic cues to word meaning. It bears noting, however, that although all four of these word-learning skills loaded on the same factor in our analyses, their relationship to measures of SES varied substantially, with mutual exclusivity and the shape bias showing the strongest association. This suggests that some early word-learning skills might be more malleable in response to environmental forces associated with SES than others. Further specifying these relationships will require a more detailed evaluation of the specific aspects of experience that might be contributing to the development of each word-learning strategy.

Third, our results confirm that word-learning skills are related to children's acquisition of real-world vocabulary. Although this conclusion might seem self-evident, there have been surprisingly few direct assessments of this relationship. The strongest evidence available comes from a training study conducted by Smith et al. (2002), causally linking acquisition of the shape-bias to vocabulary acquisition in toddlers. Several correlational studies also link the application of the mutual exclusivity assumption to measures of vocabulary (see Bion, Borovsky, & Fernald, 2013 for a review). Among the word-learning skills tested in the current investigation, these two strategies emerged as the strongest predictors of vocabulary (see Table 2). Interestingly, although a substantial body of work also indicates that early sensitivity to joint attention cues predicts language development (e.g., Carpenter et al., 1998; Mundy & Gomes, 1998; Salo, Rowe, & Reeb-Sutherland, 2018), our more direct test of children's use of eye gaze and pointing to infer the meaning of new words did not correlate strongly with vocabulary. This contradiction might be explained by differences in the age of children tested. Whereas all of the previous work was conducted with infants and toddlers under the age of 2, the youngest children in our investigation were 30 months of age. It is possible that joint attention becomes less impactful as children age and other word-learning skills begin to play a more dominant role. Further investigation will be required to be sure, especially given that our measure of children's attunement to gestural cues fell during the last session, and therefore suffered the greatest losses to attrition.

Regardless of these nuances, Study 2 crucially clarifies the directionality of effect between the composite of word-learning skills examined here and vocabulary scores. Specifically, the data reveal a predictive relationship between word-learning skills and subsequent growth in vocabulary. It is important to note, however, that this finding does not rule out the possibility of bidirectional influences whereby vocabulary growth also contributes to the development of subsequent word-learning skills. Indeed, other work is consistent with this possibility. For example, in a study with grade-school children, Maguire et al. (2018) found that vocabulary knowledge mediated the relationship between SES and word-learning ability. Relatedly, Hurtado, Marchman, and Fernald (2008) found that children's vocabulary growth and language processing speed have interdependent, bidirectional influences. Additionally, Smith et al. (2002) found that experience in learning object names tunes children's attention to the properties relevant for naming, thereby facilitating future learning. In order to test whether vocabulary growth and the development of word-learning skills show a similar bidirectional relationship in our dataset, we would have had to collect word-learning data at follow-up. However, due to the lengthy delay between Study 1 and Study 2, most children in our sample would have reached ceiling performance on our tasks, precluding this possibility. Future work could test this possibility using a younger sample and shorter delay. Finally, our results demonstrate that word-learning skills partially mediate the well-established relationship between SES and vocabulary, thus, highlighting a missing link in prior conceptions of the vocabulary gap. Specifically, this work suggests that early experiences associated with SES are not simply providing increased exposure to words and their referents (thereby strengthening their association with each other), but that they might also be contributing to the acquisition of key word-learning skills, which in turn support vocabulary acquisition. In proposing this latter possibility, Henderson and Sabbagh (2013) invited researchers to seek evidence not just that there are differences in children's opportunities to learn individual words, but that early experience is, in fact, shaping the repertoire of skills children have available for taking advantage of those opportunities. The current work provides the first such evidence toward this claim.

There are, of course, limitations to the current study. For example, although the results advance our understanding of the vocabulary gap by identifying the contribution of word-learning skills, they fall short in revealing underlying processes. While evidence and theory suggest that specialized conceptual knowledge is brought to bear in the context of early word learning (e.g., Booth et al., 2008; Waxman & Booth, 2000; Waxman & Gelman, 2009), low-level domain-general cognitive processes also surely play an important role (e.g., Namy, 2012; Weisleder & Fernald, 2014). We attempted to capture some of the most theoretically plausible cognitive contributors in our measures of EF, but these unexpectedly failed to consistently or strongly correlate with word-learning skills. A more comprehensive correlational analysis will therefore be necessary to provide further specification on this point. Given their prominence in theories of early word learning, two cognitive skills of particular interest in this analysis might be lexical processing speed (Law & Edwards, 2015; Hurtado et al., 2008; Fernald, Marchman & Weisleder, 2012; Lany, 2018) and associative learning (Hollich et al., 2000; Smith, Colunga, & Yoshida, 2010). Although our intention was to at least partially capture the former in our non-word repetition task (PSRep) and the latter in our behavioral measure of executive functioning (MEFS), more direct, and thereby potentially more sensitive, measurement is possible and should be employed in future research.

Other limitations to the current study derive from our sampling approach. While the sample closely reflected the racial and ethnic composition of the Austin metropolitan area (and was not dissimilar to the U.S. Population overall), it encompassed insufficient diversity to adequately explore interactions between our measures of SES and other key demographics. Indeed, the sample was skewed toward higher SES households, and maternal education was partially confounded with race and ethnicity. This is important in light of work by Farkas and Beron (2004) demonstrating that the vocabulary gap ceases widening for Caucasian children by 36 months, but continues widening until 60 months for African American children. Explicitly comparing relationships among SES, word-learning, and vocabulary across groups will be essential to developing a full understanding of the mechanisms at play, and to establish the generalizability of the current findings.

It is also important to emphasize that the current work cannot speak to the specific experiential origins of children's word-learning skills. Maternal education and income-to-needs ratio are but two of numerous distal indicators of early experience. Future work should include additional measures of other potentially relevant sources of variability in experience within and across SES, including culture, dual language exposure, dialect, family structure, and health metrics. It will also be important to focus on more proximal measures of early communicative input that might support early word learning. Based on existing theory and evidence (e.g., Cartmill et al., 2013; Hoff, 2006; Pace, Luo, Hirsh-Pasek, & Golinkoff, 2017), one example might be the degree to which children hear new words applied to referents in the context of joint attention or other disambiguating contexts. These circumstances might be particularly helpful to children in detecting patterns of language use, and gestural support, that forms the basis of expectations intrinsic to the word-learning strategies under consideration here.

In conclusion, it is important to note that, in addition to its theoretical contribution, the current research suggests a novel approach to addressing current challenges the United States is facing in ensuring children from all backgrounds are well prepared for school. Specifically, this work suggests that we might fruitfully shift the focus of early interventions from teaching children specific words alone to also explicitly teaching word-learning skills. This approach has the potential to powerfully facilitate the generalization of vocabulary gains beyond the specific words taught in any particular intervention. We are currently developing an intervention study to directly test the malleability of early word-learning skills in the face of direct instruction, and the viability of this approach more generally speaking. Regardless of the outcome of this investigation, our hope is that by further elucidating the nature of early emerging disparities in vocabulary knowledge, we will ultimately help to maximize academic outcomes for all children.

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