Received: 16 January 2019 | Revised: 9 October 2019 | Accepted: 30 October 2019

DOI: 10.1111/sode.12425

ORIGINAL MANUSCRIPT

WILEY

What you say, and how you say it: Preschoolers' growth in vocabulary and communication skills differentially predict kindergarten academic achievement and self-regulation

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Funding information
This project was supported by National Institute of Child Health and Human Development Grant HD046064 and the Institute of Education Sciences grant R305B090007. The views expressed in this article are ours and do not necessarily represent the granting agencies

Abstract

The idea that language skills support school readiness, predicting later self-regulation and academic success, is widely accepted. Although vocabulary is often emphasized in the developmental literature, the ability to use language appropriately in the classroom, or *social communication skills*, may also be critical. This article examined longitudinal contributions of children's vocabulary and social communication skills, from preschool to kindergarten, to kindergarten academic achievement (reading and math) and self-regulation (executive functions and learning behaviors). Participants were 164 children (14% Latinx, 30% Black, 56% White; 57% girls) enrolled in Head Start programs. Results revealed that initial levels and growth in vocabulary and communication skills predicted better academic achievement. Social communication skills uniquely predicted self-regulation, after accounting for vocabulary. We discuss potential mechanisms for these links and recommend that strategies to build social communication skills be incorporated in preschool interventions promoting school readiness.

KEYWORDS
academic achievement, language development, pragmatics, self-regulation, vocabulary

We appreciate the cooperation of our partners in this project: the parents, students, teachers, and program personnel of the Head Start programs of Huntingdon, Blair, and York counties in Pennsylvania and the many school districts that supported follow-up assessments.

1 | INTRODUCTION

Language skills support children's school functioning in multiple domains (Dickinson, 2011; Morgan, Farkas, Hillemeier, Hammer, & Maczuga, 2015). Children from economically disadvantaged families, such as children enrolled in Head Start programs, often show delays in language development and can have problems adapting to the linguistic demands of school at kindergarten entry (Wasik & Hindman, 2014). These findings have raised interest in the developmental pathways linking growth in preschool language skills and later elementary school functioning, with the hope of informing preschool interventions designed to serve at-risk populations and reduce socioeconomic disparities in school attainment.

Preschoolers' language skills predict several aspects of school functioning, including academic achievement and self-regulation (Dickinson & Porche, 2011; Petersen et al., 2013; Purpura, Hume, Sims, & Lonigan, 2011). The current study focuses on two areas of academic achievement, emergent literacy and math skills, and conceptualizes self-regulation as cognitive and behavioral processes required to engage in context-appropriate, goal-directed learning in the classroom (Blair & Ursache, 2011). To assess self-regulation, we examined children's performance on tasks designed to asses *executive functions* (EF), defined as higher order processes that are thought to facilitate top-down self-regulation, including inhibitory control, working memory, and attention set-shifting (Blair & Ursache, 2011; Roebers, 2017). We additionally examined *learning behaviors* that children displayed in the classroom context, as indicated by teachers' ratings of children's ability to follow school rules and routines and stay focused.

Language skills are diverse, and include structural linguistic competencies (e.g., vocabulary, syntax) and competency in using language effectively in social contexts, referred to as social communication or pragmatic language skills (Bishop, 1998). Links between vocabulary and school functioning have been studied fairly extensively, including in children enrolled in Head Start preschools (Wasik & Hindman, 2014). This study focused specifically on children's ability to use language effectively to navigate the social and behavioral demands of the preschool classroom, including understanding spoken instructions and asking for clarification when needed, expressing ideas clearly, and getting along with others (initiating and sustaining appropriate conversations; using language to settle disagreements). Research on these social communicative aspects of language is less extensive than research on vocabulary but suggests that they represent a distinct dimension of developing language (Roy & Chiat, 2014). Focused primarily on clinical populations, studies have documented links between poor social communication skills and difficulties inhibiting impulsive behaviors and engaging in adaptive learning behaviors (Camarata & Gibson, 1999; Clark, Prior, & Kinsella, 2002).

Additional studies are needed to understand the relative contributions that developing structural skills (such as vocabulary) and social communication skills make to kindergarten adjustment in samples of children at-risk for school difficulties due to family socioeconomic disadvantage. This study addressed this need by examining how level and growth of vocabulary and social communication skills contributed to kindergarten adjustment in areas of academic achievement and self-regulation in a sample of children attending Head Start programs. For achievement, we focused on emergent literacy and numeracy skills that predict and support later academic learning (Duncan et al., 2007). For self-regulation, we focused on EF tasks tapping inhibitory control, working memory, and set-shifting, and teacher ratings of learning behaviors tapping self-discipline and attentional focus.

1.1 | Vocabulary and school functioning

1.1.1 | Vocabulary and academic achievement

Several studies have documented links between early vocabulary and later reading achievement (NICHD Early Child Care Research Network, 2005); as early as 24 months, vocabulary predicts kindergarten reading achievement (Morgan et al., 2015). A larger vocabulary helps children efficiently recognize and identify words in print,

thereby improving later reading comprehension (Muter, Hulme, Snowling, & Stevenson, 2004; Verhoeven, van Leeuwe, & Vermeer, 2011). In addition, vocabulary facilitates the development of code-related skills (e.g., print knowledge, phonological awareness) that are fundamental for learning to read (Mitchell & Brady, 2013) and work together with vocabulary to predict reading achievement in later elementary school (Storch & Whitehurst, 2002).

In addition, evidence suggests that vocabulary influences mathematics achievement. Larger vocabularies may facilitate comprehension of math concepts presented orally during classroom instruction and in story or word problems (Powell & Nelson, 2017). The acquisition of new words often involves creating symbolic labels for abstract concepts, a skill that is fundamental to early math concepts, in which children must represent quantities in words and represent words with number symbols (LeFevre et al., 2010). Empirical studies demonstrate that preschoolers' vocabulary is related to symbolic mathematics skills (e.g., counting) and story problem-solving, even after accounting for other cognitive abilities (Purpura & Ganley, 2014). Moreover, preschoolers' vocabulary predicts their performance on symbolic mathematics and word problem tasks 1 year later, over and above print knowledge and phonological awareness (Purpura et al., 2011).

1.1.2 | Vocabulary and self-regulation

Building a larger vocabulary requires children to attend to, integrate, and manipulate complex streams of information in the environment (Kuhn, Willoughby, Vernon-Feagans, & Blair, 2016; White, Alexander, & Greenfield, 2017). These information processing and representational abilities are thought to create a foundation for EF (Marcovitch & Zelazo, 2009). Children with larger vocabularies when they start preschool perform better on EF tasks at the end of the school year relative to peers with smaller vocabularies, controlling for baseline EF (Fuhs & Day, 2011). Moreover, Kuhn and colleagues (2016) found that rate of change in vocabulary from age of 24–36 months predicted children's performance on EF tasks at 60 months, suggesting that vocabulary growth enhances EF. Although less often studied, toddlers' vocabulary size also predicts self-regulation indexed by learning behaviors, 1–2 years later (Morgan et al., 2015; Vallotton & Ayoub, 2011).

In sum, there is substantial evidence supporting longitudinal links between vocabulary and academic achievement, and emerging evidence linking vocabulary with self-regulation. These studies imply that vocabulary may be an important early intervention target. However, few studies have examined whether *changes* in vocabulary during the prekindergarten year can promote academic achievement. As many preschool interventions target vocabulary growth, this is an important next step.

1.2 | Social communication skills and school functioning

Social communication skills refer to the appropriate use of language in social contexts (Bishop, 1998). As they enter formal schooling, children's social communication skills may provide an important foundation for success. Notably, 84% of kindergarten teachers surveyed by the National Center for Education Statistics identified the ability to verbally articulate wants, needs, and thoughts as a basic index of kindergarten readiness (Lin, Lawrence, & Gorrell, 2003). Problems in preschoolers' social communication that may interfere with effective classroom adaptation include difficulties in academic or emotional support-seeking, explaining one's ideas or viewpoints, using language to collaborate with others and settle disagreements, and initiating, maintaining, and terminating conversations (Landa, 2005).

1.2.1 | Social communication skills and academic achievement

Few studies have directly tested associations between social communication skills and academic achievement. However, one study documented significant correlations between preschoolers' social communication and early

literacy skills (Pinto, Pessanha, & Aguiar, 2013), and a longitudinal study linked lower social communication skills at preschool entry with lower teacher ratings of academic progress by the end of the school year (Norbury et al., 2016). The authors suggest that children with poor social communication skills may not be ready to meet classroom demands or receive instruction. In a notable study of elementary school children with clinical impairments in social communication skills, approximately 40% of children performed at least one standard deviation below average in reading assessments (Freed, Adams, & Lockton, 2015). No known studies link communication skills with math achievement, yet the Principles and Standards for School Mathematics list communication skills as fundamental to facilitating comprehension of abstract mathematic material (National Council of Teachers of Mathematics, 2000).

1.2.2 | Social communication and self-regulation

Conceptually, social communication skills may support children in communicating their needs and wants in words rather than through socially inappropriate or disruptive emotional displays (Izard, 2002), thereby potentially reducing problem behaviors (Cole, Pemberton, & Armstrong, 2010; Greenberg & Kusché, 1993). Deficits in social communication skills have been documented in clinic samples of children with disruptive behavior disorders, including attention problems and oppositional behaviors (Helland, Lundervold, Heimann, & Posserud, 2014; Kim & Kaiser, 2000). In addition, language skills of preschoolers with disruptive behavior disorders are best differentiated from those of normative peers by deficits in social communication skills and expressive vocabulary (Gremillion & Martel, 2014). Population-based evidence also suggests that children with better communication skills display fewer concurrent behavior problems (Norbury et al., 2016). Moreover, once social communication skills were accounted for in a regression predicting concurrent behavior problem of 4-year olds, structural language abilities (vocabulary and grammar) no longer made a significant contribution (Ketelaars, Cuperus, Jansonius, & Verhoeven, 2010).

In sum, extant research suggests that social communication skills are linked with preschoolers' difficulties with self-regulation. However, additional research is needed to test longitudinal links and examine associations with positive indicators of self-regulation and academic achievement.

1.3 | Current study

The current study examined vocabulary and social communication skills at the start of preschool, and from preschool to kindergarten, and explore their relative contributions to kindergarten school functioning, specifically academic achievement (emergent reading and math skills) and self-regulation (EF tasks and teacher-rated learning behaviors). We hypothesized that initial levels and growth in vocabulary would predict enhanced emergent academic and self-regulation skills in kindergarten and that initial levels and growth in social communication skills would predict self-regulation. Given the limited literature examining social communication skills and academic achievement, we had no a priori hypothesis.

2 | METHOD

2.1 | Participants

Data were collected as part of the Research-based Developmentally Informed intervention (REDI; Bierman et al., 2008); present analyses used data from the control group, who received “usual practice” Head Start curriculum. Participants included 164 children (57% girls; 14% Latinx, 30% Black, 56% White), recruited in two successive cohorts from 22 Head Start classrooms from three counties in Pennsylvania. Children were 4.59 years old at the start

of the preschool year (*SD* = .30). Families had a median annual income of $15,000. One-third of parents had not completed high school and most others (65%) had graduated from high school or attained a GED, sometimes with additional technical training; 2% had a college degree. Head Start teachers were all female and predominantly White (lead teachers: 86% White, 9% Black, 5% Latinx; assistant teachers: 80% White, 5% Black, 5% Latinx, 10% Multiracial). Most lead teachers completed a 4-year degree (64%) and others had an associate degree/vocational certificate (36%). Kindergarten teachers were 84.3% female and predominantly White (89% White, 0.8% Latinx, 0.3% Other). All but one kindergarten teacher had completed a 4-year degree, and 46.8% additionally completed a master's degree.

At the beginning of the preschool year, brochures were distributed to parents of all 4-year-old children in participating Head Start classrooms; 86% elected to participate in the study and completed initial assessments. Children were followed as they transitioned into 112 kindergarten classrooms. All but seven children participated in the follow-up assessment at the end of kindergarten (96% retention). *T* tests comparing the seven children who were missing all kindergarten data with the 157 children who remained in the study revealed no significant differences on family demographics or baseline measures used in this study.

2.2 | Procedures

Three waves of data collection were used: start of preschool, from 3 weeks into school year through October (Wave 1), end of preschool, April–May (Wave 2), and end of kindergarten, March–April (Wave 3). Direct assessments were administered individually in school by trained research assistants during two 30–45-min sessions (in preschool) or one 45–60-min session (in kindergarten). Teacher ratings were delivered and explained by a trained research assistant, and then mailed into the research office. In Waves 1 and 2, ratings were completed independently by two co-teachers (lead and assistant), and averaged. In Wave 3, kindergarten teachers provided ratings. Teachers were compensated financially for completing ratings.

2.3 | Measures

2.3.1 | Family socioeconomic status

Families' income-to-needs ratios were calculated as an index of family socioeconomic status (SES). Parents reported on their annual household income and household size. Scores of 1 indicate income-to-needs at the poverty threshold.

2.3.2 | Vocabulary

The Expressive One-Word Picture Vocabulary Test (EOWPVT; Brownell, 2000) was administered at each wave. Children were asked to name pictures of objects. Items were administered sequentially until children failed 6 consecutive items, with 170 possible items total. Scores were total number of correctly identified pictures (α = .93–.94, across waves).

2.3.3 | Social communication

Social communication skills were assessed at each wave using the Social Communication Scale (Welsh, Nelson, & REDI, 2003), an 11-item teacher-rated scale of children's language use, based on work supporting the accuracy of teachers' judgments of student language (Williams, 2006). The scale is similar to the Children's Communication

Checklist, designed to assess communication skills in clinical populations (Bishop, 1998). Items included children's ability to use language to initiate appropriate interactions, settle disagreements, express ideas clearly, along with understanding of spoken instructions and daily conversations (α = .97–.98, across waves). Teachers rated items on a 5-point scale, ranging from "more than 1 year behind other children his/her age" to "more than 1 year ahead of other children his/her age." Items were averaged to create a total scale score. During Head Start when children had lead and assistant teacher ratings, scores were averaged, Wave 1 (r = .61, p < .001) and Wave 2 (r = .63, p < .001).

2.3.4 | Reading achievement

At Wave 1, reading achievement was assessed using three subtests from Pre-CTOPP, now Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen, & Rashotte, 2007) assessing phonological awareness and print knowledge. To create a composite for phonological awareness, scores on the 21-item Blending scale (α = .86), in which children identified the picture or word that best captured the combination of two words or sounds (e.g., light and house) and the 18-item Elision scale (α = .83), in which children identified words that best represented part of a deconstructed word (e.g., snowshoe without shoe), were standardized (z-scored) and averaged, r = .34, p < .001. Additionally, the 36-item Print Knowledge subscale (α = .95), in which children were asked recognition questions about letters and words (e.g., Which letter is M?), was included as a separate covariate due to its smaller correlation with other scales, rs = .16 and .28 with Blending and Elision, respectively.

At Wave 3, reading achievement was assessed with two tests. In the Letter-Word Identification subtest of the Woodcock–Johnson Tests of Achievement, 3rd edition (Woodcock, McGrew, & Mather, 2001), children read aloud from a list of letters and words until they failed four consecutive items (76 possible items; α = .89). In the Sight Word Efficiency subscale of the Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999), children read as many words as they could in 45 s (test–retest reliability reported by the developers of .85–.90). Scores were significantly correlated (r = .86, p < .001), and standardized (z-scored) and averaged to create a kindergarten composite.

2.3.5 | Math achievement

At Waves 1 and 3, math achievement was assessed using the Applied Problems scale of the Woodcock–Johnson Tests of Achievement, 3rd edition (Woodcock et al., 2001). Children performed tasks designed to assess their understanding of numbers of quantity, for example, counting or adding and subtracting small numbers until they failed four consecutive items (58 possible items, α = .81–.82). Scores were total number of correct responses.

2.3.6 | Executive functions

At Waves 1 and 3, three EF tasks were administered. In *Backward Word Span* (Davis & Pratt, 1996) which tapped working memory, children listened to a list of words and tried to repeat them in reverse order, beginning with two words and increasing up to seven. Scores represented the longest sequence that a child could repeat backward correctly. In *Peg Tapping* (Diamond & Taylor, 1996) which tapped inhibitory control, children watched an experimenter tap a wooden dowel; if tapped once, children were to tap theirs twice, and if tapped twice, children were to tap theirs once. Practice trials were given to teach the rule, and then 16 trials were administered. Scores were total number of correct responses. In *Dimensional Change Card Sort* (Frye, Zelazo, & Palfai, 1995) which tapped inhibitory control and set-shifting, children were initially asked to sort a set of cards depicting blue or red rabbits or boats, either by color or by shape for 12 trials. For the remaining six trials, children were required to switch to sorting by the other dimension. Scores were the percentage of postswitch trials correctly sorted. Scores were

significantly correlated (preschool *r*s = .23–.35, $p < .001$; kindergarten *r*s = .23–.35, $p < .001$). Consistent with research demonstrating that early EF skills are generally undifferentiated (Willoughby, Wirth, Blair, & Greenberg, 2012), scores were standardized (*z*-scored) and averaged to create composites.

2.3.7 | Learning behaviors

At Waves 1 and 3, two teacher-rating scales were used to assess learning behaviors. The *School Readiness Questionnaire* (Nix, Bierman, Domitrovich, & Gill, 2013) included 14 items designed to assess self-regulation behaviors in the context of classroom learning, including "This child can follow rules and routines that are part of the school day," "This child has the self-control necessary to do well in school," and "This child can work independently" ($\alpha = .96–.97$). Teachers rated items on a 6-point scale, ranging from "strongly disagree" to "strongly agree." The Inattention subscale of the *Attention Deficit Hyperactivity Disorder Rating Scale* (DuPaul, 1991) included eight items assessing attentional focus and concentration, including "Is easily distracted" and "Doesn't seem to listen" ($\alpha = .93–.97$). Teachers rated items on a 4-point scale, ranging from "not at all" to "very much," and the scale was reverse-scored. Scores were significantly correlated at each wave (*r*s > .73, *p*s < .001), and standardized (*z*-scored) and averaged to create composites.

2.4 | Data analytic approach

Models were fit in R version 3.4.1 lme4/lmerTest packages (Bates, Maechler, Bolker, & Walker, 2015; Kuznetsova, Brockhoff, & Christensen, 2017). Analyses were conducted using a two-stage multilevel modeling (MLM) approach. Firstly, MLMs examined growth in vocabulary and social communication skills across the three waves. Time was centered at Wave 1, so that the extracted parameters represented initial level at start of preschool (intercept) and growth from preschool to kindergarten (slope) for each child, controlling for quadratic rate of change.

Secondly, MLMs tested whether children's intercepts and slopes of vocabulary and social communication skills predicted kindergarten outcomes (reading achievement, math achievement, EF, learning behaviors). Models controlled for child age at Wave 1, child sex, family SES, recruitment cohort, Wave 1 "baseline" for outcome measures in fixed effects, and nesting within classroom in random effects. Likelihood ratio tests were conducted on nested models to compare relative fit of models with covariates only (Model 1), covariates and vocabulary predictors (Model 2), and covariates, vocabulary, and social communication predictors (Model 3).

2.4.1 | Missing data

Only 7 children were missing all sources of data in kindergarten, but an additional 14 students lacked direct assessments ($N = 143$ for reading and math assessments; $N = 137$ for EF assessments due to six invalid assessments) and 16 students lacked teacher ratings ($N = 141$ for learning behavior ratings). Missing data were handled using maximum likelihood estimations.

3 | RESULTS

3.1 | Descriptive statistics

Descriptive statistics for study variables are shown in Table 1. Vocabulary and social communication skills were moderately stable from preschool to kindergarten ($r = .59$ for vocabulary, $r = .53$ for communication skills), and

TABLE 1 Means, standard deviations, and correlations for study variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. W1 age	–																
2. Family SES	.07	–															
3. W1 phonological awareness	.13	.18*	–														
4. W1 print knowledge	.19*	.02	.27*	–													
5. W1 mathematics	.24*	.15	.52*	.42*	–												
6. W1 EF	.30*	.10	.56*	.45*	.58*	–											
7. W1 learning behaviors	.20*	.05	.16*	.21*	.23*	.26*	–										
8. W1 vocabulary	.26*	.19*	.45*	.45*	.53*	.44*	.24*	–									
9. W2 vocabulary	.24*	.07	.41*	.41*	.54*	.49*	.23*	.82*	–								
10. W3 vocabulary	.26*	.15+	.37*	.27*	.47*	.38*	.26*	.69*	.69*	–							
11. W1 social comm.	.20*	.12	.43*	.36*	.48*	.43*	.31*	.48*	.49*	.39*	–						
12. W2 social comm.	.14+	.08	.47*	.34*	.41*	.41*	.29*	.47*	.52*	.35*	.81*	–					
13. W3 social comm.	.21*	−.04	.46*	.35*	.42*	.41*	.31*	.35*	.42*	.43*	.53*	.56*	–				
14. W3 reading	.19*	.01	.30*	.37*	.34*	.29*	.20*	.37*	.42*	.43*	.37*	.37*	.56*	–			
15. W3 mathematics	.21*	.08	.53*	.32*	.54*	.50*	.31*	.41*	.47*	.47*	.40*	.43*	.46*	.44*	–		
16. W3 EF	.06	.04	.40*	.16+	.35*	.43*	.31*	.29*	.31*	.36*	.25*	.33*	.42*	.23*	.52*	–	
17. W3 learning behaviors	.16*	.04	.27*	.30*	.28*	.28*	.09	.11	.20*	.20*	.32*	.31*	.52*	.44*	.31*	.26*	–
Mean	4.59	.88	.00	7.97	9.77	.01	.03	34.62	41.03	50.77	−.02	.13	−.15	.00	18.50	−.01	.01
SD	.30	.53	.82	8.31	3.94	.72	.29	10.77	11.24	11.20	.58	.55	.63	.97	3.57	.66	.94

Note: Reading, EF, learning behaviors were standardized (z-scored) composites.

Abbreviations: EF = executive functions; Social comm. = social communication; *SD* = standard deviation; SES = socioeconomic status; W = wave.

$^{+}p < .10$; $^{*}p < .05$.

TABLE 2 Growth models for vocabulary and social communication skills

	Estimate (*SE*)					
	Vocabulary			Social Communication Skills		
	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
Fixed effects						
Intercept	42.02 (.79)**	34.13 (.86)**	34.68 (.88)**	1.99 (.04)**	2.05 (.05)**	1.98 (.05)**
Wave (linear)	–	8.02 (.35)**	4.61 (1.09)**	–	−.06 (.02)*	.36 (.06)**
Wave (quadratic)	–	–	1.71 (.52)*	–	–	−.22 (.03)**
Random effects (SD)						
Intercept, child	8.28	9.74	9.83	.46	.50	.52
Slope, child	–	1.94	2.17	–	.16	.20
Covariance *(r)*	–	−.25	−.27	–	−.36	−.42
Residual	9.87	5.46	5.28	.38	.34	.29
Model fit						
AIC	3,710.27	3,377.35	3,368.84	711.84	704.06	657.70
BIC	3,722.76	3,402.33	3,397.98	724.36	729.09	686.90
Log likelihood	−1,852.137	−1,682.68	−1,677.42	−352.92	−346.03	−321.85
χ^2 from previous	–	338.92**	10.52*	–	13.78*	48.36**

Note: $N = 164$; Quadratic used for parameter extraction.
$^{+}p < .10$; $^{*}p < .01$; $^{**}p < .001$.

inter-correlated across waves, *rs* ranging from .43 to .52. Kindergarten outcomes were moderately inter-correlated, ranging from $r = .52$ (for EF and math) to $r = .23$ (for EF and reading).

3.2 | Level and growth in language skills

Multilevel models were fit to examine change in vocabulary and social communication skills across waves (Table 2 summarizes model building steps and results). The best-fitting model for vocabulary included linear and quadratic terms and revealed overall significant linear increases in vocabulary across waves ($b = 4.61$, $SE = 1.09$, $p < .001$) and acceleration of growth ($b = 1.71$, $SE = .52$, $p < .01$). There was substantial variation in children's intercepts ($SD = 9.83$, 95% CI: 8.56, 11.28) and slopes ($SD = 2.17$, 95% CI: 1.25, 3.75). The best-fitting model for social communication skills included linear and quadratic terms and revealed overall significant linear increases in social communication skills across waves ($b = .36$, $SE = .06$, $p < .001$) and deceleration of growth ($b = -.22$, $SE = .03$, $p < .001$). There was substantial variation in children's intercepts ($SD = .52$, 95% CI: .46, .60) and slopes ($SD = .20$, 95% CI: .16, .26). Higher initial levels of social communication skills were associated with smaller slopes ($r = -.42$, 95% CI: −.60, −.21).

3.3 | Predicting kindergarten outcomes

Multilevel models were conducted to examine whether initial levels of vocabulary and communication skills, and linear slopes reflecting growth across waves, were associated with academic achievement (Table 3) and

TABLE 3 Vocabulary and social communication skills predicting academic achievement

	β (*SE*)					
	Reading			Mathematics		
	Covariates	Vocabulary	Vocabulary and social comm.	Covariates	Vocabulary	Vocabulary and social comm.
Fixed effects						
Intercept	−2.65 (*1.29*)*	−3.87 (*1.18*)**	−4.61 (*1.14*)***	10.19 (*4.23*)*	6.15 (4.12)	4.37 (*4.00*)***
Baseline score(s)	0.20 (0.*10*)*	0.10 (0.*10*)	−0.03 (0.*10*)	0.51 (0.*07*)***	0.38 (0.07)***	0.32 (0.*07*)
	0.30 (*0.01*)***	0.22 (*0.01*)**	0.16 (*0.01*)*			
Recruitment cohort	0.13 (0.*15*)+	0.15 (0.*14*)*	0.12 (0.*13*)+	−0.05 (0.*55*)	−0.03 (0.50)	−0.05 (0.*47*)
Sex	0.05 (0.*15*)	0.10 (0.*14*)*	0.04 (0.*14*)	−0.12 (0.*51*)+	−0.07 (0.49)	−0.11 (0.*48*)
Family SES	−0.05 (0.*15*)	−0.07 (0.*14*)	−0.01 (0.*13*)	−0.02 (0.*50*)	−0.03 (0.47)	−0.01 (0.*46*)
Age	0.13 (0.*26*)+	0.07 (*0.25*)	−0.04 (0.*23*)	0.08 (0.*90*)	0.05 (0.86)	0.03 (0.*83*)
Vocabulary intercept	–	0.36 (0.*01*)***	0.26 (0.*01*)**	–	0.31 (0.03)***	0.20 (0.*03*)*
Vocabulary slope	–	0.18 (0.*06*)*	0.10 (0.*06*)	–	0.19 (0.22)**	0.17 (*0.22*)*
Social comm. intercept	–	–	0.31 (0.*19*)***	–	–	0.25 (*0.64*)**
Social comm. slope	–	–	0.33 (0.*54*)***	–	–	0.15 (*1.84*)*
Random effects (SD)						
Intercept, classroom	<0.001	<0.001	0.05	0.54	0.32	<0.001
Residual	0.87	0.82	0.76	2.97	2.82	2.74
Model fit						
Conditional R^2	0.16	0.30	0.40	0.34	0.41	0.44
AIC	385.50	369.77	355.11	737.49	723.57	718.15
BIC	412.17	402.37	393.62	761.20	753.20	753.70
Log Likelihood	−183.75	−173.89	−164.55	−360.75	−351.80	−347.07
χ2 from previous	–	19.73***	18.67***	–	17.92***	9.42**

Abbreviations: Social comm. = social communication; *SD* = standard deviation; SE = standard error; SES = socioeconomic status; baseline scores for reading: Row 1 = phonological awareness, Row 2 = print knowledge.

Italics used to indicate Standard Error (SE) of estimates

$^{+}p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

TABLE 4 Vocabulary and social communication skills predicting self-regulation

	β (*SE*)					
	Executive functions			**Learning behaviors**		
	Covariates	**Vocabulary**	**Vocabulary and social comm.**	**Covariates**	**Vocabulary**	**Vocabulary and social comm.**
Fixed effects						
Intercept	.80 (*.87*)	.34 (*.88*)	−.13 (*.86*)	−2.97 (*1.22*)*	−3.47 (*1.26*)**	−4.40 (*1.12*)***
Baseline score	.46 (*.07*)***	.38 (*.08*)***	.32 (*.08*)***	.07 (*.26*)	.04 (*.26*)	−.08 (*.24*)
Recruitment cohort	.02 (*.11*)	.02 (*.11*)	.002 (*.10*)	.02 (*.15*)	.03 (*.15*)	−.04 (*.14*)
Sex	−.02 (*.10*)	.01 (*.10*)	−.04 (*.10*)	.29 (*.15*)***	.31 (*.15*)***	.21 (*.13*)**
Family SES	−.01 (*.10*)	−.02 (*.10*)	.02 (*.09*)	.03 (*.14*)	.01 (*.14*)	.06 (*.13*)
Age	−.08 (*.18*)	−.11 (*.18*)	−.13 (*.17*)	.17(.26)*	013 (.26)	.10 (.23)
Vocabulary intercept	–	.23 (*.01*)*	.14 (.01)	–	.21 (*.01*)*	−.05 (*.01*)
Vocabulary slope	–	.08 (*.05*)	.02 (.05)	–	.10 (*.07*)	.02 (*.06*)
Social comm. intercept	–	–	.19 (.13)*	–	–	.52 (*.18*)***
Social comm. slope	–	–	.29 (.37)***	–	–	0.42 (*0.51*)***
Random effects (SD)						
Intercept, classroom	.12	.11	.07	<.001	<.001	.11
Residual	.57	.56	.54	.87	.85	.74
Model fit						
Conditional R^2	.26	.31	.35	.12	.16	.37
AIC	257.44	254.74	246.86	376.81	374.60	342.47
BIC	280.80	283.94	281.90	400.40	404.10	377.85
Log likelihood	−120.72	−117.37	−111.43	−180.41	−177.30	−159.24
χ2 from previous	–	6.70*	11.88**	–	6.21*	36.14***

Abbreviations: Social comm. = social communication; *SD* = standard deviation; *SE* = standard error; SES = socioeconomic status.

*p < .05; **p < .01; ***p < .001; ^{+}p < .10.

self-regulation (Table 4) in kindergarten. Because the social communication measure required teachers to rate children's skills relative to same-age peers, in contrast to vocabulary which measured absolute change in task performance, we refer to social communication slopes as indicating rate of growth and vocabulary slopes as indicating growth.

3.3.1 | Reading achievement

Initial levels of vocabulary (β = .27, *SE* = .01, *p* < .01) and social communication skills (β = .31, *SE* = .19, *p* < .001) each predicted better reading achievement at Wave 3. Rate of growth in social communication skills (β = .33, *SE* = .55, *p* < .001), but not growth in vocabulary (β = .10, *SE* = .06, *p* = .18) predicted reading achievement at Wave 3.

3.3.2 | Mathematics achievement

Initial levels of vocabulary (β = .20, *SE* = .03, *p* < .05) and social communication skills (β = 0.25, *SE* = .64, *p* < .01) each predicted math achievement at Wave 3. Growth in both vocabulary (β = .17, *SE* = .22, *p* < .05) and rate of growth in social communication skills (β = .15, *SE* = 1.84, *p* < .05) was associated with better math achievement at Wave 3.

3.3.3 | Executive functions

Initial levels of social communication skills (β = .19, *SE* = .13, *p* < .05) were significantly associated with EF at Wave 3, but initial levels of vocabulary were not (β = .14, *SE* = .01, *p* = .15). Similarly, rate of growth in social communication skills significantly predicted EF at Wave 3 (β = .29, *SE* = .37, *p* < .001), but growth in vocabulary was not associated with EF at Wave 3 (β = .02, *SE* = .04, *p* = .84).

3.3.4 | Learning behaviors

Initial levels of social communication skills were significantly associated with learning behaviors at Wave 3 (β = .52, *SE* = .18, *p* < .001), but initial levels of vocabulary were not (β = −.05, *SE* = .01, *p* = .57). Similarly, rate of growth in social communication skills predicted learning behaviors at Wave 3 (β = 42, *SE* = .51, *p* < .001), but growth in vocabulary was not associated with learning behaviors at Wave 3 (β = .02, *SE* = .06, *p* = .76).

4 | DISCUSSION

The present study examined the relative contributions of vocabulary and social communication skills at preschool entry and change in these skills from preschool to kindergarten to children's academic achievement and self-regulation at the end of kindergarten. Overall, the raw scores reflecting vocabulary knowledge showed significant growth from preschool to kindergarten, with substantial individual variation in initial levels and in pace of skill development. Social communication skills were rated on a relative scale (i.e., compared to teachers' expected age norms). They showed significant rate of growth during the preschool year as teachers observed improvements relative to expectations, again with substantial individual variation. Deceleration in social communication skill rate of growth was evident as children entered kindergarten. This trend likely reflected the relative norms of the Head Start teachers (who served only low-income children) and kindergarten teachers (who served children

from more advantaged families as well, and hence likely had higher expectations for normative skill levels). The vocabulary and social communication skills children had at the start of the preschool year predicted their reading and math achievement at the end of kindergarten, controlling for baseline skills. In addition, growth in vocabulary and rate of growth in social communication skills each incrementally contributed to math achievement and rate of growth in social communication skills also incrementally contributed to reading skills. Social communication skills emerged as the unique predictor of self-regulation, with initial levels of and rate of growth in social communication skills contributing significantly to kindergarten EF and learning behaviors in models that included vocabulary.

4.1 | Academic achievement

As expected, vocabulary at preschool entry predicted kindergarten reading and math achievement. This finding is consistent with prior studies documenting links between vocabulary and reading in early childhood (e.g., Morgan et al., 2015). Given our measures of reading achievement, this study supports the hypothesis that preschoolers' initial vocabulary facilitates code-related reading skills that are fundamental to early literacy (Mitchell & Brady, 2013). However, contrary to hypotheses, *growth* in vocabulary from preschool to kindergarten did not predict reading achievement. This may be related to the outcome measure's focus on code-related reading skills. If we had included broader measures of reading comprehension, they may have been more sensitive to the incremental contribution of children's growth in vocabulary skills from preschool to kindergarten.

The finding that vocabulary predicted math skills builds on recent evidence linking these two domains of development (Purpura & Ganley, 2014). Our findings suggest that vocabulary facilitates understanding of basic numeracy skills (quantity and counting), possibly because vocabulary enhances the uptake of classroom instruction and understanding of abstract concepts. The current findings extend prior research by documenting that *growth* in vocabulary from preschool to kindergarten predicts kindergarten math achievement, after controlling for preschool math achievement. These findings suggest that, in addition to earlier efforts, interventions that boost vocabulary growth during prekindergarten can incrementally impact kindergarten math performance, thus highlighting vocabulary growth as an important ongoing target for prekindergarten interventions.

Social communication skills also predicted better kindergarten reading and math achievement. A few prior studies have documented positive concurrent associations between social communication skills and academic performance in elementary school students (Freed et al., 2015) and preschoolers (Pinto et al., 2013). This study expands upon those findings, documenting longitudinal prediction of academic skills with incremental contributions made by initial preschool levels and rate of growth in social communication skills, after controlling for vocabulary and baseline academic skills. The social communication skills measured here (initiating and maintaining verbal interactions with adults and peers, asking for academic support or clarification when needed) likely facilitated children's abilities to participate effectively in group discussions and group-based learning activities that are common in early education, providing them with enhanced learning opportunities.

Overall, these findings suggest that social communication skills, along with vocabulary, should be a focus of early education and preschool intervention efforts. Although skills at preschool entry matter, advancing vocabulary and social communication skills throughout preschool also predicts better kindergarten academic achievement, suggesting that intervening in these areas could be fruitful.

4.2 | Self-regulation

Initial levels of social communication skills and rate of growth in these skills from preschool to kindergarten uniquely predicted both measures of kindergarten self-regulation. The unique links between social communication skills and self-regulation that emerged here are consistent with prior studies documenting associations

between poor social communication skills and problems with self-regulation, specifically teacher-rated inattention and hyperactivity (Norbury et al., 2016). However, the present findings additionally suggest that social communication skills are related to positive indicators of self-regulation. That *rate of growth* in social communication skills also uniquely predicted kindergarteners' EF and learning behaviors suggests that interventions targeting this domain of language may be useful for promoting early self-regulation, an area of interest in Head Start programs (U.S. Department of Health and Human Services, 2015).

Consistent with Ketelaars and colleagues (2010), the inclusion of social communication skills in predictive models reduced the variance in self-regulation accounted for by vocabulary in prior studies (e.g., Fuhs & Day, 2011). Indeed, initial levels of preschool vocabulary predicted better kindergarten EF and learning behaviors prior to the inclusion of social communication skills in the model (see Table 4), but social communication skills emerged as the unique predictor of kindergartners' EF skills and learning behaviors in the best-fitting model. These findings broadly suggest a distinction between understanding the structural components of language, such as vocabulary, and social communications skills which allow children to use language appropriately in classroom interactions. Mechanisms uniquely linking social communication skills with self-regulation are not well understood, but we offer possible explanations that can be tested in future research.

Communicating effectively with others may draw on and promote the self-regulation skills that EF facilitates, such as organizing simultaneous streams of information appropriately and shifting rule sets (Kuhn, Willoughby, Wilbourn, Vernon-Feagans, & Blair, 2014). For example, effective social communication skills reflect the capacity to adjust one's language use when interacting with teachers versus peers and inhibiting/shifting responses across classroom and play contexts. Relatedly, better social communication skills may increase productive engagement in group-based classroom learning activities, fostering the development of EF through opportunities for turn-taking, role play and discussion (Bierman & Torres, 2016).

Additionally, social communication skills may help children initiate verbal interactions that support their wants, needs, and feelings. Hence, children with better social communication skills may be more effective at negotiating peer conflicts and achieving social goals, demonstrating better emotional self-control and communication (Cole, Armstrong, & Pemberton, 2010; Greenberg et al., 1991). Conversely, children with poor social communication skills may express wants, needs, and feelings in less adaptive ways, such as inappropriate emotional displays or disruptive behaviors; this may, in turn, interfere with maintaining goal-oriented learning.

In contrast to present findings, a prior study documented a significant link between vocabulary and EF in toddlerhood (Morgan et al., 2015). It may be that vocabulary acquisition promotes EF during the early toddler years, when children are rapidly acquiring novel words (Fenson et al., 1994), but additional communication skills play a more central role as children move into the more complex social contexts that characterize preschool. Indeed, Kuhn and colleagues (2016) found that growth in vocabulary from 24 to 36 months, but not from 36 to 60 months, predicted EF at 60 months.

4.3 | Limitations

This study relied on teacher ratings of children's communication skills. Although there are some standardized measures of pragmatic language designed for older children (Carrow-Woolfolk, 1999), other studies of preschoolers' social communication skills have similarly used teacher or clinician ratings. This study's measure demonstrated strong internal consistency in this sample, although inter-rater reliability among teachers was somewhat low and correlations between preschool and kindergarten waves were weaker than associations between start and end of preschool ratings, possibly suggesting a shift in teacher expectations at kindergarten entry. The scale also used *relative* ratings, such that “about average” was the midpoint, which likely influenced rating distributions and the meaning of growth. In addition, teacher evaluations may be affected by correlated student characteristics, such

as better teacher–child or peer relationships. These unmeasured factors may have inflated associations between social communication skills and outcomes.

Although predictive correlations found in this study are consistent with causal interpretations, this kind of passive longitudinal study cannot determine causality and hence the discussion of developmental pathways in this article is speculative. We also note that our assessment of reading achievement used different measures at Waves 1 and 3, and these measures tapped rather narrow aspects of emerging reading skills, possibly attenuating associations with vocabulary. A related limitation is the possibility that untested pathways exist, including bidirectional effects among the study variables.

Finally, this study focused on children from low-income families enrolled in Head Start programs. We did not find associations between family SES and outcomes, likely due to attenuation associated with the restricted range of family SES in the sample. Children from economically disadvantaged families typically lag behind their more advantaged peers in areas of language development and school readiness. In this sample, children's average Standard Scores in vocabulary were below norms at Wave 1 (M = 82.37, SD = 13.53), Wave 2 (M = 85.00, SD = 13.08), and Wave 3 (M = 86.50, SD = 11.65). Additional research is needed to determine whether associations found in this study generalize to children from more economically advantaged families.

4.4 | Implications for intervention and future research

The current study highlights the importance of tracking and suggests the promise of promoting two dimensions of developing language—vocabulary and social communication skills—in classrooms serving children from economically disadvantaged backgrounds. These language skills were moderately correlated yet contributed in differential ways to children's school success. In particular, a novel finding of this study was that initial levels and rate of growth in social communication skills during preschool predicted kindergarten self-regulation over and above the contributions made by vocabulary. Thus, social communication skills, along with vocabulary, may be an important target for future interventions, particularly given the importance of self-regulation for successful adaptation to schooling for children facing economic disadvantage (Ursache, Blair, & Raver, 2012).

A substantial empirical literature provides guidance regarding the type of interactive reading strategies and teacher language use that promote vocabulary in children from diverse economic backgrounds (see review by Wasik, Hindman, & Snell, 2016). Although not yet evaluated at the classroom level, interventions that have been useful for clinical populations with social communication deficits should be explored in future research (Adams, Norbury, Tomblin, & Bishop, 2008). These interventions target skills that could be addressed with expanded interactive reading programs, such as children's question-asking, verbal turn-taking, and narrative skills. Interventions designed to promote teacher–child conversations may also foster growth in children's social communication skills. Indeed, low-income children who received a home visiting program that included interactive reading and social communication games showed improvement in receptive social communication skills (Bierman, Welsh, Heinrichs, & Nix, 2018). Targeting children's ability to use their language effectively in the classroom, as well as increasing their knowledge of words may have broad benefits for children's school success.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the senior author upon reasonable request.

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How to cite this article: Ramsook KA, Welsh JA, Bierman KL. What you say, and how you say it: Preschoolers' growth in vocabulary and communication skills differentially predict kindergarten academic achievement and self-regulation. *Social Development*. 2019;00:1–18. https://doi.org/10.1111/sode.12425