Early Word-Learning as a Mediator Between Socioeconomic Status and Vocabulary

Fewer than half of children living in poverty in the United States begin school at grade level (Isaacs, 2012), with vocabulary knowledge serving as a particularly salient metric (e.g., Fernald, Marchman, & Weisleder, 2013; Hart & Risley, 1995; Hoff, 2013; Pungello et al., 2009). Although children's vocabulary growth varies substantially within socioeconomic strata (e.g., Pan, Rowe, Singer, & Snow, 2005), and the language of children raised in disadvantaged conditions show some unique strengths (see Pace et al., 2017), early emerging social disparities in vocabulary unfortunately fail to narrow appreciably over time, and have long-term consequences for literacy, as well as broader academic achievement (e.g., Cunningham & Stanovich, 1997; Stahl & Nagy, 2006).

Although these disparities have received quite a lot of empirical attention, important questions remain. For example, how, if at all, do socioeconomically related differences in vocabulary knowledge connect to what we know about the skills young children utilize in learning new words? When faced with a novel word, children apply a number of strategies to hone-in on the intended referent from among what are often many viable alternatives. And once a child has identified the intended referent, they rely on still other strategies to determine what else can (and cannot) be accurately labeled with that same word. 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 & Sabbagh (2013) argue that the same factors that have been implicated as contributing to early emerging differences in children's accumulated vocabulary also have the potential to contribute to disparities in the repertoire of skills and strategies available to children for further word learning (See Fig 1). Consistent with a number of early word-learning theories (Diesendruck & Markson, 2001; Hirsh-Pasek, Golinkoff, & Hollich, 2000; Smith, 2000; Tomasello, 1992; Waxman, 1998), the specific idea is that early socio-linguistic experiences provide a critical backdrop for learning how speakers indicate communicative intentions, as well as the patterns of generalization they follow. To the extent that parents vary in the degree to which they provide opportunities for unambiguously associating new words with their referents, help children identify multiple exemplars associated with any given word, and label in accordance with useful strategies, children might have varying levels of success at abstracting appropriate expectations and developing effective word-learning skills.

In order to evaluate the viability of Henderson and Sabbagh's (2013) model, we examined relationships between children's SES (as a distal indicator of early socio-linguistic experience), word-learning skills, and accumulated vocabulary. We specifically test three key relationships. First, we evaluate whether SES relates to early word learning skills [path (a) in Figure 1]. Although the theories referenced above suggest that word-learning skills and strategies emerge gradually through social-communicative exchange, it is possible that development in this area is robust across a wide range of early experiences, and, in some instances, might even be innately

specified (Golinkoff et al., 1994; Hoff & Naigles, 2002; Markman, 1991). Second, we evaluate whether early word learning skills relate to accumulated real-world vocabulary knowledge [path (b) in Figure 1]. Although research and theory strongly suggest that this relationship too should hold, little systematic evaluation of this possibility has been conducted in the age range targeted here. If both of these relationships are evident, we will then directly evaluate the possibility that early word-learning skills mediate the already well-documented relationship between early experience (as indexed by SES) and vocabulary.

Method

Participants. 205 two- to three-year-old, typically-developing, and English-speaking, children (118 female) participated. Based on parent report, 11.7% were Black or African American, 82% were White, and 5.9% were multiple races or "other." In addition, 33.2% were Hispanic/Latino. Maternal education ranged from 7 to 23 years, with an average of 15.7 years. Over 20% of the sample had no more than a high school degree.

Procedure. Over the course of three experimental sessions (no more than 1-hour each), children completed one standardized test of receptive vocabulary and four tests of word-learning skills. The word-learning tasks all involved asking children to choose the referents of novel words (e.g., *noop*) from a small array of novel items (e.g., a potato masher) based on specific cues as outlined below.

Gaze and Point Following (see Fig 2). It is well established that young children use social cues like pointing and eye gaze to infer the intended referents of novel words (e.g., Baldwin & Tomasello, 1998). We assessed sensitivity to these cues by introducing children to a series of eight treasure boxes, each containing three novel objects. After allowing the child to play briefly with the objects, the experimenter lined them up out of the child's reach. While looking at one of the objects, the experimenter labeled it 3 times (e.g., "Look, it's a *goom*!"). She then put the objects in a clear container, shook them up, and asked for the target object ("Can you give me the *goom*?"). In the first four trials, the experimenter only looked at the target, while in the latter four, she also pointed.

The Mutual Exclusivity Assumption (see Fig 3). Young children tend to map new words onto referents for which they do not already know a name. This *Mutual Exclusivity Assumption* (Markman & Wachtel, 1988) allows children to rule out all potential referents in a naming context that are already represented in their vocabulary. We assessed adherence to the Mutual Exclusivity Assumption by introducing eight boxes, each filled with three known objects and one novel one. The experimenter opened each box in turn, and allowed the child to briefly play with the objects inside before lining them up and asking the child to hand her an item using a novel label (e.g., 'Where is the *hux*?).

The Shape Bias (see Fig 4). 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). We assessed children's reliance on the Shape Bias by introducing children to eight boxes, each containing a target item and three other objects that matched it on a single dimension (color, texture or shape). For each box, the experimenter first pulled out the target object, labeled it ("Look, it's a *blick*), and allowed the child to play with it briefly. She then took it back and labeled it again before lining up the other three objects and asking the child to find another '*blick*' from among them.

Adjective Mapping (see Fig 5). Evidence suggests that children utilize the syntactic frames in which novel words are heard to determine their appropriate range of extension (e.g., Booth & Waxman, 2003; Waxman & Markow, 1998). In order to test children's sensitivity to adjectival syntactic frames, the experimenter began each of eight trials by placing a card depicting a target object on the table, and labeling it three times with a novel adjective (e.g., "Wow - this one is very *yaddish*!). She then introduced a test card picturing three novel items. Although all of these items differed from the labeled target in category membership, one matched its distinctive color and patterning. The experimenter then reminded the child of the target property and requested another one from the test options (e.g., "Remember, that one is very *yaddish*. Can you find another *yaddish* one?")

***Receptive vocabulary*.** Children also completed the Peabody Picture Vocabulary Test – Fourth Edition (Dunn & Dunn, 2007).

***Socio-economic status*.** Parents self-reported information regarding income-to-needs ratio and maternal education (Ensminger & Fothergill, 2003).

Results

Due to the multiple sessions required by our study design and age of our participants, data was partially missing from more than half of our participants. The following analyses were therefore computed based on pooled values obtained through multiple imputation (thereby retaining all 205 participants in our sample). Descriptive statistics and bivariate correlations between our variables are presented in Table 1.

We used Structural Equation Modeling (SEM) in LISREL 8.80 (Jöreskog & Sörbom, 2006) to test our key research questions, as described graphically in Figure 6. The hypothesized model fits the data well; X^2 (df=12) = 13.322 (p = 0.346), CFI = .995, TLI =.991; and RMSEA = 0.025 (CI= 0.000; 0.078), thereby precluding the need for post-hoc modification. More specifically, the model suggests that the environment does affect children's word-learning skills, as socioeconomic status was predictive of word-learning skills, B = 0.40 (SE = 0.09), $p < .05$. The model also confirms that those word-learning skills are predictive of vocabulary scores, B = 0.57 (SE = 0.18), $p < .05$. Standardized parameter estimates are provided in Figure 6.

Given these results, we next sought to test the possibility that word-learning skills mediate the already well-established between SES and vocabulary. To this end, we used the unstandardized parameter estimates from our SEM to conduct a formal mediation analysis (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) with our SES construct serving as the independent variable, our word-learning skill construct serving as the mediator variable, and our measure of accumulated vocabulary serving as our outcome variable. Figure 1 can also be used to visually understand our (structural) mediation model. The direct effect (path c) was significant, thereby providing yet another replication of the 'vocabulary gap,', $p < .05$. 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]. As all values contained in this interval are nonzero, we have confidence that the relation between SES and vocabulary is at least partially mediated by our measures of word-learning skill.

Discussion

In this study, we 1) replicated the already well-established relationship between socioeconomic status and vocabulary 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 socioeconomic status. Furthermore, we provide the first evidence that variation in these word-learning skills partially mediate the relationship between socioeconomic status and accumulated vocabulary.

Importantly, this study does not attempt to explain *why* SES might be related to word-learning skills. We have taken maternal education and income as broad, distal and imperfect indicators of early socio-linguistic experiences and fully acknowledge the complexity of forces embedded therein, as well as independently acting, to shape children's language development. Better specifying the causal forces at play will require a finely tuned analysis of early input, as well as a longitudinal perspective, both of which we are actively working towards.

In the meantime, these results are important because they can help adjudicate between competing theoretical models of social disparities in early vocabulary. Our work suggests that the traditional conception in which SES-related experiences early in life only influence vocabulary acquisition directly is incomplete. Rather, we conclude that Henderson and Sabbagh's (2013) model better fits the available data. Accordingly, early experiences not only directly shape vocabulary acquisition, but they might also influence the development of word-learning skills, which in turn, contribute to vocabulary acquisition. To the extent that this model is correct, it suggests a new approach to helping those children who begin school without foundational vocabulary knowledge to catch up with their peers. Instead of focusing only on teaching children new words, it might also be useful to teach them word-learning skills. Indeed, this approach could be

particularly powerful in facilitating acquisition beyond the specific words taught in any particular intervention.

Figure 1

Adaptation of Henderson & Sabbagh's (2013) proposed model

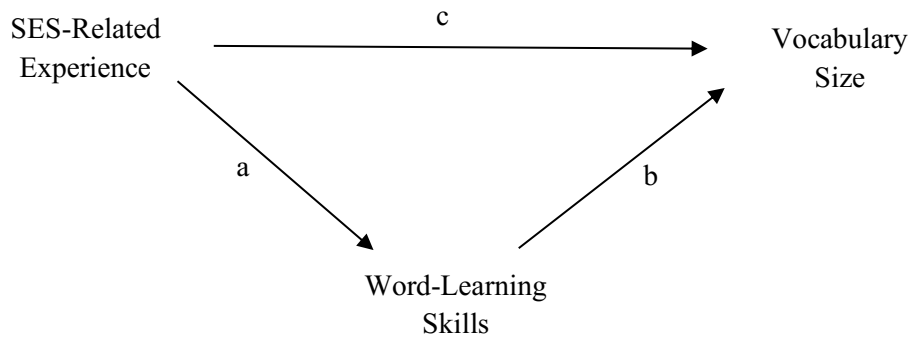

Figure 2

Gaze-and-Point Task administration

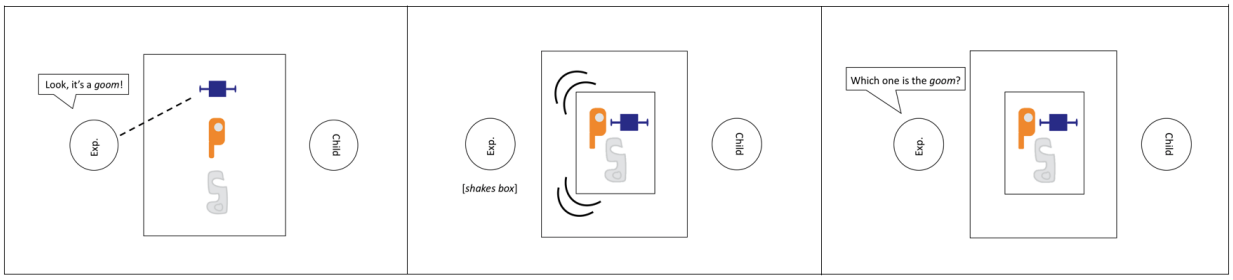

Figure 3

Mutual Exclusivity Task administration

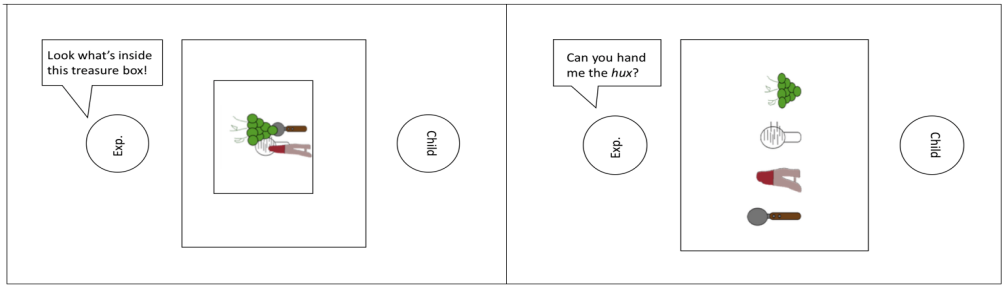

Figure 4

Shape Bias Task administration

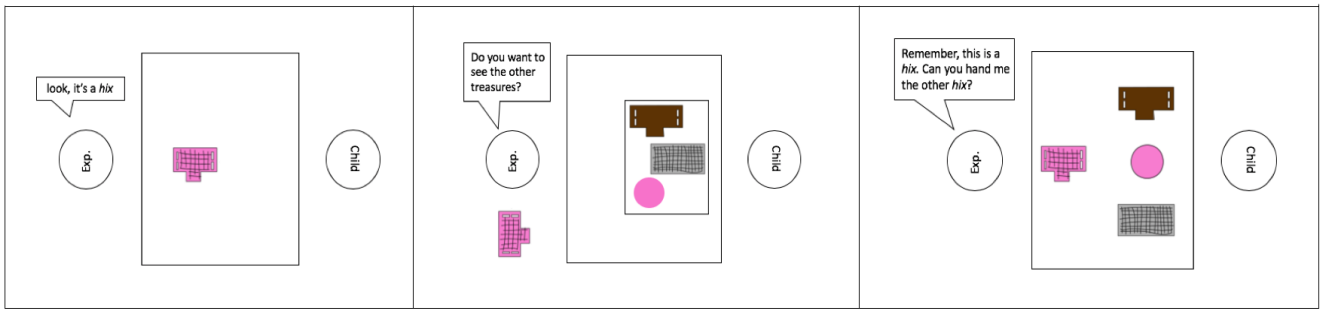

Figure 5

Adjective-Mapping Task administration

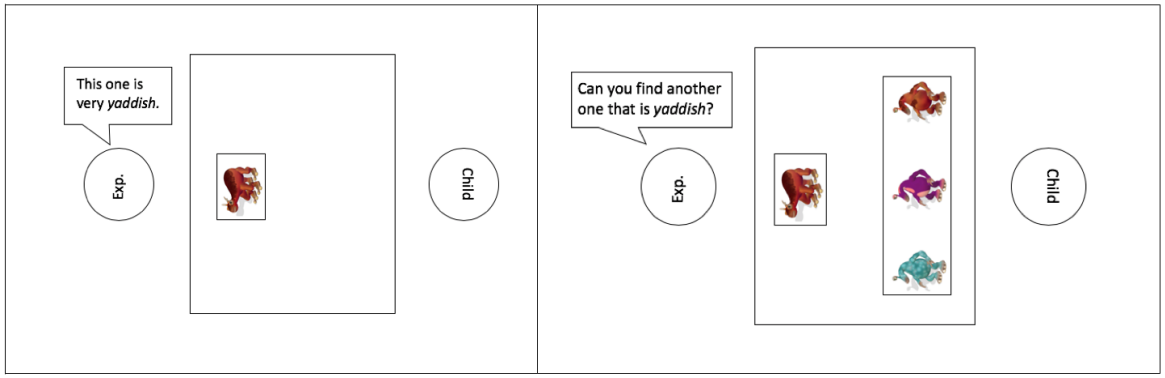

Figure 6

Structural Equation Model. Narrow lines represent measurement components while bold lines represent structural (i.e., theory-driven) components. Circles represent latent variables, and rectangles represent measured variables. All parameter estimates provided are standardized completely and $p < .05$.

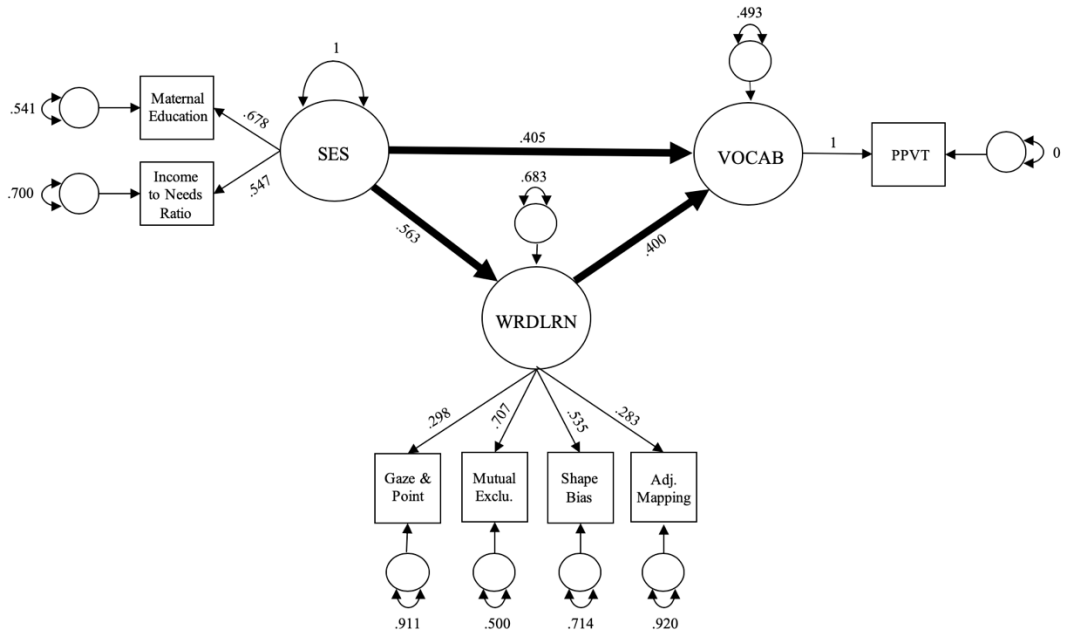

Table 1

Descriptive Statistics and Bivariate Correlations

	Mean (SD)	Bivariate Correlations								
		1	2	3	4	5	6	7	8	9
1. Age	2.883 (.288)	1	-	-	-	-	-	-	-	-
2. Ethnicity	-	.032	1	-	-	-	-	-	-	-
3. Maternal Education	15.726 (2.939)	.000	**-.400****	1	-	-	-	-	-	-
4. Income-to-Needs	3.379 (2.831)	-.051	**-.320****	**.371****	1	-	-	-	-	-
5. PPVT	44.665 (20.783)	**.247****	**-.212****	**.427****	**.346****	1	-	-	-	-
6. Gaze & Point Following	.626 (.225)	.112	-.066	**.184****	.089	.104	1	-	-	-
7. Mutual Exclusivity	.609 (.281)	.124	**-.173***	**.242****	**.197****	**.473****	**.233****	1	-	-
8. Shape Bias	.727 (.236)	**.159***	-.084	**.206****	**.165***	**.326****	**.177***	**.366****	1	-
9. Adjective Mapping	.674 (.279)	.017	-.082	**.169***	**.170***	.159	.147	.145	**.220****	1

** $p < 0.01$ (2-tailed). *$p < 0.05$ (2-tailed).

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