Published in final edited form as:

Merrill Palmer Q (Wayne State Univ Press). 2011 April ; 57(2): 105–128.

Shyness and Vocabulary: The Roles of Executive Functioning and Home Environmental Stimulation

A. Nayena Blankson, Marion O'Brien, Esther M. Leerkes, Stuart Marcovitch, and Susan D. Calkins

The University of North Carolina at Greensboro

Abstract

Although shyness has often been found to be negatively related to vocabulary, few studies have examined the processes that produce or modify this relation. The present study examined executive functioning skills and home environmental stimulation as potential mediating and moderating mechanisms. A sample of 3.5-year-old children ($N=254$) were administered executive functioning tasks and a vocabulary test during a laboratory visit. Mothers completed questionnaires assessing child shyness and home environmental stimulation. Our primary hypothesis was that executive functioning mediates the association between shyness and vocabulary, and home environmental stimulation moderates the relation between executive functioning and vocabulary. Alternative hypotheses were also tested. Results indicated that children with better executive functioning skills developed stronger vocabularies when reared in more, versus less, stimulating environments. Implications of these results are discussed in terms of the role of shyness, executive functioning, and home environmental stimulation in early vocabulary development.

Keywords

Shyness; Vocabulary; Mediation; Executive Function; Environment

Shyness and Vocabulary: The Roles of Executive Functioning and Home Environmental Stimulation

Although there are currently different conceptualizations about the origins and definitions of shyness, one common thread among various definitions is that shyness involves wariness about, and fear of, people and social stimuli that are unfamiliar (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Evans, 2001; Gartstein & Rothbart, 2003). In young children, shyness is usually measured through behavioral observation (e.g., crying at presentation of a novel stimulus), physiological reactivity (e.g., heart rate increase accompanying presentation of an unfamiliar stimulus), and parent reports of child behavior (e.g., child is uncomfortable asking other children to play; child does not like to try new activities; child is wary of strangers). Using various indicators, individual differences in shyness have been observed at

Correspondence concerning this article should be addressed to: A. Nayena Blankson, Department of Psychology, Spelman College, 350 Spelman Lane, S. W., Box 259, Atlanta, GA 30314. ablanks1@spelman.edu.

A. Nayena Blankson, Marion O'Brien, Esther M. Leerkes, and Susan D. Calkins, Department of Human Development and Family Studies; Stuart Marcovitch, Department of Psychology.

A. Nayena Blankson is now at Spelman College, Department of Psychology.

Portions of this research were presented at the 2009 Biennial Meeting of the Society for Research in Child Development.

This is a pre-copyedited version of an article accepted for publication in *Merrill-Palmer Quarterly*. 2010 following peer review. The definitive publisher-authenticated version is available from Wayne State University Press.

every stage of the lifespan (Asendorpf, 1990; Burgess, Marshall, Rubin, & Fox, 2003; Sanson, Pedlow, Cann, Prior, & Oberklaid, 1996; Scarpa, Raine, Venables, & Mednick, 1995). Shyness is thought to be maladaptive (Schmidt & Tasker, 2000; Scott, 2006) and indeed, childhood shyness has been found to be related to health and behavior problems (Evans, 2001; Kerr, 2000). Evidence has also indicated that shyness is related to social maladjustment--peer rejection, anxiety, depression, and loneliness (Rubin, LeMare, & Lollis, 1990; Sroufe, 1977)--and that these relationships extend into adolescence (Kerr, 2000).

The significance of early temperamental characteristics, such as shyness, to later development makes it important to investigate such characteristics and the conditions under which they may or may not be related to outcomes. Although there has been research conducted on the psychosocial correlates of early childhood shyness, research on the cognitive correlates of early childhood shyness is in its infancy. The goal of the present research was to further our understanding of the mechanisms underlying the link between shyness and vocabulary in a sample of 3 year old children, through an examination of the role of executive functioning skills and home environmental stimulation in this relation. Our hypothesized model of the relations among these variables appears as Figure 1. Because there has been relatively little prior research to support the specific relations we propose, alternative models testing shyness as a moderator and as a mediator of the relation between executive functioning and vocabulary were also examined.

The importance of vocabulary to life success makes it of practical importance for investigation (Gathercole, Willis, Emslie, & Baddeley, 1992; Hoff, 2007). It is particularly important to examine vocabulary development early in life because it has important implications for development and achievement throughout the lifespan (Hart & Risley, 1995; Kastner, May, & Hildman, 2001; Vineyard & Massey, 1957). For example, children's prereading vocabulary is an important predictor of later reading competence, which has links not only with academic success, but with life success in general (Chall, 1983; Hart & Risley, 1995). Thus, examining the associations between shyness and vocabulary in early childhood may be useful for treatment and intervention efforts.

Shyness and Vocabulary

There is some evidence that shyness is negatively related to vocabulary (e.g., Paul & Kellogg, 1997; Slomkowski, Nelson, Dunn, & Plomin, 1992), although others have not found this relation (e.g., Coplan & Armer, 2005; Dixon & Smith, 2000; Ludwig & Lazarus, 1983). Research by Gewirtz (1948) indicated that shyness (measured with teacher ratings of social apprehension) correlated negatively with expressive language abilities in a sample of 5- and 6-year-old children. More recent evidence supports this early finding of a negative relation between shyness and productive vocabulary (e.g., Paul & Kellogg, 1997; Prior et al., 2008; Spere, Schmidt, Theall-Honey, & Martin-Chang, 2004). Shyness has also been found to be negatively related to receptive vocabulary (Slomkowski et al., 1992; Spere et al., 2004).

A negative association between shyness and vocabulary is in accord with the interactionist perspective of language development, which emphasizes that language abilities emerge from a child's interactions with the environment. The development of cognitive abilities requires that one learn about the unfamiliar (Horn & Blankson, 2005; Piaget, 1960). To the extent that social anxiety or withdrawal inhibits one from learning about the unfamiliar, shyness would be expected to be negatively related to vocabulary.

Although numerous studies have examined direct relations between shyness and vocabulary, little research has been conducted on the processes by which shyness and vocabulary are

related, or the conditions under which shyness does or does not hinder vocabulary acquisition. Thus, the mechanism by which shyness comes to be related to vocabulary is not yet fully understood. In this study, we used a sample of 3.5 year old children to investigate the potential impact of executive functioning skills, and we explore the role of home environmental stimulation in these associations.

Shyness and Executive Functioning

Executive functioning refers to a variety of related cognitive skills that involve the ability to maintain task-relevant information in short-term memory, as well as the ability to manipulate this information through the engagement of focused attention (NICHD Early Child Care Research Network, 2005; Wolfe & Bell, 2007). Among these skills are working memory and cognitive inhibitory control, both of which are associated with frontal lobe function. Children who are able to engage in goal-directed behavior by reducing their attention to distracting stimuli, either internal or external, demonstrate such skills. When in a learning situation with other children or adults, increasing levels of shyness may be associated with a decreased ability to focus attention on the task at hand. Thus, the processing of cognitive information in shy children might be limited due to social anxiety such that executive functioning skills, such as working memory and cognitive inhibitory control, are hampered (Arnold & Cheek, 1986; Ludwig & Lazarus, 1983). For example, in a sample of fourth- and fifth-grade students, shy children performed less well on the Stroop Color-Word Test than did their less shy counterparts (Ludwig & Lazarus, 1983). Additionally, studies have shown a negative relationship between shyness and working memory (Humphreys & Revelle, 1984; Lieberman, 2000; Tanwar & Malhotra, 1992).

There is evidence that individual differences in shyness emerge in infancy and are relatively stable across the lifespan (Burgess et al., 2003; Sanson et al., 1996; Scarpa et al., 1995). These individual differences emerge before the maturation of frontal lobes that are typically implicated in the development of executive functioning (Diamond & Doar, 1989). Although the early precursors for executive functioning are observed in the first years of life (Diamond, 1991), these abilities continue to develop throughout childhood (Garon, Bryson, & Smith, 2008; Rueda, Posner & Rothbart, 2005). Thus, it may be the case that negative affect, such as that associated with shyness, may be related to the development of executive functioning skills (Blair & Peters, 2003).

Executive Functioning and Vocabulary

Individual differences in executive functioning have been found to be positively related to individual differences in vocabulary (Blair & Razza, 2007; Gathercole et al., 1992; McClelland et al., 2007; Wolfe & Bell, 2007). In particular, the findings by Gathercole and colleagues (e.g., Adams & Gathercole, 1995; Gathercole & Baddeley, 1989) suggest that executive functioning predicts vocabulary early in development. Recently, it has been suggested that executive control may enable one to properly distribute attention either to words in a word-learning event, or away from other distracting stimuli in word-learning situations (Dixon, Salley, & Clements, 2006). Thus, our principal hypothesis (shown in Figure 1) was that shyness restricts executive functioning, thereby reducing distribution of attention toward word-learning events and in turn hindering the development of vocabulary.

Two alternative hypotheses were also tested. First, it could be that the relation between executive functioning and vocabulary may differ for different levels of shyness. Individuals who are not shy may engage with their social environments more actively and develop language skills regardless of their executive functioning skills. For shy individuals, however, executive functioning skills may be needed to shift attentional focus away from the self and toward word-learning events. If so, the relation between executive functioning and

vocabulary may be stronger for more versus less shy individuals. Thus, we tested the alternative hypothesis that shyness moderates the relation between executive functioning and vocabulary.

Additionally, although we expected to find that executive functioning mediates the relation between shyness and vocabulary, we also tested shyness as a mediator of the executive functioning-vocabulary relationship. It could be that decreasing levels of executive functioning may lead to increased levels of shyness, which in turn may affect vocabulary development. Moreover, given that the data were collected concurrently, this hypothesis is an equally plausible alternative to our primary hypothesis. Thus, we tested this alternative hypothesis to account for the issue of directionality of effects. Testing of both alternative hypotheses was considered important because the links between and among shyness, executive functioning, and vocabulary have not been extensively studied in past work.

The Role of Environmental Stimulation

Exploration of, and engagement with, the environment fosters the development of vocabulary (Hart, 2004; Horn & Blankson, 2005; Main, 1983; Tomasello, 1992). Family environments provide opportunities for the development of vocabulary. Individuals who are reared in home environments that encourage exploration have many opportunities for the development of vocabulary. Indeed, research has repeatedly supported the proposition that “opportunities for productive activity”—the extent to which toys and learning materials are available in the home environment, along with the extent to which parents directly teach their child concepts and take their child to places and events that provide enrichment—are positively related to vocabulary (Bradley & Corwyn, 2005; Bradley, Corwyn, Burchinal, McAdoo, & Garcia Coll, 2001; Griffin & Morrison, 1997). Research also indicates that engagement in productive activities is related to attention focusing and memory, both of which are elements of executive functioning (NICHD Early Child Care Research Network, 2005).

In light of this evidence, we explored the extent to which environmental stimulation moderates the path from executive functioning to vocabulary. It could be the case that for children who are reared in stimulating environments, the stronger the executive functioning skills, the more these children are able to benefit from their environments. Thus, the relation between executive functioning and vocabulary may be stronger in more stimulating home environments such that children with higher executive functioning skills who are reared in stimulating environments have an added benefit and therefore have larger vocabularies than their counterparts with lower executive functioning skills who may be overwhelmed by the toys and materials in stimulating homes and/or may not engage in the types of activities and play that would enhance vocabulary to the extent that those with higher executive functioning skills do. In less stimulating environments, the association between executive functioning skills may not be as strong because the opportunities for the development of vocabulary are themselves limited; thus, having better executive functioning skills may not be beneficial in such homes. However, an alternate hypothesis is also plausible for the reason that when the home environment is more impoverished, learning words in such environments might require stronger executive functioning skills. Thus, it could be the case that the relation between executive functioning and vocabulary would be stronger in less stimulating home environments, rather than in more stimulating environments. In less stimulating home environments, children with stronger executive functioning skills may be better able to make use of the materials that are in the home, whereas in more stimulating home environments executive functioning skills need not be particularly heavily involved.

Moderation of the relation between executive functioning and vocabulary by home environmental stimulation would suggest that the mediation effect of shyness to vocabulary

through executive functioning would also be moderated by home environmental stimulation. Hence, stimulation in the home environment is expected to alter the relation between shyness and the development of vocabulary through executive functioning skills such that the negative relation between shyness and vocabulary through executive functioning skills will differ across different levels of home environmental stimulation.

Overview of Study Hypotheses

Previous research and theory suggests that: (a) shyness is negatively related to vocabulary acquisition; (b) shyness is negatively related to executive functioning; (c) executive function is related to vocabulary acquisition in early childhood; and (d) home environmental stimulation is positively related to executive function and vocabulary acquisition. Based on this theoretical and empirical background, we proposed the following hypotheses: (1) There will be a negative relation between shyness and executive functioning; (2) There will be a positive relation between executive functioning and vocabulary (3) There will be a significant and negative indirect relation between shyness and vocabulary through executive functioning that will be moderated by home environmental stimulation. No hypothesis was specified about the direct relation between shyness and vocabulary because our hypotheses suggest shyness will have different effects in different contexts. Furthermore, evidence of a significant effect of the predictor on the criterion variable is not required for evidence of mediation or an indirect effect (MacKinnon, Krull, & Lockwood, 2000). The alternative hypotheses of shyness as a moderator or mediator between executive functioning and vocabulary were also examined.

Methods

Participants

The sample was comprised of children and their mothers who participated in a study examining emotional and cognitive contributions to early school success. The present analyses were conducted using the sample of children who at age 3.5-years had complete data on the study variables ($N = 254$). Children with incomplete data ($N = 9$) were from families with lower income ($t [257] = 2.25, p < .05$) than the included children. No other comparisons on demographic variables (child gender, child age, child ethnicity, maternal age, and maternal education) were significant. Mothers¹ in the study sample were 33 years of age on average ($SD = 5.87$). Approximately 51% had a 4-year college degree or had completed higher levels of education; 75% of the respondents were married and living with their partner; and 79% were currently working outside the home. Average income-to-needs ratio, derived by dividing the total family income by the poverty threshold for that family size was 2.92 ($SD = 1.72$). Approximately 23% of the sample had an income-to-needs ratio of 1 or less, 67% between 2 and 5, and 10% had income-to-needs ratios greater than 5. Mean age of the children was 41.79 months ($SD = 2.40$). Fifty-two percent of the children were female; 59% were European American, 35% African American, and 6% were of other ethnicities.

Participating families were recruited from preschools and child care centers in a small southeastern city through letters sent home with the children. Families interested in participating returned contact information to the researchers who then called the families to schedule a laboratory visit that lasted approximately two hours. Mothers provided written consent before the start of the session, during which time children played a game with the experimenter. During the lab session, children were videotaped while completing tasks

¹Of the 254 children, one child was accompanied to the lab by his father, who was the primary caregiver; three by their grandmothers, with whom the children lived; and all others by their mothers. Caregivers are referred to as mothers.

assessing executive control and vocabulary, with task order held constant across children. The executive control and vocabulary tasks were administered one half hour to one hour into the protocol; the children were accustomed to the testing session by this time. Mothers completed questionnaires during the session. Families received \$40 and children selected a toy as thanks for their participation.

Measures

Shyness was measured with the *Children's Behavior Questionnaire Short Form* (CBQ-Short; Putnam & Rothbart, 2006). The CBQ-Short assesses temperament in 3- to 7-year-olds. Mothers described their child's typical reactions to various situations using a 7-point Likert scale ranging from 1 (*extremely untrue of your child*) to 7 (*extremely true of your child*). Of interest in the present analyses was the 7-item shyness subscale (e.g., "Acts shy around new people"). Items were averaged (Cronbach's alpha was .76).

Executive Functioning was measured with two tasks, the *Day/Night Stroop* task (Stroop; Gerstadt, Hong, & Diamond, 1994), and the Kaufman Assessment Battery for Children (K-ABC, Kaufman & Kaufman, 1983) *number recall test*. The Stroop was developed from the classic task (Stroop, 1935) which is widely used to index cognitive inhibitory control. Children were presented with a deck of cards, half of which were black with a yellow moon and several stars, and half were white with a bright sun. Children were instructed to say "day" in response to the black cards and "night" to the white cards. Following two practice trials, each type of card was presented eight times in a fixed order (16 in total). Children were administered the test trials only if they answered at least one question correctly in two practice trials. Children who failed both practice trials received a score of zero ($n = 74$). The possible range of scores was from 0 to 16 with higher scores indicating stronger cognitive control or inhibition. The number recall subtest of the K-ABC was administered to children to assess working memory capacity. The examiner recited a series of numbers, and children were asked to repeat them in the same sequence. Number sequences increased in size until children missed three sequences in a row. Each sequence was scored as correct (1) or incorrect (0). The raw score was computed as the difference between the ceiling item and the total number of errors. The Stroop and number recall tests correlated significantly ($r = .42, p < .01$) in the sample and were standardized and summed to form an executive functioning composite².

Home Environmental Stimulation was measured using two questionnaires, *Watching Television, Reading, and Computers at Home* (TVRC) and the *Toys and Activities Questionnaire* (TAQ), that were completed by the caregiver. The TVRC is comprised of 9 items ($\alpha = .57$) and was adapted for the study from a measure by Griffin and Morrison (1997). Example items include "number of books owned by child" and "someone reads to child at home". The TAQ is comprised of 20 items ($\alpha = .65$) and was adapted for the study from the Home Observation for Measurement of the Environment (Caldwell & Bradley, 1984). Example items include "in your home, does your child have toys that help him/her learn colors" and "do you encourage your child to read a few words in his/her books". The TVRC and TAQ scores correlated significantly ($r = .49, p < .01$) and were standardized and summed to form a home environmental stimulation composite ($\alpha = .66$). The composite represents the extent to which toys and learning materials are available in the home environment, the child engages with the toys and learning materials, and parents directly teach their child concepts and take their child to places and events that provide enrichment.

²Conclusions were the same when the tasks were examined separately.

Vocabulary was measured with the *Peabody Picture Vocabulary Test-III* (PPVT, Dunn & Dunn, 1997). The PPVT is a standardized measure of receptive vocabulary. Items are arranged in 17 sets of 12 items. For each item, the child was asked to point to one of four drawings named by the examiner. Items were administered by complete sets until the child missed eight in a set, upon which time testing stopped. A raw score was computed as the difference between the ceiling item set and the number of errors made in all of the sets administered. The possible range of scores was from 0 to 204.

Results

The correlations, means, and standard deviations for the major study variables are displayed in Table 1. As expected, shyness and executive functioning were negatively correlated. Additionally, both executive functioning and home environmental stimulation were positively correlated with vocabulary.

To address the primary research question, we used a bootstrap procedure described by Preacher, Rucker, and Hayes (2007). The bootstrap method is considered superior to other methods for testing mediation, such as the Baron and Kenny (1986) causal steps approach (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The Preacher et al. SPSS macros for testing moderated mediation produces a simple ordinary least squares (OLS) regression test for a mediator variable model (shyness on executive functioning), along with a test for a dependent variable model (shyness and executive functioning on vocabulary) that includes any relevant interaction terms. The interaction terms in the model test for moderation of the meditation hypothesis.

To probe significant moderated mediation effects, conditional indirect effects are tested by the Preacher et al. (2007) macros; that is, whether the indirect effect (of shyness on vocabulary in this case) is significant at specific levels of the moderator (home environmental stimulation), similar to the Aiken and West (1991) methods for probing significant interactions. More specifically, k bootstrap samples (usually 1000 or greater) of N units are drawn from the original sample of N units, with replacement, and the indirect effect is calculated for each sample as the product of the unstandardized weight for the path from the predictor to the mediator and the unstandardized weight for the path from the mediator to the outcome variable at various levels of the moderator. An average indirect effect is calculated as the mean across the k samples along with a 95% bias corrected and accelerated confidence interval for the indirect effect that does not assume normality of the sampling distribution of the test statistic or the variables in the analysis. The null hypothesis of no indirect effect is rejected if the confidence interval does not contain zero (MacKinnon, Lockwood, & Williams, 2004).

Preacher et al. (2007) discuss at least five ways in which an indirect effect can be dependent upon a moderator. Because our hypotheses specified an interaction between executive functioning and environmental stimulation, we specified Preacher et al.'s model 3, testing the significance of the interaction between executive functioning and home environmental stimulation in predicting vocabulary (the interaction between home environmental stimulation and shyness on executive functioning was tested and was not significant). Child gender, ethnicity (dichotomized to distinguish European American [=0] from non-European American [=1] children), age in months, and family income-to-needs ratio were entered as covariates. Examination of interaction effects with these variables were beyond the scope of the current paper.

Results of the OLS regressions that provide a test of the mediation hypothesis (executive functioning as a mediator of the shyness-vocabulary link) are presented in Table 2. For the

mediator variable model, the path from shyness to executive functioning was negative and significant, as expected. For the dependent variable model, the path from executive functioning to vocabulary was significant.

The hypothesis that home environmental stimulation will moderate the association between executive functioning and vocabulary was tested by examining the significance of the interaction between executive functioning and environmental stimulation in the prediction of vocabulary. As can be seen in Table 2 under the dependent variable model, the executive functioning by environmental stimulation interaction was significant. This interaction is depicted in Figure 2, at ± 1 *SD* from the mean of home environmental stimulation. The positive relation between executive functioning and vocabulary was stronger in home environments that are more stimulating.

The significance of the moderation effect suggests that the mediation effect is also moderated. The moderation of home environmental stimulation in the indirect effect of shyness to vocabulary through executive functioning is depicted in Figure 3 at plus and minus one standard deviation from the mean. To further probe the moderated mediation effect, bootstrap estimates of the indirect effects, along with bias corrected and accelerated bootstrap confidence intervals for the indirect effect, were calculated at the mean environmental stimulation as well as plus and minus one standard deviation from the mean, based on 5000 bootstrapped samples. These results are presented in Table 3. The indirect effect was negative and significant at the mean and one standard deviation above the mean for home environmental stimulation. The indirect effect was not significant at the .05 level at one standard deviation below the mean, although the confidence interval does not contain zero, therefore suggesting significance. Thus, the indirect relation between shyness and vocabulary via executive function was most robust when environmental stimulation was average or high.

Two alternative hypotheses were tested. The first examined whether shyness moderates the association between executive functioning and vocabulary. This hypothesis was tested using hierarchical multiple regression. The first step of the regression analysis included the predictor variables and the covariates. The second step included the interaction between shyness and executive functioning. Results are presented in Table 4. The interaction between shyness and executive functioning was not significant in the second step of the regression, nor was the *F* change significant ($\Delta F = 2.42, p = .12$). The second alternative hypothesis examined shyness as a mediator of the executive functioning-vocabulary relation. This hypothesis was tested using a bootstrap procedure similar to that described above for the test of moderated mediation (Preacher & Hayes, 2004). The estimated indirect effect was .04, 95% CI [-.09, .28]. Because the confidence interval for the indirect effect contained zero, we failed to reject the null hypothesis of no indirect effect.

Discussion

The primary questions of the present study were whether there was a significant indirect effect of shyness on vocabulary through executive functioning and whether home environmental stimulation moderated the mediated link between shyness and vocabulary. Consistent with our expectations, executive functioning mediated the shyness-vocabulary link, and the mediation was stronger at high levels of environmental stimulation. Examination of alternative hypotheses in which shyness was examined as a moderator or mediator of the relation between executive functioning and vocabulary found no evidence for these relationships.

That shyness was indirectly linked with poorer vocabulary scores is consistent with some previous research (e.g., Gewirtz, 1948; Spere et al., 2004), suggesting that shyness may be negatively associated with vocabulary acquisition. The finding of a positive relation between executive functioning and vocabulary also supports previous research (e.g., Gathercole et al., 1992; McClelland et al., 2007), adding more evidence to the notion that cognitive control is necessary in the acquisition of vocabulary. These findings call attention to the importance of executive functioning skills in development and the need for further research that addresses the link between shyness and executive functioning.

The significance of the indirect link between shyness and vocabulary through executive functioning suggests that shyness may be associated with the distribution of attention toward word-learning events through the relation with executive functioning skills. This in turn may be associated with the acquisition of vocabulary. These effects, however, were more pronounced in stimulating home environments; children with better executive functioning skills develop stronger vocabularies when reared in stimulating environments than when reared in less stimulating environments. The negative arousal of shy children in social situations may interfere with their ability to exert the cognitive control necessary to learn new words, particularly in stimulating environments.

Results of this research indicated a significant interaction between executive functioning and environmental stimulation in the prediction of vocabulary. This result implies that children with higher executive functioning skills who are reared in more environmentally stimulating homes may be more likely to develop large vocabularies compared to children with higher executive functioning skills who are reared in less stimulating environments; children with stronger executive functioning skills who are reared in stimulating environments might have an added bonus and therefore develop better vocabularies than their counterparts with who are reared in less stimulating environments.

Home environmental stimulation is important for all children, regardless of their temperamental characteristics. However, our results indicate that not all children may benefit fully from the environmental stimulation parents provide. First, results indicated that children in more stimulating environments with weaker executive functioning skills may perform no better than their counterparts who are reared in less stimulating environments. Thus, home environmental stimulation may not by itself promote the development of vocabulary in all children. Additionally, the negative association between shyness and executive functioning skills we observed suggests that shy children may benefit less than other children from their stimulating environments with regard to vocabulary development to the extent that shyness may interfere with the effectiveness of executive functioning skills.

The results of the present study have important applications for intervention and treatment efforts for children and for making educators and caregivers aware of the challenges that children may face in the development of vocabulary skills. Most early intervention programs target “at-risk” children-- children who are often reared in families of low socioeconomic status. The effect of home environmental stimulation on child outcomes in the present study was significant over and above income differences, highlighting the importance of home environmental stimulation in child outcomes. However, the findings of this research suggest that it is the combination of a stimulating environment along with child characteristics that produce the strongest outcomes in vocabulary acquisition.

While results of this research highlight the importance of the development and/or maintenance of intervention methods and programs that are aimed at improving the environmental stimulation received by children in their homes, such interventions may not

be beneficial for all children. Moreover, the findings of this research underscore the importance of executive functioning skills in development. Based on findings that executive functioning is positively related to vocabulary, it is possible that interventions and treatments for improving the outcomes of children, perhaps especially shy children, could be targeted at improving executive functioning skills, particularly in the early years. There is research suggesting that executive functioning skills can be enhanced through training and schooling (Diamond, Barnett, Thomas, & Munro, 2007; McCrea, Muller, & Parrila, 1999), suggesting that incorporating such training procedures into treatment protocols for children might prove fruitful in terms of vocabulary development.

There are several limitations of the present research that should be noted. Foremost, the data were collected at only one time point. Although there is evidence to support the hypothesized direction of effects, we acknowledge that the relations among the variables examined in this research may operate in a manner other than that specified by our model. For example, it has been suggested that some forms of shyness may appear early in infancy, while other forms may appear around the age of four or five, after the emergence of a “sense of self” (Cheek, 1998; Crozier, 2002). Therefore, it could be that executive functioning skills, vocabulary, and shyness have reciprocal relationships. However, alternative hypotheses, such as the possibility that shyness mediates the link between executive functioning and vocabulary, and the hypothesis that shyness moderates the link between executive functioning and vocabulary, were tested and were not supported by these data. Nevertheless, that the present research design was non-experimental, such that random selection and random assignment were not employed, restricts our ability to determine the temporal order of effects. Therefore, statements about causality should be interpreted cautiously.

An additional limitation was that only receptive vocabulary was examined. Although productive and receptive vocabulary abilities are related, research has more consistently found a negative relation between shyness and productive vocabulary than between shyness and receptive vocabulary (Coplan & Armer, 2005). We speculate that results using productive vocabulary measures would be similar to those obtained in this study. However, further research is needed to examine the extent to which this is the case.

It is also possible that shy children do not display their knowledge of vocabulary or executive functioning in unfamiliar research settings. To the extent that shyness is provoked by the novelty of the experimental setting, children’s responses may be inhibited. We believe this possible limitation was minimized in the present study for several reasons. First, as previously mentioned, our measure of vocabulary was receptive rather than productive, and shy children are likely to perform better on tests of receptive vocabulary than tests of productive vocabulary (Crozier & Hostettler, 2003). Furthermore, the vocabulary and executive functioning tests were administered 30–60 minutes into the laboratory session, giving the children time to become comfortable with the situation and build rapport with the experimenter, and, the lab protocol included activities that aided in the maintenance of rapport throughout the visit. Nevertheless, research suggests that shyness may impede rapport building efforts (Rotenberg et al., 2003). Therefore, further research should be conducted under conditions that may be more familiar to shy children to see if results replicate. However, in young children of pre-reading age, the source of vocabulary development is primarily through audition and interaction with others. Therefore, even if child performance were restricted due to shyness rather than actual capabilities, this does not run counter to our conjecture that executive functioning skills may decrease with increasing levels of shyness, which in turn may be implicated in the development of vocabulary, but in fact, may provide increased support for this hypothesis. Similarly, the novelty associated with laboratory settings are in some ways similar to school settings in the sense that school

settings can also be very novel and socially intimidating to shy children. Thus, the examination of shyness in the laboratory perhaps represents a more ecologically valid assessment of the kind of problems that will eventually emerge in the school setting than would examination of shyness in more familiar settings³.

In addition to the limitations of the research, there are also several strengths, one of them being the diversity of the sample. Research on the relation between and among shyness, vocabulary, and executive functioning have often been conducted using samples of primarily Caucasian children from middle-class homes. The present study includes a more diverse sample of children. Relatedly, the sample size employed in the present research was relatively larger than has often been used in investigations of the link between shyness and vocabulary (e.g., Coplan & Armer, 2005; Dixon & Smith, 2000); shyness and executive functioning (e.g., Lieberman, 2000; Ludwig & Lazarus, 1983); and executive functioning and vocabulary (e.g., Adams & Gathercole, 1995; Blair & Razza, 2007). An additional strength of the research was in its focus on processes by which shyness may come to be related to vocabulary. The results of this study extend previous work in two ways. First, it provides evidence regarding the potential role of executive functioning in the relation between shyness and vocabulary acquisition, thereby adding to our understanding of the role of temperamental characteristics in the development of cognitive abilities. Second, it provides evidence that environmental stimulation moderates the mediation of executive functioning in the association between shyness and vocabulary. These results add to our knowledge of the ways in which temperamental characteristics, such as shyness, may influence vocabulary acquisition.

Future research is needed that not only examines different aspects of shyness and different types of vocabulary as well as other aspects of knowledge, but employs a longitudinal design, to increase understanding of the nature of the relation between shyness and cognitive development as well as the role that environmental stimulation might play in this relation. Results of such research would enhance our understanding of the contexts under which shyness may or may not interfere with cognitive and language development. Finally, while shyness in the U.S. has often been pathologized, there is evidence that shyness is not viewed as maladaptive in some nonwestern cultures such as China (e.g., Chen, Rubin, & Sun, 1992). Therefore, it would be of interest to examine the extent to which results obtained in the present study would generalize to societies in which shyness is viewed as a valued characteristic of children.

The present study contributes to the extant literature by examining processes that may account for the link between shyness and vocabulary, which very few research studies have done, thereby adding to the theories on the relation between shyness and vocabulary. This research adds to the existing literature by not only examining the potential mediation of executive functioning in the relation between shyness and vocabulary, but also examining environmental stimulation as a moderator of this mediation. The results of this research provide an impetus for further research on the mechanisms by which shyness is related to vocabulary.

Acknowledgments

This research was supported by grant 5R01HD050806 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health and Human Development or the National Institutes of Health. The authors wish to express their thanks to Lauren Keel Shinn,

---

³We thank an anonymous reviewer for this suggestion.

Korinne Chiu, Pamela D. Baldwin, the students and staff who assisted with data collection, and the families who participated in the study

References

- Adams A-M, Gathercole S. Phonological working memory and speech production in preschool children. *Journal of Speech and Hearing Research*. 1995; 38:403–414. [PubMed: 7596106]
- Aiken, LS.; West, SG. Multiple regression: Testing and interpreting interactions. Thousand Oaks: Sage; 1991.
- Arnold AP, Cheek JM. Shyness, self-preoccupation and the Stroop Color and Word Test. *Personality and Individual Differences*. 1986; 7:571–573.
- Asendorpf JB. Development of inhibition during childhood: Evidence for situational specificity and a 2-factor model. *Developmental Psychology*. 1990; 26:721–730.
- Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*. 1986; 51:1173–1182. [PubMed: 3806354]
- Blair C, Peters R. Physiological and neurocognitive correlates of adaptive behavior in preschool among children in Head Start. *Developmental Neuropsychology*. 2003; 24:479–497. [PubMed: 12850755]
- Blair C, Razza RP. Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*. 2007; 78:647–663. [PubMed: 17381795]
- Bradley RH, Corwyn RF. Productive activity and the prevention of behavior problems. *Developmental Psychology*. 2005; 41:89–98. [PubMed: 15656740]
- Bradley RH, Corwyn RF, Burchinal M, McAdoo HP, Garcia Coll C. The home environments of children in the United States part II: Relations with behavioral development through age thirteen. *Child Development*. 2001; 72:1868–1886. [PubMed: 11768150]
- Burgess KB, Marshall PJ, Rubin KH, Fox NA. Infant attachment and temperament as predictors of subsequent externalizing problems and cardiac physiology. *Journal of Child Psychology and Psychiatry*. 2003; 44:819–831. [PubMed: 12959491]
- Caldwell, BM.; Bradley, RH. Home Observation for Measurement of the Environment. Little Rock, AR: University of Arkansas at Little Rock; 1984.
- Chall, JS. Stages of reading development. New York: McGraw-Hill; 1983.
- Cheek, JM. Development of subtypes of shyness. Presented at INABIS '98 - 5th Internet World Congress on Biomedical Sciences at McMaster University; Dec 7–16th; Canada. 1998. Invited Symposium. Available at URL <http://www.mcmaster.ca/inabis98/ameringen/cheek0760/index.html>
- Chen X, Rubin KH, Sun Y. Social reputation and peer relationships in Chinese and Canadian children: A cross-cultural study. *Child Development*. 1992; 63:1336–1343.
- Coplan RJ, Armer M. Talking yourself out of being shy: Shyness, expressive vocabulary, and socioemotional adjustment in preschool. *Merrill-Palmer Quarterly*. 2005; 51:20–41.
- Crozier WR. Shyness. *The Psychologist*. 2002; 15:460–463.
- Crozier WR, Hostettler K. The influence of shyness on children's test performance. *British Journal of Educational Psychology*. 2003; 73:317–328. [PubMed: 14672146]
- Diamond, A. Frontal lobe involvement in cognitive changes during the first year of life. In: Gibson, KR.; Petersen, AC., editors. Brain maturation and cognitive development: Comparative and cross-cultural perspectives. NY: Aldine de Gruyter; 1991. p. 127-180.
- Diamond A, Barnett WS, Thomas J, Munro S. Preschool programs improves cognitive control. *Science*. 2007; 318:1387–1388. [PubMed: 18048670]
- Diamond A, Doar B. The performance of human infants on a measure of frontal cortex function, the delayed response task. *Developmental Psychobiology*. 1989; 22:271–294. [PubMed: 2707496]
- Dixon WE, Salley BJ, Clements AD. Temperament, distraction, and learning in toddlerhood. *Infant Behavior and Development*. 2006; 29:342–357. [PubMed: 17138290]

- Dixon WE, Smith PH. Links between early temperament and language acquisition. *Merrill-Palmer Quarterly*. 2000; 46:417–440.
- Dunn, LM.; Dunn, L. Peabody Picture Vocabulary Test. 3rd ed.. Circle Pines, MN: American Guidance Service; 1997. [Test Materials]
- Eisenberg N, Shepard SA, Fabes RA, Murphy BC, Guthrie IK. Shyness and children's emotionality, regulation, and coping: Contemporaneous, longitudinal, and across context relations. *Child Development*. 1998; 69:767–790. [PubMed: 9680684]
- Evans, MA. Shyness in the classroom and home. In: Crozier, WR.; Alden, LE., editors. *International handbook of social anxiety: Concepts, research and interventions relating to the self and shyness*. Sussex: John Wiley & Sons; 2001. p. 159-183.
- Garon N, Bryson SE, Smith IM. Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*. 2008; 134:31–60. [PubMed: 18193994]
- Gartstein MA, Rothbart MK. Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development*. 2003; 26:64–86.
- Gathercole SE, Baddeley AD. Evaluation of the role of phonological STM in the development of vocabulary in children: A longitudinal study. *Journal of Memory and Language*. 1989; 28:200–213.
- Gathercole SE, Willis CS, Emslie H, Baddeley AD. Phonological memory and vocabulary development during the early school years: A longitudinal study. *Developmental Psychology*. 1992; 28:887–898.
- Gerstadt CL, Hong YJ, Diamond A. The relation between cognition and action: Performance of children 3 ½–7 years old on a Stroop-like day-night test. *Cognition*. 1994; 53:129–153. [PubMed: 7805351]
- Gewirtz JL. Studies in word-fluency: II. Its relation to eleven items of child behavior. *Journal of Genetic Psychology*. 1948; 72:177–184. [PubMed: 18891161]
- Griffin EA, Morrison FJ. The unique contribution of home literacy environment to differences in early literacy skills. *Early Child Development and Care*. 1997; 233–234:127–128.
- Hart B. What toddlers talk about. *First Language*. 2004; 24:91–106.
- Hart, B.; Risley, TR. *Meaningful differences in the everyday experiences of young American children*. Baltimore: Paul H. Brookes; 1995.
- Hoff E. The uses of longitudinal data and person-centered analyses in the study of cognitive and language development. *Merrill-Palmer Quarterly*. 2007; 52:633–644.
- Horn, JL.; Blankson, N. Foundations for better understanding of cognitive abilities. In: Flanagan, DP.; Harrison, PL., editors. *Contemporary intellectual assessment: Theories, tests, and issues*. 2nd ed.. New York: The Guilford Press; 2005. p. 41-68.
- Humphreys MS, Revelle W. Personality, motivation, and performance: A theory of the relationship between individual differences and information processing. *Psychological Review*. 1984; 91:153–184. [PubMed: 6571423]
- Kastner JW, May W, Hildman L. Relationship between language skills and academic achievement in first grade. *Perceptual and Motor Skills*. 2001; 92:381–390. [PubMed: 11361297]
- Kaufman, AS.; Kaufman, NL. *Kaufman Assessment Battery for Children (K-ABC)*. Circle Pines, MN: American Guidance Service; 1983.
- Kerr, M. Childhood and adolescent shyness in long-term perspective: Does it matter?. In: Crozier, WR., editor. *Shyness: Development, consolidation and change*. London: Routledge; 2000. p. 64-87.
- Lieberman MD. Introversion and working memory: Central executive differences. *Personality and Individual Differences*. 2000; 28:479–486.
- Ludwig RP, Lazarus PJ. Relationship between shyness in children and constricted cognitive control as measured by the Stroop Color-Word Test. *Journal of Counseling and Clinical Psychology*. 1983; 51:386–389.
- MacKinnon DP, Krull J, Lockwood CM. Equivalence of the mediation, confounding, and suppression effect. *Prevention Science*. 2000; 1:173–181. [PubMed: 11523746]

- MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. Comparison of methods to test mediation and other intervening variable effects. *Psychological Methods*. 2002; 7:81–104.
- MacKinnon DP, Lockwood CM, Williams J. Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*. 2004; 39:99–128. [PubMed: 20157642]
- Main M. Exploration, play, and cognitive functioning related to infant-mother attachment. *Infant Behavior and Development*. 1983; 6:167–174.
- McClelland MM, Connor CD, Jewkes AM, Cameron CE, Farris CL, Morrison FJ. Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*. 2007; 43:947–959. [PubMed: 17605527]
- McCrea SM, Mueller JH, Parrila RK. Quantitative analyses of schooling effects on executive function in young children. *Child Neuropsychology*. 1999; 5:242–250. [PubMed: 10925708]
- NICHD Early Child Care Research Network. Predicting individual differences in attention, memory, and planning in first graders from experiences at home, child care, and school. *Developmental Psychology*. 2005; 41:99–114. [PubMed: 15656741]
- Paul R, Kellogg L. Temperament in late talkers. *Journal of Child Psychology and Psychiatry*. 1997; 38:803–811. [PubMed: 9363579]
- Piaget, J. *Psychology of intelligence*. Paterson, NJ: Littlefield Adams; 1960.
- Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*. 2004; 36:717–731.
- Preacher KJ, Rucker DD, Hayes AF. Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*. 2007; 42:185–227.
- Prior M, Bavin EL, Cini E, Reilly S, Bretherton L, Wake M, Eadie P. Influences on communicative development at 24 months of age: Child temperament, behavior problems, and maternal factors. *Infant Behavior and Development*. 2008; 31:270–279. [PubMed: 18190967]
- Putnam SP, Rothbart MK. Development of short and very short forms of the Children's Behavior Questionnaire. *Journal of Personality Assessment*. 2006; 87:103–113.
- Rotenberg KJ, Eisenberg N, Cumming C, Smith A, Singh M, Terlicher E. The contribution of adults' nonverbal cues and children's shyness to the development of rapport between adults and preschool children. *International Journal of Behavioral Development*. 2003; 27:21–30.
- Rubin, KH.; LeMare, L.; Lollis, SP. Social withdrawal in childhood: Developmental pathways to peer rejection. In: Asher, SR.; Coie, JD., editors. *Peer rejection in childhood*. Cambridge, UK: Cambridge University Press; 1990. p. 217-249.
- Rueda MR, Posner MI, Rothbart MK. The development of executive attention: Contributions to the emergence of self-regulation. *Developmental Neuropsychology*. 2005; 28:573–594. [PubMed: 16144428]
- Sanson A, Pedlow R, Cann W, Prior M, Oberklaid F. Shyness ratings: Stability, and correlates in early childhood. *International Journal of Behavioral Development*. 1996; 19:705–724.
- Scarpa A, Raine A, Venables PH, Mednick SA. The stability of inhibited/uninhibited temperament from ages 3 to 11 years in Mauritian children. *Journal of Abnormal Child Psychology*. 1995; 23:607–618. [PubMed: 8568083]
- Schmidt, LA.; Tasker, SL. Childhood shyness: Determinants, development, and 'depathology'. In: Crozier, WR., editor. *Shyness: Development, consolidation, and change*. London: Routledge; 2000. p. 30-46.
- Scott S. The medicalisation of shyness. From social misfits to social fitness. *Sociology of Health and Illness*. 2006; 28:133–153. [PubMed: 16509950]
- Slomkowski CL, Nelson K, Dunn J, Plomin R. Temperament and language: Relations from toddlerhood to middle childhood. *Developmental Psychology*. 1992; 28:1090–1095.
- Spreng KA, Schmidt LA, Theall-Honey LA, Martin-Chang S. Expressive and receptive language skills of temperamentally shy preschoolers. *Infant and Child Development*. 2004; 13:123–133.
- Sroufe LA. Wariness of strangers and the study of infant development. *Child Development*. 1977; 48:731–746.

- Stroop JR. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*. 1935; 18:643–662.
- Tanwar U, Malhotra D. Short-term memory as a function of personality and imagery. *Personality and Individual Differences*. 1992; 13:175–180.
- Tomasello M. The social bases of language acquisition. *Social Development*. 1992; 1:67–87.
- Vineyard EE, Massey HW. The interrelationship of certain linguistic skills and their relationship with scholastic achievement when intelligence is ruled constant. *Journal of Educational Psychology*. 1957; 48:279–286.
- Wolfe CD, Bell MA. Sources of variability in working memory in early childhood: A consideration of age, temperament, language, and brain electrical activity. *Cognitive Development*. 2007; 22:431–455.

Figure 1. Environmental stimulation as moderator of the mediation of executive functioning in the relationship between shyness and vocabulary.

Figure 2.
Interaction between executive functioning and environmental stimulation in the prediction of picture vocabulary.

Figure 3.
Moderation of home environmental stimulation in the indirect relation between shyness and vocabulary through executive functioning.

Table 1

Zero-order Correlations, Means, and Standard Deviations for Major Study Variables

Variable	1	2	3	4
1. Shyness	---			
2. Executive Functioning	-0.16 *	---		
3. Home Environmental Stimulation	0.02	0.11	---	
4. Vocabulary	-0.10	0.41 **	0.30 **	---
<i>M</i>	3.82	0.01	0.01	42.39
<i>SD</i>	1.18	1.68	1.68	16.39

*
 $p \leq .05$ (two-tailed).**
 $p \leq .01$ (two-tailed).

Table 2

Test of Moderated Mediation

Predictors	<i>b</i>	<i>SE</i>	<i>T</i>
Mediator Variable Model (Predicting Executive Functioning)			
Shyness	−0.19	0.09	−2.20*
Gender	−0.51	0.20	−2.46*
Ethnicity	−0.11	0.21	−0.51
Age	0.12	0.04	2.61**
Income-to-needs Ratio	0.21	0.06	3.37**
Dependent Variable Model (Predicting Vocabulary)			
Shyness	−0.29	0.75	−0.38
Executive Functioning	3.05	0.54	5.60**
Environmental Stimulation	2.00	0.56	3.55**
Executive Functioning×Environmental Stimulation	0.73	0.32	2.32*
Gender	−3.50	1.77	−1.98*
Ethnicity	−5.66	1.84	−3.07**
Age	1.20	0.38	3.16**
Income-to-needs Ratio	1.13	0.56	2.00*

*
 $p \leq .05$ (two-tailed).**
 $p \leq .01$ (two-tailed).

Table 3

Indirect Effect of Shyness on Vocabulary via Executive Functioning at Various Levels of Environmental Stimulation

Level	Coefficient	(95% CI)	SE	z
1 <i>SD</i> below mean	−0.36	(−1.00, −0.01)	0.24	−1.47
Mean	−0.59	(−1.26, −0.06)	0.30	−1.97*
1 <i>SD</i> above mean	−0.82	(−1.72, −0.09)	0.41	−2.01*

Note. CI = Confidence Interval.

*
 $p \leq .05$ (two-tailed).

Table 4

Moderation between Shyness and Executive Functioning in the Prediction of Vocabulary

Predictors	<i>b</i>	<i>SE</i>	<i>T</i>	ΔR^2	ΔF
Step 1: <i>df</i> = 6, 247				0.28	15.63**
Shyness	-0.37	0.77	-.48		
Executive Functioning	3.20	0.56	5.73**		
Gender	-4.06	1.81	-2.24*		
Ethnicity	-6.79	1.86	-3.64**		
Age	1.13	0.39	2.88**		
Income-to-needs Ratio	0.21	0.06	3.37**		
Step 2: <i>df</i> = 7, 246				0.01	2.42
Shy $\times$ Exec Functioning	0.70	0.45	1.56		

*
 $p \leq .05$ (two-tailed).**
 $p \leq .01$ (two-tailed).