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Use Your Words:

Do Expressive Language Skills Help Toddlers Self-Regulate?

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Use Your Words: Do Expressive Language Skills Help Toddlers Self-Regulate?

Abstract

Self-regulation emerges throughout early childhood, and predicts later success in socially and cognitively challenging situations. Vygotsky proposed that symbols, particularly words, serve as mental tools to be used in service of self-regulation. Cross-sectional research indicates a positive but inconsistent associations between language and self-regulation skills throughout toddlerhood, but has not accounted for general cognitive development, nor gender differences in these domains. We used growth modeling of longitudinal data for 120 toddlers collected when children were 14, 24, and 36 months to test the impact of two expressive language skills – spoken vocabulary and talkativeness – on the growth of toddlers' self-regulation, and to determine whether associations between these domains exists when controlling for cognitive development. Results reveal gender differences in self-regulation trajectories, and in the impact of language on self-regulation. Vocabulary is a better predictor of self-regulation than talkativeness, and both concurrent and prior vocabulary positively affected children's levels of self-regulation. When cognitive development was controlled, 24-month vocabulary still predicted the trajectory of self-regulation. Results reveal that even in early development words are tools that can be applied to the task of self-regulation, and may be a more necessary tool for boys than for girls at this age.

Key Words: self-regulation, language development, symbol, gender differences, Vygotksy

Use Your Words: Does Expressive Language Help Toddlers Self-Regulate?

Introduction

"Use your words" is a common phrase addressed to toddlers and preschoolers who are acting out in frustration. This phrase reveals the common belief that when children have the words to express their desires, needs, or feelings, they can better regulate their behavior to match the social expectations of the situation. The ability to self-regulate enables children to adapt to and gain the most from their environments; thus much attention is given to the developmental processes and experiences that help children develop self-regulation skills. Several studies have found positive associations between language skills and pro-social and self-regulatory behavior in three to five year olds in both typical (e.g. Astington & Jenkins, 1999; Cutting & Dunn, 1999) and atypical populations (Cole, Zhan-Waxler, & Smith, 1994; Spira & Fischel, 2005). However, few studies have examined such associations for children under three, when there is wide variation in language skills, and when developmentally based interventions may be most valuable. Cole, Armstrong, and Pemberton (2010) review the research on the development and integration of expressive language and self-regulation skills, and pose the question: Do children need to develop a certain level of expressive language, executive functioning, and emotion regulation as separate domains before these skills are integrated? Thus, we may ask whether parents and educators have unrealistic expectations about the role of language in the self-regulatory skills of toddlers when they use the phrase "Use your words" to encourage a child's verbal self-regulatory skills. Do language skills support the self-regulation of even very young children, or do these skills integrate only later in development once children are more consistent users of language? Further, if language skills do support self-regulation, which aspects of language help children self-regulate? It might be that children who talk more exert more control

over their environments and thus are less frustrated. Or it may be that children who have larger vocabularies, indicative of larger symbolic repertoires, have more mental tools to use in service of self-regulation. This paper addresses the commonly held belief that young children's language skills support their self-regulation by examining the longitudinal development of these skills in toddlers.

The Development of Self-regulation in Young Children

Self-regulation is widely recognized as a critical social-emotional skill underpinning children's abilities to act pro-socially with peers and adults, participate productively in learning activities, and adapt successfully to new or challenging situations. Kopp (1982) described the basic development of self-regulation in early childhood as growing from early reactive reflexes to proactive and conscious planning processes (Bronson, 2000; Kopp, 1982). In the toddler years, between one and three years of age, self-regulatory skills are still rudimentary, yet develop rapidly. In the first half of the second year, children gain awareness of social requirements and expectations and can initiate and terminate actions to comply with these expectations and to achieve social and physical goals. In the third year of life, children's growing representational skills underpin their ability to exert control on their own actions in response to internal representations such as rules, rather than just in reaction to a parent's immediate prohibitions or reminders (Kopp, 1982).

One source of variation in early self-regulation is gender. Weinberg and Tronick (1995) have documented that within the first year of life, girls show a greater diversity of self-regulatory strategies, and maintain their physiological regulation more consistently in the face of external challenges, such as mothers' absence. Further, Raikes and colleagues found that girls had higher self-regulation skills throughout toddlerhood between 14 and 36 months of age (Raikes,

Robinson, Bradley, Raikes, & Ayoub, 2007). Another source of variation in young children's self-regulation is their general cognitive skills, particularly the development of executive functioning which, during early childhood, is particularly dependent upon brain maturation of (e.g. Bernier, Carlson, & Whipple, 2010; Stevens, Lauinger, & Neville, 2009).

Symbol Skills Support Self-Regulation

Vygotsky (1934/1986) proposed that self-regulation of thought and behavior is learned through a process in which children learn their culture's symbols and thought patterns by internalizing their caregivers' regulatory speech. According to Vygotsky, internalized symbols – typically words – become mental tools to be used in service of manipulating one's own mind and behavior. Thus, we reason, the broader one's symbolic repertoire, the more tools for self-regulation one has. Kopp (1982; Vaughn, Kopp, & Krakow, 1984) frames the development of self-regulation similarly as an internalization of caregiver-modeled regulatory strategies. In early development, caregivers play a central role in regulating children's behavior and emotion using increasingly cognitive means – that is, by talking to them, providing verbal prohibitions or comforts (Vaughn, Kopp, & Krakow, 1984). Thus, the transition from reactive (e.g. self-soothing after upset) to proactive (e.g. inhibiting pre-potent behavior) regulation is facilitated by children's growing representational abilities, including the internalization of their caregivers' self-regulatory speech facilitated by language development. If this is true for even very young children, we might expect their self-regulation skills to grow as their vocabulary grows rapidly in the second and third year of life.

There is a body of research linking self-regulation and language skills, most of these studies have been conducted with preschool and older children (e.g. Müller, Zelazo, Lurye, Liebermann, 2008; Ponitz, McClelland, Matthews, & Morrison, 2009). For example, Bono

(2003) found an association between self-regulation and language development in children entering kindergarten, and found that self-regulation mediated the relationship between language and cognitive school readiness. Further, there are studies showing associations between delayed language and behavior problems. For example, observing preschool children with and without language delays in a classroom setting, Qi and Kiser (2004) found that preschoolers with language delays more often acted aggressively and disruptively, and less were likely to initiate and engage pro-socially. Thus, as preschool children's representational repertoire grows so do their abilities to regulate their behavior in service of social expectations.

While these studies with older children provide support for the hypothesis that language supports self-regulation, as pointed out by Muller and colleagues (2009), most studies of these two domains either test non-directional associations between language and self-regulation, or use language as a control variable, rather than investigating the contribution of language to self-regulation. In the current study, we are interested in whether and how language supports the development of self-regulation.

Evidence for a supportive relationship between language skills and self-regulation come from intervention studies. One intervention study by Lederer (2001) documented the effects of a language intervention for late-talking toddlers in the early third year of life. Though the intervention was focused on child vocabulary, parents reported increases in children's social as well as language skills. Another intervention aimed at increasing preschoolers' language skills found that children's participation during preschool predicted their social skills in early adolescence (Niles, Reynolds, & Roe-Sepowitz, 2008). Specifically, the participants had lower acting out behaviors, higher assertiveness, and better social skills with peers. Importantly, these effects varied by gender and by family risk status. Participation in the language intervention had

a greater impact on boys' than girls' acting out behavior, and children who came from higher-risk families – in terms of income, parental education, parental employment, and family structure – had greater gains in assertiveness and positive social behavior with peers (Niles, Reynolds, & Roe-Sepowitz, 2008).

Cole, Armstrong, and Pemberton (2010) propose several ways that expressive language may support self-regulation skills, even in young children. They propose that expressive language provides children with a socially acceptable way to communicate their needs, that language enhances children's abilities to understand internal states, and that language may also serve to help children regulate their own behavior (p. 59). One way that language skills have been documented to contribute to preschool children's self-regulatory abilities is through the use of private speech. While this evidence does not yet extend to children under three years old, it is useful to review it here to consider whether this may be one mechanism by which greater language skills may lead to greater self-regulation.

Self-regulatory private speech – or talking to one's self in order to monitor and modify one's own behavior – has been documented as early as the fourth year of life (Winsler, Carlton, & Barry, 2000). Private speech among preschool children predicts social skills such that children who use more private speech to solve problems have greater social skills and fewer problem behaviors (Winsler, De Leon, Wallace, Wilson-Quayle, & Carlton, 2003). Further, both boys' and girls' use of private speech during solitary activities has been associated with teacher-rated self-regulation skills (Broderick, 2001). Both children who are at risk for behavior problems and those who are not benefit from using private speech; further, both groups increase their use of private speech and their subsequent performance on challenging motor tasks when instructed by a teacher to use speech (Winsler, Manfra, & Diaz, 2007). While the documentation of language

used in the service of self-regulation – through private speech – is sparse for infants and toddlers under three years old, there is no published evidence that private speech *does not* occur prior to three years old. In fact, some work on gestures indicates that children in their second and third years of life can use gestures in a self-reflexive way to modify their own behavior (see Pea, 1980; Rodriguez & Palacios, 2007; Vallotton, 2008).

There are two cross-sectional studies that have addressed the relationship of language and self-regulation in children under three years old, both of which show positive associations between the domains. Vaughn, Kopp, and Krakow (1984) examined the developmental predictors of self-control during toddlerhood between 18 and 30 months of age. They measured self-control with a series of tasks testing the ability to delay or inhibit predominant responses and to comply with parents' requests; they measured language and overall developmental age using the Gesell Scales (Knobloch & Pasamanick, 1974). They found that language development was correlated with self-control in the combined cross-age sample. However language was only related to one of the four self-control measures when age was partialled out. In the same study, the authors found that developmental quotient was correlated with three of four self-control composites (Vaughn, Kopp, & Krakow, 1984), but the authors did not report testing the association between language and self-control when either age or developmental quotient was controlled. However, comparison of the different correlations between language and self-control across ages shows that while language skill was not associated with self-control at 18 months, the skills were positively associated at 24 months; however, the authors stated that the small sample size – 19 children at 30 months old – did not allow the authors to determine the relationship at 30 months. Thus it is possible that the relationship between language and self-control changes through early development, or that a consistent relationship might be seen with a

larger sample. The cross-sectional design of this study limited it to correlational associations and did not allow the authors to test whether earlier language skills might support later self-control.

Cournoyer, Solomon, and Trudel (1998) examined the relationship between language and self-control in two groups of toddlers, 18-month olds and 24-month olds. They tested age and sex differences in both developmental domains, and the relationship between the domains at each age. They found that girls had higher self-control and higher language skills at both ages. Similar to the findings of Vaugh, Kopp, and Krakow (1984), as reviewed above, they also found that language skills and self-control were positively correlated at 24 months, but not at 18 months (Counoyer, Solomon, & Trudel, 1998).

Though these studies provide convergent evidence on the positive relationship between language abilities and self-regulation skills during toddlerhood, they share several limitations. Both studies are cross sectional and do not allow for a test of the effect of earlier language skills on later development of self-regulation; thus they both test non-directional associations between the domains. With null results due to small sample sizes at 18 and 30 months, these studies leave uncertain the strength and stability of the relations between domains across early childhood, particularly the relation between language and self-regulation when developmental timing or general cognitive ability is taken into account. Further, though gender differences in both domains are noted by Counoyer, Solomon, and Trudel (1998), they do not report testing whether the relationship between the domains may be different for boys and girls, nor whether the gender differences in one domain may be explained by gender differences in the other. Finally, both studies used very general assessments of language ability, rather than assessing specific aspects of language skills. As proposed by Cole and colleagues (2010), it may be the expressive aspects of language that are most useful as tools for children's self-regulation.

The studies reviewed above provide convergent evidence for the positive association between language and self-regulation in preschool and older children, and preliminary evidence for the same association in very young children, those under three years of age. However, in order to test the unique role of language in self-regulation in early childhood, both age and general cognitive development must be taken into account. Further, to determine whether there is a truly supportive relationship between language and self-regulation in early childhood, as suggested by Vygotsky's theory, a longitudinal study involving repeated measures of the development of language, self-regulation, and general cognitive development is needed in order to test whether earlier language skills predict later self-regulation controlling for the contribution of concurrent language skills.

Early Development in the Context of Poverty

The negative effects of poverty, and its associated risks, on child development are far-reaching, impacting both the self-regulation (Raver, 2004) and vocabulary (Hoff, 2006). Research demonstrates that although poor children perform near national norms on standardized tests in infancy, as a group their scores are significantly lower than national norms by the preschool years in language (Hart & Riskley, 1995) and in cognitive skills more generally (Ayoub et al., 2009; Black, Hess, & Berenson-Howard, 2000). This negative association between poverty and development, specifically verbal language skills, exists across cultures and persists throughout the school years (Bradley & Corwyn, 2002; Farkas & Baron, 2004). Further, this gap between children growing up in poverty and those with higher socio-economic status can be linked to parents' language and communicative behaviors in their interactions with their children; the richness of parents' language used with children, including spoken vocabulary, predicts children's growth in spoken vocabulary (Hoff, 2003; Rowe & Goldin-Meadow, 2009).

Thus family poverty and the influential differences in parent-child interaction associated with poverty form an important context in which to examine the development of children's language skills, and the effects of those skills on other domains.

The Current Study

The current study extends Vygotksy's theory regarding words as mental tools into very early childhood, testing whether there is a supportive relationship between language skills and self-regulation in children who are just learning to use language. We analyze a dataset from a three-wave longitudinal design covering the period of first language learning, including measures at 14 months when inter-individual variation in language and communication skills begin to emerge, 24 months when variation in children's early language skills is at its greatest, and 36 months when typically developing children have some expressive language and the individual variation in vocabulary has decreased (Fenson et al., 1994). Substantial individual differences in language development emerge around age two and predict vocabulary size around five years of age (Hart & Risley, 1995); thus we are particularly interested in how language skills at two years is related to self-regulation. The data were originally collected as part of the National Early Head Start Evaluation Study (Administration for Children and Families, 2002).

Among the many aspects of language rapidly developing during early childhood (e.g. Pan, Rowe, Singer, & Snow, 2005; Reich, 1986), we focus on two aspects of expressive language: talkativeness, as indicated by the total number of word tokens children speak during a given time, and spoken vocabulary, as indicated by the number of unique vocabulary words children speak during a given time. Contrasting these two aspects of expressive language allows us to test whether it is children's frequent use of language to express themselves and get their needs met that results in less frustration and thus less need to regulate their behavior; or, more in

line with the theories of Vygotsky and Kopp, whether self-regulation is related to children's growing vocabulary which gives them more mental tools to manipulate their own thoughts, emotions, and behavior.

The current study tests whether children's talkativeness (word tokens) and spoken vocabulary (unique vocabulary words) are associated with self-regulation during toddlerhood, from one to three years old. We test whether the data are consistent with the hypothesis that self-regulation is influenced by children's language skills, by determining whether language at two years old predicts the trajectory of self-regulation, when accounting for concurrent language skills. Further, given the average gender differences in the timing of language development for very young children (Fenson et al., 1994; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991) and preliminary evidence that there are gender differences in self regulation during toddlerhood (Raikes, Robinson, Bradley, Raikes, & Ayoub, 2007), we test whether a gender difference in the trajectory of self-regulation is explained by a gender difference in language. Finally, we test whether the association between children's language and self-regulation skills is explained by their overall cognitive development, or whether language contributes something unique to children's self-regulation skills over and above general cognitive development. We address the following questions:

1 Which child language skills – talkativeness or spoken vocabulary – if either, support the development of self-regulation between 14 and 36 months of age?

2 Do talkativeness and spoken vocabulary account for the gender differences in self-regulation form 14 to 36 months of age?

3 Is the relationship between these expressive language skills and self-regulation explained by general cognitive development?

Methods

Sample

The dataset used in the current study included 146 children and their mothers who participated in a longitudinal study on the effects of Early Head Start (EHS; Administration for Children and Families, 2002). These data come from the New England site of the national Early Head Start Research and Evaluation study. We use data from this particular site because it is the only site in which children's and mothers' expressive language use was captured the same way at each wave, enabling us to use growth modeling to examine the relationship between language and self-regulation over the course of toddlerhood. Baseline data were collected when families entered the study; then three waves of data were collected when children were approximately 14, 24, and 36 months old. In the New England site, 77.4% of the children were White, 14.4% were Black, 4.8% Hispanic, and 3.4% other. Ninety nine percent of families spoke English as their first language. At baseline, 84% of families had an income below the federal poverty line, and 68% of mothers had the equivalent of a high school education or less.

There was some expectable attrition between the baseline and third waves of data collection. We include in the current study those children who participated in at least one wave of data collection for the outcome measure – children's self-regulation; thus the total sample used to address the research questions in the current study is 120. The possibility of selective attrition was tested in the New England sample used for the current study, as well as in the national sample. In the current sample, we tested differences in family demographic characteristics between the families on whom we have baseline data and those who participated in the study at each subsequent wave. In the current sample, we found no differences in the participating and non-participating families in maternal education, maternal age, family income,

and child gender. Further, an extensive study of the national EHSRE sample determined that there were no significant differences between the remaining families at wave three and the full sample of families in terms of baseline socio-demographic characteristics, indicating that the data are missing at random (Love et al., 2005). More information on the number of children observed at each wave is provided in Table 1.

Procedures

Families were recruited into the National Early Head Start Research and Evaluation study (EHSRE) during a 27-month period through extensive outreach efforts including posting flyers, door-to-door visits, and contacting families through social service providers. Eligible families had to (a) have incomes near or below the poverty level established by the federal government; (b) have had a child under 12 months born during the recruitment period; (c) have not participated in a program similar to Early Head Start; and (d) understand random assignment and be willing to be randomly assigned to either Early Head Start or the control group.

Children and parents were enrolled in the study during mother's pregnancy or before the child was 12 months old. Data collection for the national EHS study included an assortment of child development assessments, maternal interviews, and observations in both the home and childcare when applicable (see Love et al., 2005 for complete description of the methods and procedures of the national study).

Basic demographic information for the families, including maternal education and family income, was collected through an interview when participants entered the study.

Children participated in the Bayley Mental Development Index (MDI; Bayley, 1993) during a home visit at each wave; during the Bayley MDI, an observer rated their behavior using the Bayley Scales of Infant Development Behavior Rating Scales (BBRS; Bayley, 1993). The

BBRS includes an observation of children's self-regulation; this measure and the derived variable are described further below.

Mother-child dyads were videotaped at home for 10 minutes in a semi-structured play task comparable to that used by Vandell (1979); dyads were given three bags of age-appropriate toys to facilitate interaction. They progressed through each bag at their own pace. Children's and mothers' use of language were transcribed and coded from the videotapes using the CHILDES transcription system (MacWhinney, 2000). Every vocalization by mothers and children was transcribed, allowing for a variety of language measures to be derived, including vocabulary and talkativeness.

Measures and Variables

The outcome of interest is children's self-regulation ability. The primary predictors of interest are two aspects of language development: the child's talkativeness and their spoken vocabulary. Further, there are two additional predictors that help us answer questions two and three; these are children's gender and cognitive skills. Control predictors include children's age, maternal education, family income, and mothers' talkativeness and spoken vocabulary. Each variable and its measurement are described in detail below. Descriptive statistics for these variables are provided in Table 1.

Self-regulation. As part of the Bayley MDI, a trained observer used the Bayley Behavior Rating Scale (BBRS; Bayley, 1993) to rate the child's ability to self-regulate. Children were rated on each of seven items which included behaviors such as their ability to maintain attention on the tasks, their degree of negativity, and their adaptation to changes in testing materials. Each item was scored on a 5-point scale in which better self-regulatory scores were indicated by higher values. Ratings were averaged across the seven items to obtain a single summary score in

which higher scores indicate better self-regulation. The Bayley Behavior Rating Scale (BBRS) was normed on 1,700 children in the United States, with equal numbers of males and females; children were selected with respect to creating a sample that matched the demographics of the United States in terms of race/ethnicity, parents' education, and family income. The Emotion Regulation portion of the BBRS has good internal reliability, with an Alpha of .84, and a test-retest correlation of .69 (Bayley, 1993). In the current study, administers of the Bayley and BBRS underwent formal training, and had to meet the 85% reliability on the certification criteria. Subsequent reliability was monitored by the certification team that oversaw data collection for the national EHSRE study (see Love et al., 2005 for further information).

Language skills. Children's verbal behavior during the videotaped ten-minute dyadic play episodes at each wave was coded using the Child Language Data Exchange System (CHILDES) coding system (MacWhinney, 2000). Individual transcripts were created for each dyad (see Pan, Rowe, Spier, & Tamis-LeMonda, 2004, for complete description of the methods used to code children's language use). All transcripts were checked by a second transcriber for reliability; or by the same transcriber two weeks later. Transcribers of language were distinct from observers of self-regulation and were naïve to children's scores on other measures and the hypotheses of this study. Following the transcription of mother and child interactions, automated computer analyses available in the CHILDES system software were used to create several language variables to summarize children's productive language use during each observation. These variables included two time-varying and two time-invariant variables. First, the child's spoken vocabulary was measured as the number of unique vocabulary words spoken during the mother-child observation at each wave; for example "dog" and "cat" are two unique vocabulary words, but "dog" and "dogs" are considered one vocabulary word. Second, child's talkativeness

was measured by total number of word tokens – the raw number of words – spoken during the mother-child observation at each wave. In addition, we created time-invariant variables for spoken vocabulary and talkativeness at the 24 month wave in order to test their effects on the rate of change in self-regulation over time. These measures of spoken vocabulary have been found to correlate highly with parents' ratings of children's expressive vocabulary as reported on the MacArthur Communicative Development Inventory (Pan et al., 2004). Further, the observational vocabulary data in this dataset is unique in that it meaningfully assesses expressive vocabulary in the same way at three different waves, providing us with the ability to use it as a time-varying variable. Only measures that are vertically equitable can be used as time-varying variables (Singer & Willett, 2003), and such data is rare in longitudinal studies of development.

Cognition. Children's general scores on the Bayley MDI at each wave are used as our measure of cognitive abilities. This measure encompasses an array of cognitive skills, including skills based on children's verbal abilities. Thus its inclusion as a control provides a very conservative test of our hypothesis that language skills will contribute uniquely to children's self-regulation.

Gender. Child gender was coded as a dummy variable in which boys were represented as zero and girls as one.

Age. Child age was measured as the difference in months between the child's birth date and the data collection date at each wave, measured in tenths of months; children's actual ages at each wave varied from the precise intended ages of 14, 24, and 36 months (see Table 1). This variation permits us to use continuous age as a predictor, and model the shape of development with more subtlety than simple linear change. We present the actual ages of children in descriptive analyses, and subsequently center age at 14 months so that the intercept of the growth

model is interpreted as the level of self-regulation at 14 months of age, and the rate of change is interpreted as the change during each month after 14 months.

Maternal language. Mothers' spoken language was measured using the same transcripts from which we derived the measures of children's language. Variables equivalent to the child variables – talkativeness and spoken vocabulary – were created for mothers through the same procedure they were created for children. Because mothers' use of language with their children may be related both to children's language and to their social skills, we consider it an important control for a conservative test of the relationship between children's language skills and their social-emotional skills.

Family demographics. When mothers entered the EHSRE study, they participated in a baseline interview in which they were asked about their educational level and their household income. Mothers education is measured as less than a high-school education or equivalent, high-school education or equivalent, or greater than high-school or equivalent. Family poverty ratio is measured as percent of the USA national poverty line.

Table 1 displays univariate statistics for all variables at each wave; the number of participants at each wave, means, standard deviations, and 25th and 75th percentiles for the total sample are in columns one through five, and the means and standard deviations for girls and boys are in columns six and seven. Significant gender differences in the means are noted. We use the means, standard deviations, and 25th and 75th percentiles of the predictors shown in Table 1 to create the figures that display the effects of the predictors on the outcome.

<Table 1 about here>

Analyses and Results

We used SAS PROC MIXED, full maximum likelihood method of estimation, to fit a sequence of multilevel growth models in order to answer the research questions (see Singer & Willett, 2003, for use of SAS PROC MIXED to fit individual growth models). The full maximum likelihood method of estimation utilizes all available data, which means that we can include in our analyses all children for whom we have at least one wave of the outcome variable; this procedure, coupled with the fact that any missing data have been determined to be missing at random, means that substitution of missing data is unnecessary (Singer & Willett, 2003).

The Shape of Development of Self-Regulation for Boys and Girls

Before we began addressing our three research questions, we established a baseline model to understand the underlying shape of self-regulation to more accurately build our subsequent models, and to serve as a point of comparison. First we fit an unconditional means model with which to compare the fits of subsequent models by using the *-2LL* (-2 Log Likelihood) statistic in which a lower number indicates a better fitting model, but must be considered in relation to the number of degrees of freedom. Then to determine the underlying shape of development in self-regulation across all children in the sample during toddlerhood, we fit linear and quadratic growth models using linear and quadratic specifications of child's actual age (in tenths of months) at each wave as the only predictors. We chose the quadratic model as our baseline growth model because it best fit the data. Next we included child gender and interacted gender with the linear and quadratic specifications of child age to determine whether gender affected the level (main effect) or rate of growth (interactions between age and gender) in self-regulation. We chose the model with the best fit according to the *-2LL* statistic. This model, which serves as our baseline for subsequent analyses, is seen in Equation (1) below; Equation (1) is followed by its interpretation The results of this fitted model are Model A in Table 2.

Quadratic growth model controlling child gender.

$$[REGULATE_{ij}] = \pi_{0i} + \pi_{1i}(AGE_{ij}) + \pi_2(AGE_{ij})^2 + \varepsilon_{ij}$$

where

$$\pi_{0i} = \gamma_{00} + \gamma_{01}GIRL_i + \zeta_{0i}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11}GIRL_i + \zeta_{1i}$$

$$\pi_2 = \gamma_{20} + \gamma_{21}GIRL_i$$

where

$$\left(\begin{bmatrix} \zeta_{0i} \\ \zeta_{1i} \end{bmatrix} \sim N \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} \sigma^2_0 & \sigma_{01} \\ \sigma_{10} & \sigma^2_1 \end{bmatrix} \right) \quad (1)$$

In Equation (1) $REGULATE_{ij}$ is the self-regulation of child *i* at age *j*. We centered child's age at 14 months, thus the Level 1 parameter π_{0i} is the initial status of self-regulation at 14 months of age, π_{1i} is the instantaneous rate of growth in self-regulation at 14 months, and π_{2i} as the monthly change in rate of growth. Residual ε_{ij} is the portion of child *i*'s self-regulation not explained by her age. While we allowed initial status and linear change parameters to vary across individuals, we constrained the quadratic age term because it did not vary significantly across children and constraining it preserved degrees of freedom for estimating other parameters.

At Level 2, γ_{00} is the average initial status across boys, γ_{01} is the additional average score for girls' initial status of self-regulation, and ζ_{0i} is the deviation of child *i* from that average; γ_{10} is average linear rate of change, γ_{11} is the average additional linear rate of change for girls, and ζ_{1i} is the deviation of child *i* from that average rate; γ_{20} is average monthly acceleration of change which we did not allow to vary between individuals, and γ_{21} is the average additional quadratic rate of change for girls.

Boys lag behind girls in development of self-regulation. Though boys and girls shared the same level of self-regulation at 14 months, they had different subsequent trajectories of self-regulation on average. Referring to Model A in Table 2, there was no effect of child gender on the initial status of self-regulation at 14 months, but gender affected the linear and quadratic rates of change in self-regulation. Figure 1 shows the distinctly different quadratic growth trajectories for girls' and boys' self-regulation. Girls' self-regulation rises steadily in their second year, decelerating slightly toward their second birthday. On the other hand, boys' average self-regulation declines sharply until their second birthday after which it rises again, approaching the girls' average level near their third birthday. This result is not explained by a bimodal distribution of self-regulation for boys nor a cluster of boys with lower scores. Univariate analysis revealed normal distributions of boys' self-regulation scores at each wave.

<Figure 1 about here>

Question 1: Which Language Skills, If Any, Support the Development of Self-Regulation in Young Children?

Because there were significant gender differences in the basic trajectory of self-regulation in this sample, we addressed our first and second research questions simultaneously with a single suite of models. To do otherwise would likely have produced results in which the true relationship between language and self-regulation was obscured by the underlying and unaccounted for gender differences. Nonetheless, for the sake of clarity we describe the analysis of these questions separately below, but will refer the reader to the same set of fitted models.

To answer our first research question – Are language skills associated with self-regulation in early childhood, and if so, which aspect of language is most predictive? – we took two approaches: we examined the associations between concurrent language and self-regulation

skills to determine their effects at each time, then we examined the effects of early language skills (at 24 months) on the growth trajectory of self-regulation when controlling for concurrent language skills. With this latter approach, we can test whether earlier language predicts growth in self-regulation, beyond just supporting concurrent self-regulation skills.

Starting with the baseline growth model that included child age and gender and their interactions (Table 2, Model A), we added the control variables for maternal education and family poverty ratio. Then we added the time-varying language skills predictors for children's talkativeness and spoken vocabulary along with the corresponding measures of mothers' language use as controls (mother's talkativeness and mother's spoken vocabulary). We added the child language variables individually (that is, either talkativeness or vocabulary), along with the corresponding maternal language variable. We controlled maternal language at each wave because the observations from which the measures of children's language were taken were mother-child interactions, and thus mothers' language could be responsible for much of the inter-individual variance in our observation of children's language. When the maternal language variables were added, the effects of maternal education and family poverty no longer contributed to the models; thus we removed them for the sake of parsimony. The results of fitting these model are in Table 2, Models B and C. Finally, we included both vocabulary and talkativeness in the same model to determine whether they were both simultaneously associated with self-regulation, and whether one of them was a stronger predictor of self-regulation than the other (results in Table 2, Model D).

To address the gap in the literature regarding whether language skills have a stable relationship to self-regulation, or whether this relationship is stronger at two years than earlier and later in toddlerhood, we interacted time-varying language skills with child age. A positive

interaction between age and the time-varying variable would indicate a change in the effect of the time-varying predictor.

In order to determine whether earlier language skills (at two years old) would affect the rate of growth in self-regulation, in addition to their effects on the level of self-regulation at each time, we added time-invariant early language skills measured at 24 months to the models already containing the corresponding time-varying language skills measured at each wave. We then interacted these variables with child age to determine whether children's language skills at 24 months predicted growth in self-regulation over time, and retained parameters that significantly reduced the *–2LL* (results in Table 3, Model E).

<Table 2 about here>

Vocabulary is a better predictor of self-regulation than talkativeness is. When they were tested in separate models, both children's talkativeness (Model B, Table 2) and their vocabulary (Model C, Table 2) were positively related to children's self-regulation, when controlling for the corresponding maternal language behavior. This confirms our primary hypothesis that even for very young children, language skills are related positively to self-regulation skills. When both child language skills (and the corresponding maternal variables) were entered into the same model (Model D, Table 2) only children's vocabulary remained significant. Comparing the *-2LL* statistics between Model B (only talkativeness) and Model D (both talkativeness and spoken vocabulary) shows that talkativeness does not contribute to the fit of the model when spoken vocabulary is controlled (X^2 = 1.3, df = 3, p = n.s.); whereas, comparing the *-2LL* statistics between Model C (only spoken vocabulary) and Model D shows that the spoken vocabulary parameters do contribute to the fit of the model when talkativeness is

controlled (X^2 = 11.4, df = 3, p < .01). Thus, spoken vocabulary is a better predictor of self-regulation than child talkativeness.

There were no significant interactions between either of the time-varying language skills variables and child age, indicating that the basic effects of vocabulary and talkativeness on concurrent self-regulation do not change over the course of toddlerhood. Instead, as language skills increase, along with inter-individual variation therein, the cumulative effects of these skills on self-regulation appear to grow, as seen in Figure 2.

<Figure 2 about here>

Vocabulary at two years predicts growth in self-regulation skills. To see whether earlier language skills predict growth in self-regulation, consistent with our hypothesis that symbol skills actually support the development of self-regulation, we tested whether vocabulary at 24 months would predict the rate of change in self-regulation. As seen in the parameter estimate for the interaction between vocabulary and child age in Model E (Table 3), vocabulary at 24 months does have a positive impact on the rate of growth in self-regulation, even when controlling for its main effect and the effects of time-varying vocabulary, though only at the p < .10 level of significance. However, looking at the subsequent model (Model F, Table 3), vocabulary at two years of age has strong and significant effects on self-regulation that vary by gender; those results will be elaborated in the next section.

Question 2: Do Language Skills Account for the Gender Differences in Self-Regulation?

To answer this question we used the same set of models described above – including child age, gender, language skills, and maternal language skills – and included interactions between gender and language skills. These interactions test whether the effects of language on self-regulation differ for boys and girls (results can be seen in Models B, C, E and F).

<Table 3 about here>

Language has a bigger impact on boys' self-regulation skills than on girls' skills. As shown in Model C (Table 2), talkativeness and vocabulary have a consistent positive effect on self-regulation at each time. However, these effects differ for boys and girls, as seen in the interaction between child gender and talkativeness in Model B and between gender and spoken vocabulary in Model C. Because vocabulary was revealed to be a more powerful predictor of language than talkativeness, we deal primarily with the results for vocabulary in this and later sections of results. To elucidate the effects of vocabulary on boys' and girls' self-regulation skills, we plotted the trajectories of prototypical boys and girls at the 25th and 75th percentiles of spoken vocabulary in Figure 2. The vocabulary variable is time-varying so that even though the effect of each unique vocabulary word on child's self-regulation skills remains constant over time, as the number of words in the child's vocabulary rapidly increases through the course of toddlerhood, so does the cumulative effect of vocabulary on children's self-regulation skills. Further, as variation in children's vocabularies grows, so does variation in self-regulation, as seen by comparing the plots for prototypical children at the 25th and 75th percentile of vocabulary.

Though girls have higher self-regulation skills (see Figure 1) and greater vocabularies than boys on average, the impact of vocabulary on self-regulation is greater for boys as indicated by the negative parameter estimate for the interaction between gender and vocabulary in Model C (Table 2). The effect of this difference can be seen in Figure 2, where the greater effect of vocabulary allows boys' with higher language skills to catch up with their female peers in self-regulation skills. The self-regulation skills of boys with lower language skills remain substantially lower than both their male peers with high language and their female peers with

equally low language skills. By three years of age, boys and girls at the 75th percentile of language skills are 0.75 standard deviations higher in self-regulation than boys at the 25th percentile, and 0.40 standard deviations higher than girls at the 25th percentile of language skills.

Vocabulary at two years predicts growth in boys' self-regulation skills and the level of girls' self-regulation skills. Vocabulary at 24 months has a strong positive effect on the overall level of girls' self-regulation skills through toddlerhood (see the parameter estimate for the interaction between gender and 24 month vocabulary in Model F). As seen in Panel A of Figure 3, greater vocabulary at 24 months predicts greater self-regulation throughout toddlerhood for girls, but does not substantially alter their rate of growth. That is, a girl's vocabulary at two years of age does not predict her growth of self-regulation in the future, but is still associated with her overall level of self-regulation skills throughout toddlerhood.

The effect of early vocabulary is substantially different for boys. Vocabulary at two years old does not have a strong main effect on self-regulation level at two years, but it has a significant positive impact on the growth rate in boys' self-regulation as revealed in the significant interaction between gender, age, and vocabulary at 24 months (parameters γ_{12} in Models E, F, and G). As seen in Panel B of Figure 3, 24 month vocabulary predicts the rate of change in subsequent self-regulation skills, such that boys' at the 25th and 75th percentiles of vocabulary at two years of age will differ by 0.4 standard deviations in self-regulation by the time they are three years old, even controlling for the effects of time-varying language skills. That is, vocabulary at 24 months appears to predict differences between boys' self-regulation skills in the future, but does not differentiate between them earlier in development.

<Figure 3 about here>

Question 3: Is the Relationship Between Language and Self-Regulation Explained by General Cognitive Development?

To determine whether language skills uniquely contribute to self-regulation beyond an association explained by general cognitive development, we added children's time-varying scores on the Bayley MDI to the best-fitting growth model with child gender and child and mother language variables. This model included child vocabulary, rather than talkativeness, along with child age and gender, and mothers' vocabulary. Equation (2) is the model we fitted to address Question 3. Equation (2) and its interpretation are provided below. Results of this fitted model are provided in Model G in Table 3.

Final model for effects of vocabulary on boys' and girls' self-regulation trajectories, controlling for general cognitive skills.

$$[REGULATE_{ij}] = [\pi_{0i} + \pi_{1i}(AGE_{ij}) + \pi_2(AGE_{ij})^2 + \pi_4 VOCAB_{ij} + \pi_5 COGNITIVE_{ij} + \pi_7 M\_VOCAB_{ij}] + [\zeta_{0i} + \zeta_{1i} + \varepsilon_{ij}]$$

where

$$\pi_{0i} = \gamma_{00} + \gamma_{01} GIRL_i + \gamma_{02} VOCAB\_24_i + \gamma_{03} GIRL_i * VOCAB\_24_i + \zeta_{0i}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11} GIRL_i + \gamma_{12} VOCAB\_24_i + \gamma_{13} GIRL_i * VOCAB\_24_i + \zeta_{1i}$$

$$\pi_2 = \gamma_{20} + \gamma_{21} GIRL_i$$

$$\pi_4 = \gamma_{40} + \gamma_{41} GIRL_i$$

$$\pi_5 = \gamma_{50}$$

$$\pi_7 = \gamma_{70}$$

where

$$\left(\begin{bmatrix} \zeta_{0i} \\ \zeta_{1i} \end{bmatrix} \sim N \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} \sigma^2_0 & \sigma_{01} \\ \sigma_{10} & \sigma^2_1 \end{bmatrix} \right) \quad (2)$$

Equation (2) is the final fitted model for children's self-regulation. At level 1, the intercept parameter (π_{0i}) is the level of self-regulation for a child at 14 months of age who has no words in his vocabulary, who has a score of 0 on cognitive development, and whose mother doesn't use any words; this parameter varies across children. The parameter (π_{1i}) associated with age (*AGE*) is the linear rate of change per month, that is, the instantaneous rate of change at 14 months of age which varies across children. The parameter (π_2) associated with $(AGE)^2$ is the average quadratic rate of change per month, that is, the acceleration in monthly growth after 14 months. The parameter (π_4) associated with the time-varying predictor *VOCAB* is the average effect of each additional unique word observed in the child's vocabulary on the child's level of self-regulation at each time. The parameter (π_5) associated with the time-varying predictor *COGNITIVE* is the average effect of each additional point on the Bayley MDI exam on the child's level of self-regulation at each time. The parameter (π_7) associated with the time-varying predictor *M_VOCAB* is the average effect of each additional unique word observed in the mother's vocabulary on the level of her child's self-regulation at each time.

At Level 2, the parameter γ_{00} is the initial status of self-regulation for boys who don't use any words at 24 months of age; γ_{01} is the effect of being a girl on this initial status; γ_{02} is the effect of each additional word observed in the child's vocabulary at 24 months for boys; γ_{03} is the additional effect of each additional word for girls; and ζ_{0i} is the unexplained variance in individual *i*'s initial status controlling for the effects of gender and vocabulary at 24 months. The parameter γ_{10} is the effect of each additional month of age on the level of self-regulation for boys; γ_{11} is the additional effect of being a girl on the average rate of change; γ_{12} is the effect of each word in the child's vocabulary at 24 months on the rate of change for boys; γ_{13} is the added effect of early vocabulary on the rate of change for girls; and ζ_{1i} is the unexplained variance in

individual *i*'s rate of change controlling for the effects of gender and early vocabulary. The parameter γ_{20} is the average monthly acceleration in self-regulation for boys, and γ_{21} is the additional average acceleration in change for girls. The parameter γ_{40} is the average effect of each additional vocabulary word on level of self-regulation at each time, and γ_{41} is the additional effect of each vocabulary word for girls. Because there are no level two predictors for the effects of time-varying child cognition and maternal vocabulary, nor do they vary across children, the parameters γ_{50} and γ_{70} have the same interpretation as their level one parameters π_5 and π_7.

Language skills uniquely support self-regulation, beyond general cognitive abilities. Children's cognitive abilities, as measured by the total score for the Bayley Mental Development Index, have a strong and significant positive impact on children's self-regulation (Model G, Table 3). The inclusion of cognitive abilities reduces, but does not eliminate the effects of children's language skills on their self-regulation. Specifically, the impact of time-varying vocabulary is reduced by approximately fifty percent (comparing the main effects of time-varying vocabulary from Model F to Model G), however, the effects of vocabulary at 24 months still positively impacts the level of girls' self-regulation and the rate of change in boys' self-regulation. Thus, even when the effects of children's age and cognitive abilities, along with mothers' vocabulary, are accounted for, children's language skills still have a unique positive impact on self-regulation during toddlerhood.

Discussion

This study explored the nature of the relationship between language skills and self-regulation through the period of development in which these skills are first developing and developmental trajectories are first beginning to differentiate. Our findings support the notion that, even for young toddlers, language skills do help children regulate their own behavior. Thus,

the parent or early child educator who asks a toddler to use his words may be encouraging a strategy that even such young children are naturally developing. Furthermore, as pointed out by Winsler, Manfra, and Diaz (2007), perhaps teachers should be instructed to encourage young children to talk aloud in class when solving difficult problems.

It appears that, on average, girls may be ready to use language for self-regulation before boys. The average trajectory of self-regulation skills through toddlerhood differed for boys and girls. We had expected to find a gender difference in the level of self-regulation; however, contradictory to previous research (Raikes et al., 2007), our current findings indicate that this difference is not stable throughout toddlerhood. Instead, it appears that the average trajectories for boys' and girls' self-regulation diverge and converge through early childhood, with boys' self-regulation dipping at 24 months, then rising again toward 36 months. This dip may be due to a convergence of developmental changes occurring around two years of age that overwhelm boys; or perhaps it is due to changes in the environment, which may hold greater expectations for children of two years than infants of 14 months. Either way, it is striking that, on average, only boys experience this dip in regulation skills; this is a finding that should be explored further, perhaps through observational research. Since the gender differences are not uniform over time, this brings to the fore the question of the nature of developmental gender differences: Are the trajectories of boys' and girls' self-regulation skills truly different in shape, or do boys simply lag behind girls in this domain during toddlerhood? This is a question that will only be answered by observing self-regulation skills over longer periods of time using vertically equitable measures.

Consistent with our hypothesis, children's early language skills – particularly the breadth of their spoken vocabulary – are associated with their abilities to self-regulate. Even the

association between these different skills at such an early age confirms the intertwined and integrative nature of development across domains. Further, the finding that earlier breadth of vocabulary predicts later self-regulation skills provides preliminary evidence consistent with Vygotsky's (1934/1986) theory that symbols, and especially spoken words (Wertsch, 1979), are mental tools with which to regulate oneself by exerting control over one's own thoughts, emotions, and behavior, and perhaps one's environment. Though greater talkativeness was also associated with greater self-regulation – confirming an implication made by Cole and colleagues (2010) – vocabulary was shown to be a stronger predictor than talkativeness. Perhaps talkativeness is more related to children's temperaments; thus, talkativeness may aid children in their attempts to communicate and control their environments, but not be as predictive as vocabulary which indicates the breadth of a child's symbol skills. To understand how children's vocabularies aid their self-regulation even at such a young age, these findings should provoke qualitative investigation of the functions of word use for very young children in challenging situations. Investigation of early use of spoken words for self-talk has thus far extended as young as the fourth year of life (e.g. Winsler, Carlton, & Barry, 2000), but not earlier.

Though we expected to find gender differences in self-regulation, as indicated by previous literature, the differential effects of language skills on boys' and girls' self-regulation were surprising. The simplest explanation for the current results is that because boys and girls differ in the timing of their language development; with girls developing somewhat ahead of boys, girls are ready earlier to bring their language skills to bear on their self-regulation skills, that is, to integrate the two domains. This is seen particularly in the results displayed in Figure 3. Girls' language skills at 24 months are strongly predictive of their ongoing level of self-regulation skills, indicating that by 24 months, the two skills are strongly linked. On the other

hand, boys' language skills at 24 months predict differences in the rate of growth in self-regulation but do not have as strong an impact on the level at two years of age; indicating that while language is supportive of the growth of self-regulation in boys, its impact on their self-regulation level is delayed compared to girls. However, these findings also lead one to wonder whether and how boys and girls might use language differently, and whether language might be more necessary for boys to exert control over their own behavior. One study of children with Specific Language Impairment found that parents of Language Impaired boys rated their total behavior problems higher than parents of control boys, whereas parents of Language Impaired girls did not rate them higher on total behavior problems (Tallal, Dukette, & Curtiss, 1989). Thus, the idea that language skills are more necessary or useful for boys could be explored further with more in-depth studies of boys' and girls' regulation strategies.

Controlling for their cognitive abilities, as well as age, children's vocabularies still positively predict their self-regulation abilities. These findings extend those of Vaughn, Kopp, and Krakow (1984) by accounting for both cognition and age, and show the association between developmental domains begins as early as the first months of the second year of life. In particular, the use of growth modeling allowed us to see that although the cumulative impact of vocabulary on self-regulation is small when vocabulary is limited – for example, between 14 and 16 months of age – the relationship between time-varying vocabulary and self-regulation is consistent. Further, while a portion of this relationship between domains is explained by children's general cognitive development, language skills still uniquely contribute to children's self-regulation skills.

Strengths and Limitations

Our sample was limited to a group of families who met the poverty guidelines to be eligible for Early Head Start enrollment upon entry to the study; most participating families were near or below the federal poverty line, and parents had relatively low education levels. Though the effects of income and education did not contribute significantly to our analyses when the more proximal context of mothers' language was added, we must consider the implications to our findings that our entire sample can be considered at risk. Poverty is associated with lower language (e.g. Bradley & Corwyn, 2002) and lower self-regulation skills (Evans & English, 2002), including delayed internalization of private speech for self-regulation (Berk & Garvin, 1984). Thus it is possible that a more socioeconomically diverse sample would reveal that the relationships between language and self-regulation occur earlier in the general population than they did in our population. There is also a possibility that the relationship between language skills and self-regulation is stronger for those at greater risk for behavioral problems, which include those living in poverty. This possibility is hinted at by the findings of Winsler, Manfra, and Diaz (2007) that showed that children who were at greater risk of behavior problems used more private speech, and used it effectively to perform as well as those who were not at risk. Our findings should be replicated with a more ethnically and socio-economically diverse sample.

A crucial strength of this study is that observational measures of the two domains were independent; their measurement was completed using different tools by different observers, and the measurement of each set of skills was not reliant on the child's use of the other set of skills, for example, rating of child's self-regulation was not dependent upon the child's use of words.

Another important strength of our study was the use of growth modeling to examine the effects of time-varying predictors (age, language, cognition) on a time-varying outcome, and thus see the subtle relationships between them. However, our use of only three waves of data

limited our growth model to the quadratic specification of age; more complex trajectories of growth would require more waves of data. Further, due to the large number of parameters in our model, and the relatively small sample, we constrained some of the variance components because we had insufficient data to estimate all of them. We constrained the quadratic rate of change and effects of time-varying words so that they did not vary across children.

Future Directions

To understand the underlying long-term growth of self-regulation skills throughout childhood – including the divergence and convergence of trajectories for boys and girls – we need a vertically equitable measure of self-regulation that encompasses a broader span of time, ideally infants to teens. No such measure of self-regulation exists, thus we are limited to understanding trajectories and individual differences within limited timeframes.

The current study examined the role of two aspects of language development – talkativeness and vocabulary – in the development of self-regulation. There are other aspects of language that may contribute to children's self-regulation, and other forms of symbols, such as gestures, that may serve as mental tools. Future studies should examine whether gestures, as early tools for communication (including communication with the self, Rodríguez and Palacios, 2007) and representation, are also associated with self-regulation skills.

In order to verify a truly causal relationship between the development of a child's symbolic repertoire and his or her self-regulation, an experimental design should be used to test the effects of an early symbol-skills intervention on the development of self-regulation skills. For example, a language enrichment program could be used to test whether language skills themselves are the cause of the reduced emotional and social skills of children with language delays (e.g. Sicherman, 2003; Westby & Cutler, 1994). One such curriculum, Tools of the Mind,

uses language and other symbols to help children learn self-regulation strategies (Bodrova & Leong, 2009). Initial results from a randomized trial indicate that it enhances children's classroom behavior (Barnett et al., 2008). Alternatively, the rising popularity of infant sign language programs (e.g. Acredolo, Goodwyn, & Abrams, 2002) may present the opportunity to test whether providing typically developing children with useable symbols earlier does indeed enhance their development of self-regulation.

Conclusion

Within the individual, the domain of language is associated with the development of self-regulatory skills, even in very young children just learning their first language. Vocabulary was a stronger predictor than talkativeness, indicating that even for very young children, words may be mental tools that support self-regulation. Breadth of vocabulary at two years of age positively impacts the level of girls' self-regulation and the growth in boys' self-regulation, even when accounting for children's ages, cognitive abilities, and mothers' language. The gender differences in self-regulation, and in the effects of language skills on self-regulation, indicate a complex picture of development that may have implications for the care and education of toddlers. The dip in boys' self-regulation skills around two years of age may indicate a greater vulnerability, and need for additional scaffolding. Further, the greater effect of language skills on boys' self-regulation than on girls indicates that boys may be more in need of language- or communication-related interventions than girls. Such interventions may allow boys to catch up to their female peers' level of self-regulation skills. Future studies should use experimental early interventions to test whether providing children with additional language skills will enhance the development of their self-regulation skills, and whether there are gender differences in these effects.

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Figures

Figure 1. *Average quadratic growth trajectories for boys' and girls' self-regulation during toddlerhood.*

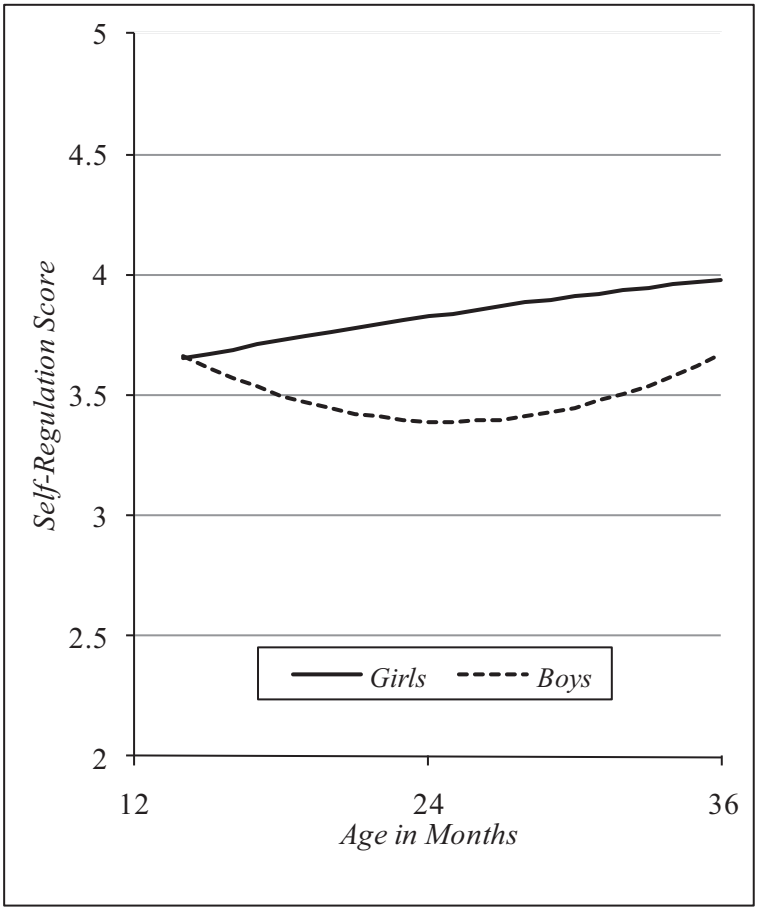
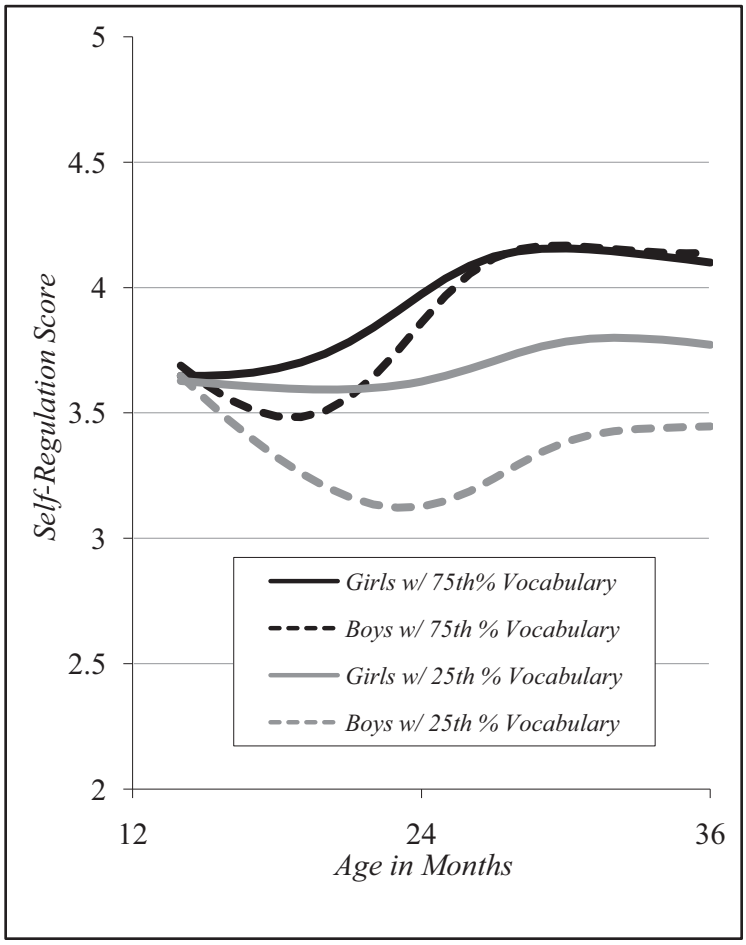
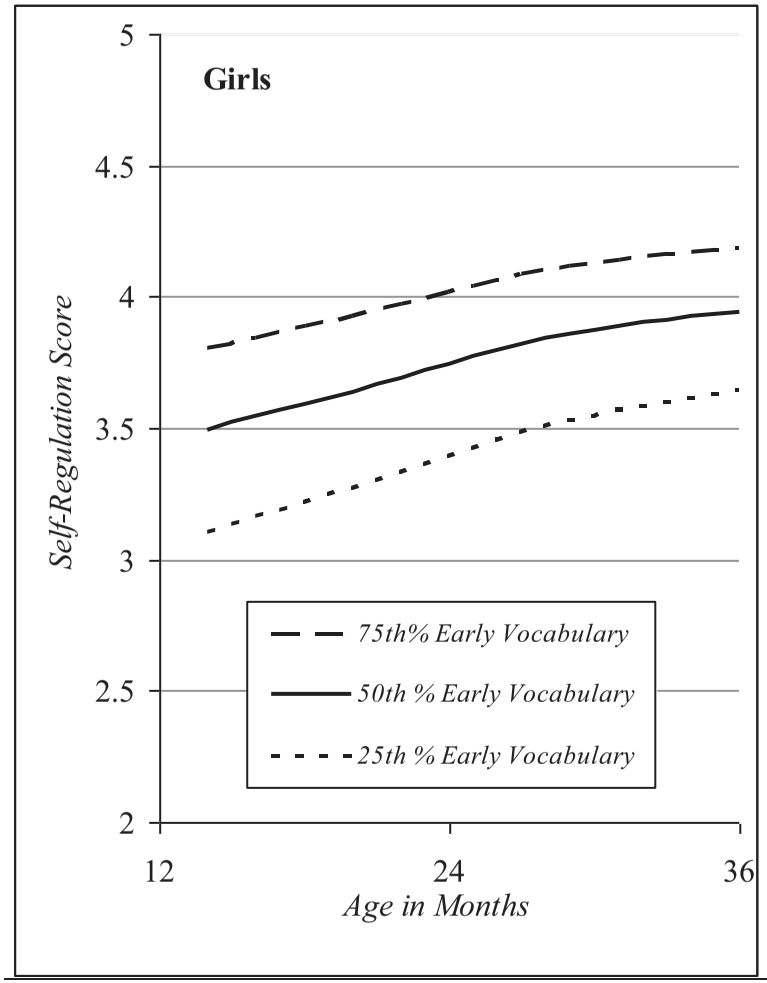


Figure 2. *Effect of time-varying vocabulary on boys' and girls' self-regulation during toddlerhood, controlling for maternal vocabulary.*

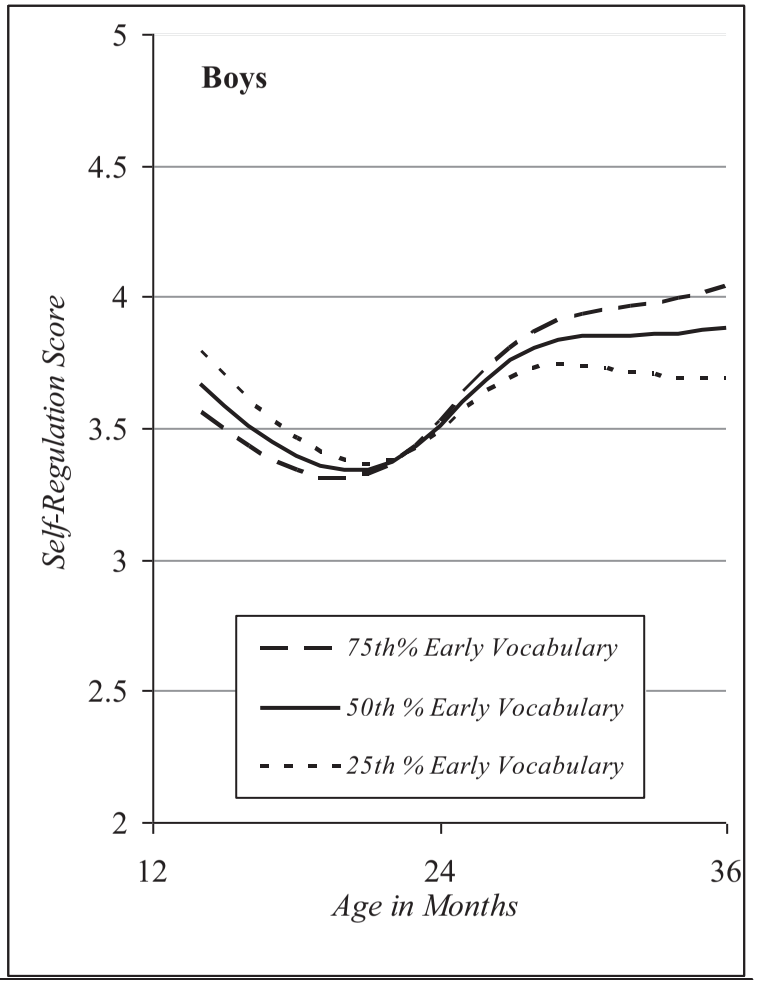


Note on Figure 1: The shape of the curves reflect the influence of vocabulary as it grown cubically; to determine the appropriate trajectory for vocabulary we analyzed its basic growth in the current sample.

Figure 3. *Differential effects of vocabulary at two years old on the growth of self-regulation for boys and girls.*



Panel A. Effect of 24-month vocabulary on the level of girls' average self-regulation trajectory, for girls with average concurrent (time-varying) vocabulary and average concurrent maternal vocabulary.



Panel B. Effect of 24-month vocabulary on the rate of growth in boys' average self-regulation trajectory, for boys with average concurrent (time-varying) vocabulary and average concurrent maternal vocabulary.

Tables

Table 1

Descriptive statistics for all variables at each wave for a population of 120 children enrolled in one site of the National Early Head Start Research & Evaluation Study.

		Total Sample			*Girls* *n = 59*	*Boys* *n =66*
Variables	*n*	*Mean (SD)*	*25th percentile*	*75th percentile*	*Mean (SD)*	*Mean (SD)*
Outcome: Self-Regulation						
Wave 1	106	3.66 (0.66)	3.29	4.14	3.67 (0.73)	3.65 (0.62)
Wave 2	100	3.62 (0.74)	3.17	4.15	3.84 (0.67)	3.40** (0.74)
Wave 3	84	3.87 (0.85)	3.38	4.57	3.98 (0.77)	3.77 (0.90)
Predictors						
Talkativeness						
Wave 1	105	4.98 (9.26)	0	5	5.87 (8.98)	4.21 (9.51)
Wave 2	91	87.81 (67.69)	27	134	100.28 (59.72)	76.65~ (72.92)
Wave 3	75	190.88 (97.09)	123	243	206.29 (100.89)	178.09 (93.12)
Spoken Vocabulary						
Wave 1	105	2.67 (4.14)	0	3	3.26 (4.73)	2.15 (3.52)
Wave 2	91	37.63	13	57	43.60	32.27*

		(24.72)			(21.35)	(26.46)
Wave 3	75	73.17	50	91	77.47	69.60
		(27.15)			(25.6)	(27.91)
Child Age						
Wave 1	125	14.57	13.76	15.08	14.79	14.37
		(1.22)			(1.41)	(1.01)
Wave 2	113	24.57	23.52	25.49	24.70	24.45
		(1.23)			(1.37)	(1.10)
Wave 3	107	37.03	35.58	37.97	36.82	37.23
		(1.77)			(1.64)	(1.88)
Bayley MDI						
Wave 1	102	97.69	91	107	97.76	97.63
		(12.84)			(13.39)	(12.42)
Wave 2	95	91.72	82	104	95.82	87.35**
		(15.45)			(14.55)	(15.22)
Wave 3	81	93.48	84	105	96.82	90.38*
		(13.23)			(13.19)	(12.53)
Controls						
Poverty Ratio						
Baseline	139	74.47	46.44	93.10	75.86	73.29
		(46.99)			(41.43)	(51.50)
Maternal Education						
Baseline	145	2.01	1	3	2.01	2.05
		(0.75)			(0.75)	(0.80)
Mothers' Talkativeness						
Wave 1	105	80.02	44	104	81.91	78.37
		(44.11)			(43.17)	(45.24)
Wave 2	90	105.96	75	131	106.76	105.25

		(47.26)			(45.38)	(49.32)
Wave 3	75	108.09	75	139	108.06	108.11
		(44.15)			(43.13)	(45.51)
Mothers' Vocabulary						
Wave 1	105	32.57	21	40	33.83	31.48
		(14.38)			(14.14)	(14.53)
Wave 2	90	50.13	34	63	50.55	49.77
		(20.51)			(19.32)	(21.54)
Wave 3	75	57.68	40	76	58.47	57.03
		(22.69)			(21.83)	(23.45)

Significant gender differences in all variables are noted with asterisks following the means for boys.

~ $p < .10$, * $p < .05$, ** $p < .01$

Table 2

Self-Regulation – Taxonomy of fitted growth models for the effects of child's gender, talkativeness, and spoken vocabulary on self-regulation from 14 to 36 months of age, controlling for maternal language (N=120 children, 290 observations).

Parameter		*Model A* Quadratic Growth + Gender	*Model A* Model A + Talkativeness	*Model B* Model A + Vocabulary	*Model C* Model A + Vocabulary and Talkativeness
Fixed Effects					
Initial Status at 14 Months					
INTERCEPT	γ_{00}	3.6639***	3.5645***	3.5467***	3.5774***
		(0.0896)	(0.1198)	(0.1146)	(0.1198)
GIRL	γ_{01}	-0.0113	-0.0219	-0.0154	-0.0154
		(0.1343)	(0.1351)	(0.1346)	(0.1355)
Linear Rate of Change each Month (instantaneous rate of change at 14 months)					
AGE	γ_{10}	-0.0502**	-0.0865***	-0.1034***	-0.1031***
		(0.0185)	(0.0201)	(0.0207)	(0.0208)
AGE*GIRL	γ_{11}	0.0695*	0.0968**	0.0864*	0.0791*
		(0.0277)	(0.0311)	(0.0337)	(0.0344)
Quadratic Rate of Change each Month (acceleration of change)					
AGE^2	γ_{20}	0.0023**	0.0022**	0.0024**	0.0023**
		(0.0008)	(0.0008)	(0.0008)	(0.0008)
AGE^2*GIRL	γ_{21}	-0.0025*	-0.0026*	-0.0023~	-0.0020~
		(0.0011)	(0.0012)	(0.0012)	(0.0012)
Main Effect of Child's Talkativeness					
TALK	γ_{30}		0.0050***		-0.0004

		(0.0009)		(0.0026)
TALK*GIRL	γ_{31}	-0.0037*		-0.0017
		(0.0014)		(0.0032)
Main Effect of Child's Vocabulary				
VOCAB	γ_{40}		0.0169***	0.0181*
			(0.0027)	(0.0078)
VOCAB*GIRL	γ_{41}		-0.0089~	-0.0040
			(0.0044)	(0.0101)
Main Effect of Mom's Talkativeness				
M_TALK	γ_{60}	0.0011		-0.0007
		(0.0010)		(0.0019)
Main Effect of Mom's Vocabulary				
M_VOCAB	γ_{70}		0.0029	0.0036
			(0.0022)	(0.0046)

Variance Components						
L 1:	Within- person	σ^2_ε	0.3128***	0.3093***	0.2960***	0.2897***
L 2:	In Intercept	σ^2_0	0.1246*	0.1198*	0.1305*	0.1416*
	In Rate of change	σ^2_1	0.0006*	0.0002	0.0002	0.0002
	Covariance 01	σ_{01}	-0.0006	-0.0003	-0.0012	-0.0019
Fit Statistics						
	Deviance		588.8	517.3	507.2	505.9

~ $p < .10$, * $p < .05$, ** $p < .01$, † $p < .001$

Table 3

Taxonomy of fitted growth models for the effects of child gender, spoken vocabulary at two years, and cognitive skills on the growth of self-regulation from 14 to 36 months of age, controlling for maternal language (N=120 children, 290 observations).

Parameter		*Model E* Model C + Early Vocabulary	*Model F* Model E + Interactions between Early Vocabulary and Gender	*Model G* Model F + Cognitive Development
Fixed Effects				
Initial Status at 14 Months				
INTERCEPT	γ_{00}	3.5264***	3.7628***	1.8074***
		(0.1537)	(0.1572)	(0.3498)
GIRL	γ_{01}	-0.1226	-0.9431***	-0.5052~
		(0.1536)	(0.2567)	(0.2520)
VOCAB_24	γ_{02}	0.0027	-0.0052	-0.0076*
		(0.0029)	(0.0034)	(0.0032)
GIRL* VOCAB_24	γ_{03}		0.0210***	0.0124*
			(0.0055)	(0.0053)
Linear Rate of Change each Month (instantaneous rate of change at 14 months)				
AGE	γ_{10}	-0.1055***	-0.1220***	-0.0458~
		(0.0217)	(0.0220)	(0.0238)
AGE*GIRL	γ_{11}	0.0958**	0.1459***	0.0814*
		(0.0344)	(0.0370)	(0.0365)
AGE*VOCAB_24	γ_{12}	0.0004~	0.0006*	0.0005*
		(0.0002)	(0.0002)	(0.0002)

AGE*GIRL*	γ_{13}		-0.0008~	-0.0005
VOCAB_24			(0.0004)	(0.0004)
Quadratic Rate of Change each Month (acceleration of change)				
AGE^2	γ_{20}	0.0025**	0.0026**	0.0010
		(0.0008)	(0.0008)	(0.0008)
AGE^2*GIRL	γ_{21}	-0.0025*	-0.0028*	-0.0016
		(0.0012)	(0.0012)	(0.0012)
Main Effect of Child's Vocabulary				
VOCAB	γ_{40}	0.0122***	0.0147***	0.0069~
		(0.0033)	(0.0037)	(0.0035)
VOCAB*GIRL	γ_{41}	-0.0088~	-0.0135*	-0.0081
		(0.0045)	(0.0056)	(0.0051)
Main Effect of Cognitive Development				
COGNITION	γ_{50}			0.0219***
				(0.0036)
Main effect of Mom's Vocabulary				
M_VOCAB	γ_{70}	0.0021	0.0025	-0.0005
		(0.0023)	(0.0023)	(0.0021)
Variance Components				
L 1: Within- person	σ^2_ε	0.2862***	0.2919***	0.2432***
L 2: In Intercept	σ^2_0	0.1433*	0.0783	0.0684
In Rate of change	σ^2_1	0.0003	0.0001	0.0003
Covariance 01	σ_{01}	-0.0024	-0.0006	-0.0028
Fit Statistics				
Deviance		441.3	427.9	353.1

~ $p < .10$, * $p < .05$, ** $p < .01$, † $p < .001$