

Language as a Mediator between Home Environment and Prefrontal Functioning  
In Early Childhood

Hossam M. Zaki

Thesis submitted to the Faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE  
IN  
PSYCHOLOGY

Martha Ann Bell, Ph.D. (Chair)

Robin P. Cooper, Ph.D.

Jane L. Abraham, Ph.D.

April, 2004

Blacksburg, Virginia

**Keywords:** children, working memory, home environment, language

Copyright 2004, Hossam M. Zaki

Language as a Mediator between Home Environment and  
Prefrontal Functioning In Early Childhood

Hossam Zaki

**(Abstract)**

The purpose of the current study was to examine the mediating role of language in explaining the relation between home environment and prefrontal functioning. Participants were 30 children from two preschool centers (Virginia Tech Lab School and Radford Head Start Center) representing a wide range of socio-economic status. Children's working memory was assessed through performing two verbal tasks, namely the Day/Night task and the Yes/No task and a non-verbal task, the Tapping task. Language, in turn, was assessed through the Peabody Picture Vocabulary Test (PPVT-III). The criteria proposed by Baron and Kenny (1986) were followed to test for the mediational hypothesis, as well as an alternative hypothesis stating that working memory might mediate the relation between home environment and language. Results indicated that language did mediate the relation between home environment and prefrontal functioning, particularly working memory. The alternative hypothesis did not prove to be successful. Theoretical and educational implications of these findings are discussed.

## DEDICATION

This thesis is dedicated to the spirit of my father (May Allah bless his soul) as well as to my mother in Egypt whom I miss a lot.

## ACKNOWLEDGEMENTS

First of all, I would like to express my deepest sense of gratitude to my supervisor Dr. Martha Ann Bell for her patient guidance, encouragement and excellent advice throughout this study.

I extend my gratitude and appreciation to Dr. Robin Cooper and Dr. Jane Abraham for their beneficial criticisms and belief in my ability as a graduate student.

Further, I would like to thank all my colleagues at the Developmental Cognitive Neuroscience Lab for their support and help.

I would like to thank both the Radford Head Start Center and the Virginia Tech Lab School teams for their welcoming.

Last, but not least I would like to express my profound gratitude to my beloved wife, Dalia, and children, Sama and Ziad, for their moral support and patience during my study.

## Table of Contents

ABSTRACT.....	ii
DEDICATION.....	iii
ACKNOWLEDGEMENTS.....	iv
INTRODUCTION.....	1
Impact of Home Environment on Cognitive Development.....	3
Home Environment and Language Skills.....	4
The Relation Between Language and Working Memory.....	6
Hypothesis.....	8
METHOD.....	8
Participants.....	8
Procedures.....	9
Prefrontal Functioning.....	9
Language Assessment.....	10
RESULTS .....	11
Correlations.....	11
Group Differences.....	12
Mediational Analyses.....	12
Testing the Proposed Hypothesis.....	12
Testing an Alternative Hypothesis.....	13
DISCUSSION.....	13
REFERENCES.....	17
Table 1. Summary of Group Comparisons.....	23

Table 2. Intercorrelations between the variables of interest in the study.....	24
Table 3. Analysis of the proposed mediational model.....	25
Table 4. Analysis of the alternative mediational model.....	26
Figures Captions.....	27
Figure 1.....	28
Figure 2.....	29
Figure 3.....	30
Figure 4.....	31
Figure 5.....	32

## Language as a Mediator between Home Environment and Prefrontal Functioning In Early Childhood

Prefrontal cortex (PFC) is a structure that is known in the cognitive psychology literature to be related to higher cognitive functions, such as reasoning, planning, problem solving, and decision-making (Duncan, 1986; Luria, 1966; Shallice, 1988; Stuss, 1984). A long tradition of neuropsychological research has established that patients suffering from damage to their PFC exhibit great malfunction in these characteristically human cognitive functions. The observation of activity among cells in PFC during very specific memory tasks (Fuster & Alexander, 1971; Kubota & Niki, 1971) suggests that this brain area is part of the neural basis for working memory (e.g., Goldman-Rakic, 1987; Barone & Joseph, 1989; Miller, Erickson, & Desimone, 1996; Petrides, 1991).

Being an integral function of PFC, working memory (WM) is also perceived as essential to higher cognitive functions. WM is conceptualized as an active system for temporarily storing and manipulating information needed in the execution of complex cognitive tasks; e.g., comprehension, learning, and reasoning (Baddeley, 1986). A number of tasks have been developed to assess WM. One example is the classic “n-back task” which has been widely used in human neuroimaging and psychophysiology studies with older children and adults (e.g. Cohen, Perlstein, Braver, Nystrom, Noll, Jonides, & Smith, 1997). In this task, participants are presented with a series of items, each appearing one at a time, followed by the next item in the series. The task is to press a button when the item that is being presented at the moment is the same as the one presented a certain number (n) of items earlier. A number of other tasks have been developed to assess WM in early childhood (e.g. the day/night task and the Tapping task; Diamond & Taylor, 1996).

Not surprisingly, patients suffering from damage in their PFC commonly find it tremendously difficult if asked to solve a two-step problem in their heads, though they might be able to successfully solve each step separately (Luria, 1973). Therefore, they tend to center their attention on only one aspect of a story not the story as a whole. In addition, these patients have difficulty inhibiting a dominant response in order to perform a sub-dominant response (Diamond, 1995). This neuropsychological or *atypical* view to PFC was the start of a recent line of research that has been focusing on examining the *typical* developmental functioning of the PFC that focuses on WM and inhibitory control (e.g., Diamond & Taylor, 1996; Diamond, Kirkham, & Amso, 2002; Gerstadt, Hong, & Diamond, 1994).

The present study is one which is considering the typical developmental side. Relations were examined among some factors (home environment and language) that are believed to have an effect on preschoolers' performance on tasks associated with the development of the PFC.

According to Diamond and Taylor (1996), preschool children, like patients with damage in their PFC, have difficulty attending to two simultaneous things as well as exercising inhibition over their behavior. They appear to understand and remember the task instructions (e.g. they can verbalize the instructions), however they cannot get themselves to act accordingly. Nevertheless, children's ability to hold two things in mind (WM) as well as to inhibit dominant responses (inhibitory control) seems to improve between 3 and 6 years of age.

To test the development of these major cognitive skills with children 3 ½ to 7 years of age, some tasks have been developed requiring them to hold two rules in mind (WM) and suppress a dominant response (inhibition). One example is the Day/Night Stroop task, which is similar to the adult Stroop task. This task was designed for younger children; the child is required to say "day" when shown a card with a moon, and say "night" when shown a card with

a sun. This is extremely difficult for the 3 ½ -year-old, but much easier for the 6 or 7-year-old (Diamond, et al., 2002; Diamond & Taylor, 1996).

Nonetheless, children's performance on some cognitive tasks has been shown to be affected by two major constructs; namely, home environment and language. In the subsequent sections, the relations between these different constructs and the degree to which cognitive functioning is affected by them is highlighted.

### *Impact of Home Environment on Cognitive Development*

The impact of the home environment on a child's cognitive outcome has been a focal issue of research in the field of cognitive developmental psychology (e.g. Linver, Brooks-Gunn, & Kohen, 2002; Smith, Fagen, & Ulvund, 2002; Votruba-Drzal, Coley, & Chase-Lansdale, 2004). Focus has mainly revolved around the socio-economic status (SES) to which the child's family belongs, as well as the extent to which the environment is stimulating, either positively or negatively, for that child.

But, how can SES affect children's cognitive abilities? In general, cognitive developmentalists have examined the ways in which family interactions, neighborhood processes, and child-care quality might mediate the effects of income on children's cognitive ability/development (Brooks-Gunn, Duncan, & Aber, 1997; Caughy, DiPietro, & Strobino, 1994; DeGarmo, Forgatch, & Martinez, 1999; NICHD Early Child Care Research Network, 1997). For example, the NICHD Early Child Care Research Network (1997) demonstrated that higher quality child care for very young children (ages 0 to 3) was consistently related to higher levels of cognitive and language development.

Other researchers have speculated that SES is associated with children's cognitive ability because it enables families to purchase materials, experiences, and services that are beneficial to

children's cognitive development and well-being. This perspective is often termed the *investment model*, given that it explains the income effects through the goods and services that income enables parents to purchase so they can invest in the human capital of their children (Becker & Thomes, 1986; Haveman & Wolfe, 1994; Mayer, 1997).

More specifically, Guo and Harris (2000) demonstrated that children's cognitive ability is influenced by the income level to which they belong. To illustrate, family income can have an effect on the *quantity* as well as the *quality* of books, newspapers, and magazines available at home. Family income also has an effect on the number of trips they can afford, e.g. museum visits, which may help children develop cognitively (Guo & Harris, 2000).

Likewise, Terrisse, Roberts, Palacio-Quintin, & MacDonald (1998) examined the effects of parenting practices and SES on child development. One of the main findings of that study was the fact that children belonging to the more advantaged milieu received higher scores in the motor, social, language, and cognitive developmental domains when they were compared to children from a less advantaged milieu. The strongest effects were for language and cognition, with better scores for more advantaged children. More advantaged mothers and more highly educated mothers had a stronger effect on children's language and cognitive development, while more advantaged fathers from a higher occupational status had stronger influence on psychomotor and social development.

### *Home Environment and Language Skills*

A number of other studies have pointed to the effect of home environment on some of the major skills of language, e.g. reading, writing, or speaking. Overall, children living in economically disadvantaged conditions grow up in social environments with different socialization patterns than those belonging to middle-SES children and it is in these

environments that they develop their language skills (Heath, 1989, 1990; Rogoff & Mistry, 1990). People living in poverty, more often than more affluent people, must contend with chronic, frustrating situations that are beyond their control (e.g., dangerous neighborhoods and poor housing conditions; McLoyd, 1990). Therefore, economically disadvantaged parents less often encourage their children's verbal expression and provide their children with less exposure to a diverse range of vocabulary through their conversation, reasoning, explanations, and attention (Hart & Risley 1992).

In addition, one line of research has focused on the relation between maternal speech on the one hand and children's syntactic growth in their early childhood on the other hand. Of these studies, it was shown that mothers belonging to higher SES talk differently to their children if compared with the style mothers of lower SES talk with their children. For instance, it was demonstrated that mothers of higher SES make use of many wh-questions (i.e., What? When? Where? Which?) which helped their children enhance their vocabulary (Hoff-Ginsberg, 1986). In one recent study, it was shown that exposing the child to longer utterances and therefore richer vocabulary as well as a variety of words, a technique that higher SES mothers usually use, has its impact on how productive the child could be with regard to vocabulary usage (Hoff, E., 2003).

Thus, Lacroix and colleagues demonstrated that children of low SES mothers had a language development inferior to those of children of high SES mother (Lacroix, Pomerleau, Malcuit, Séguin, & Lamarre, 2001). In addition, Scarborough, Dobrich, and Hager (1991) found that preschoolers who were read to more and who participated in more solitary book activities at home became better readers by Grade 2 compared to preschoolers with less frequent early literacy home experiences. Moreover, Hart and Risley (1995) demonstrated that by the age of

four, children in families that received welfare assistance were likely to have been exposed to some 13 million fewer words than those in families classified as professionals.

Furthermore, DeBaryshe (1993) observed that mothers who began reading to their children at an earlier age had children with greater receptive language abilities. This related directly to the educational level of the parents, a factor closely related to SES. Moreover, Senechal and Cornell (1993) showed that but a single storybook reading session appears to be sufficient to increase 4- and 5-year-old children's receptive vocabulary. Hence, the causal effect of home environment on language is substantiated by research.

#### *The Relation Between Language and Working Memory*

Language, in turn, may affect children's performance on one of the main aspects of the PFC's skills; that is, their WM. Baddeley and Hitch's (1974) multicomponent model of WM suggests that WM consists of three components--the central executive (CE), the phonological loop (PL), and the visuo-spatial sketchpad (VSS). In a recent study, it was shown that the capacity of the WM components start to increase when the child is as young as four-year old (Gathercole, Pickering, Ambridge, & Wearing, 2004). Within the WM model, storage capabilities are disseminated to the PL and the VSS, specifically designed to store phonological and visuo-spatial information respectively. The processing function of WM is ascribed to a separate component termed the CE, which provides the interface with information in long-term memory and also coordinates the distribution of the limited resources throughout the memory system. Research within this tradition has focused on the relationship between language and the storage capabilities of the model, particularly phonological memory skills (Baddeley, Gathercole, & Papagno, 1998).

Associations have been identified between children's receptive language and their phonological memory (Gathercole, Willis, Emslie, & Baddeley, 1992), with better vocabulary knowledge being associated with better phonological memory. Links have also been demonstrated between children's phonological memory and their expressive language skills (Blake, Austin, Canon, Lisus, & Vaughan, 1994), and it is possible to differentiate the spoken language profiles of young children grouped in terms of their phonological memory skills (Adams & Gathercole, 1995).

To make it clearer, by definition WM tasks require a processing component and a storage component. For example, the *reading span task* requires the reading of sentences (the processing component) while simultaneously the last words of these sentences have to be stored (the storage component). After a number of sentences, the last words have to be reproduced in the order in which they appeared. Variations of the reading span task, often referred to as complex span tasks, have been devised with different processing components such as listening (Siegel & Ryan, 1989), counting (Case, Kurland, & Goldberg, 1982) and arithmetic (Turner & Engle, 1989). The key measure in all these complex tasks is the amount of language information that can be stored while memory processing continues.

In a recent study, Wolfe and Bell (2004) emphasized the effect that language has on children's WM performance. In that study, receptive language was a predictor of WM performance for children 4 years of age. The researchers conducted three regression equations and language was the only variable amongst the other two (temperament and EEG) to appear in all three equations predicting children's WM performance.

Therefore, and given the above illustration of the relation among the three main constructs (Home Environment, Language, and Prefrontal Functioning), the purpose of this study

was to examine the roles of language and home environment on WM development in early childhood.

### Hypothesis

*The primary hypothesis is:*

Language mediates the relation between home environment and prefrontal functioning in early childhood (see Figure 1).

### Method

#### *Participants*

The primary objective was to recruit children from a wide range of home environments or family socio-economic (SES) backgrounds. The Virginia Tech Lab School and the Radford Head Start Center were, hence, selected for that purpose, taking into consideration that the former would be a representative of the middle to upper-middle SES and the latter would be a representative of the lower-middle SES. Initially, a request was sent to all parents of the 4-year-old children from both centers asking for their permission to let their children participate in the study. The total number who responded to the request was 36 (20 from the Lab School and 16 from the Head Start Center). Among those children, whose parents agreed to participate in the study, four children were not included in the analyses, given that those children were bilingual (3 children from Lab School and 1 child from Head Start). In addition, data of two children from the Lab School were dropped because they refused to do the language assessment (PPVT). Therefore, the total number of children whose data were analyzed was 30 children (15 children from each center). The age of the children ranged from 3.6 years to 5.07 years ( $M = 4.07$  years).

For the purpose of this study, socio-economic status was defined as the number of years of education completed by the child's parents (e.g. Terrisse et al, 1998). Every child had

information about the mothers' educational level, but not about the fathers'. Thus, the information about the mothers was used with regard to the number of education in years. Moreover, due to missing data, mean replacement was used for two of the Lab School mothers' education in years. Prior to data collection, it was assumed that the Head Start children's mothers would have less education than the Lab School children's moms. This assumption was verified through one-way ANOVA (see Table 1).

### *Procedures*

The tasks were conducted with each child individually out of his/her classroom. On average, it took each child about 20 minutes to complete the tasks. The Lab School children were assessed in a hallway in Wallace Hall adjacent to the Lab School. The Head Start staff provided a quiet, remote room. A research assistant accompanied the researcher, and all sessions were video-taped for later coding. Each child was asked to sit with the researcher with a table in between while conducting the tasks. The researcher placed the equipment needed on the table. The order of tasks was counterbalanced among all participants, except that the language task was always done last because it is the longest task.

*Prefrontal Functioning.* As in the Wolfe and Bell (2004) study, the following three tasks were used to investigate the children's WM abilities: the Day/Night Stroop-like task, the Yes-No task, and the Tapping task. Each of these tasks required the child to remember a rule and inhibit the more 'natural' response.

The Day/Night Stroop task assessed WM and verbal inhibitory control in children 3 ½ to 7 years of age. In other words, this task investigated children's ability to act according to remembered instructions and inhibit a dominant response (Gerstadt, et al., 1994). Each child was instructed to say "day" when shown a black card with a picture of a yellow moon and to say

“night” when shown a white card with a picture of a yellow sun (see Figure 2.). After two learning trials, there were 16 trials administered, eight with the sun card and eight with the moon card arranged in pseudo-random order. The variable of interest was the percentage of correct trials. For instance, if a child got 11 correct answers out of the 16 trials, his/her percentage was  $11/16 = 68\%$

The Yes-No task was similar to the aforementioned task in that it required the child to remember a rule and inhibit a more natural response, the child was instructed to say ‘yes’ when the experimenter shook his head no and to say “no” when the experimenter nodded his head yes. This task was created in our lab and has been used in a previous study (Wolfe & Bell, 2004). The variable of interest was the percentage of correct trials.

The Tapping task, a non-verbal task, was also designed for children 3 ½ to 7 years of age and assessed both WM and motor inhibitory control skills (Diamond, Prevor, Callender, & Druin, 1997). Each child was instructed to tap once when the experimenter taps twice and to tap twice when the experimenter taps once. A pen/pencil was used for tapping and was passed between the experimenter and child; the use of a single tapping item averted the child from tapping at will and at the same time the experimenter was tapping. After two learning trials, there were 16 trials, eight with the experimenter tapping once and eight with the experimenter tapping twice also arranged in pseudo-random order. The variable of interest was the percentage of correct trials.

*Language Assessment.* The Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997) is an individually administered, un-timed assessment that has been designed to determine receptive vocabulary and verbal ability. Item sets (each containing 12 picture plates) are arranged in order of increasing difficulty and consist of four black-and-white illustrations arranged on a

picture plate. Each child was instructed to touch the picture that best represented the word presented orally by the experimenter (see Figure 3.). The PPVT-III was standardized nationally and raw scores were converted to age-referenced standard scores.

### Results

Ages of the children in the two SES groups were compared using one way ANOVA. As a group, the lower SES children in the study were older than the higher SES children (see Table 1).

No gender differences were found for any of the tasks in the study. Consequently, gender was dropped as a factor in all analyses.

#### *Correlations*

Correlations were assessed among these variables: children's age, Moms' Education in Years, the Day/Night task, the Yes/No task, combined WM scores, the Tapping task and the PPVT (see Table 2). As expected, the WM tasks (Yes/No and Day/Night) were correlated. Given that the Day/Night and the Yes/No tasks are both verbal tasks, and correlated, a combined mean of these two tasks was used as the WM variable. Because the Tapping task is non-verbal, it was not used as part of the WM variable. Some children did one task and refused to do the other. A total of four children did not do the Yes/No task (3 children from the Lab School and 1 from the Head Start Center). In addition, one child from the Head Start Center did not do the Day/Night task). For those children, the one score in the task they did was used as an indication of their WM score.

Age was not correlated with any of the variables except the PPVT; they were negatively correlated. As was previously mentioned, the lower SES children were older and that explains the negative correlation. In addition, mothers' educational level was correlated with the children's performance on the Yes/No task, the PPVT task, as well as the combined WM

variable. Given its nature as a non-verbal task, the Tapping task was not correlated with any of the other variables.

### *Group Differences*

One-way ANOVA was used to compare the two SES groups with regard to the following variables of interest: performance in the Day/Night task, performance on the Yes/No task, the combined mean of the two WM tasks (Day/Night and Yes/No), performance on the Tapping task, and finally performance on the language assessment test (PPVT). These means and results are in Table 1. Children's performance on the Day/Night task did not differ between SES groups. The higher SES children scored higher than the lower SES children in the Yes/No task. When the scores of the two WM tasks (Day/Night and Yes/No) were combined, the higher SES scored higher than the lower SES group. The two groups' scores did not differ in the non-verbal task (tapping). In addition, the higher SES children scored higher than the lower SES children on the language assessment test (PPVT).

### *Mediational Analyses*

*Testing the proposed hypothesis.* The four criteria proposed by Baron and Kenny (1986) were used to test the mediating role of language in explaining the relationship between home environment and children's scores on the combined WM tasks (see Table 3 and Figure 4).

The first criterion states that the initial (independent) variable must be correlated with the outcome (in this study, mothers' educational level must be correlated with the outcome, that is; the WM tasks). In other words, using the WM tasks as the criterion variable and mothers' educational level as the predictor in a regression equation, it was established that there is an effect that may be mediated. This criterion was satisfied (see path A, Figure 4 and Table 3).

The second criterion states that the initial variable (mothers' educational level) must be correlated with the mediator (PPVT). That is, using PPVT as the criterion variable and mothers' educational level as a predictor in a regression equation, establishes treating the mediator as if it were an outcome variable. This criterion was satisfied as well (see path B, Figure 4 and Table 3).

The third and fourth criteria are tested in the same regression equation. The third criterion states that the mediator (PPVT) must relate to the outcome variable. Specifically, using the WM tasks as the outcome variable and the PPVT as the predictor variable, a regression equation was performed to show such a relation (see path C, Figure 4 and Table 3).

The fourth and last criterion states that the effect of the independent variable must become non-significant or substantially reduced in magnitude once the mediator is taken into account. This condition was also met (see path D, figure 4 and Table 3).

*Testing an alternative hypothesis.* The following hypothesis was also tested: working memory mediates the relation between home environment and language (see figure 5). However, it turned out to be unsuccessful in meeting the criteria of a mediational model. More specifically, after conducting the regression equations, the relation between the independent variable (mothers' education in years) and the dependent variable (PPVT) was still significant (see path D, Table 4).

## Discussion

This study sought to examine the mediating role language might play in establishing the relation between children's home environment and their prefrontal functioning. Language was hypothesized to mediate such a relation for two reasons. The first is that it is considered one of the main components of the WM model, as well as the fact that the classic WM tasks have a

crucial verbal (language) component. The second is that it is affected by the standard of living to which the child belongs.

Compared to a correlational model which measures the degree of relation between two variables, a mediational model could be perceived as more valuable in that it reflects an explanatory hypothesis about variables (Baron & Kenny, 1986). Thus, the child's level of language appears to be the mechanism by which the home environment affects cognitive outcome in children. This appears particularly true for working memory, which has an important language component (Baddeley, 1986).

Participants of this study were children representing a wide-range of SES. In general, the lower SES children were older than the higher SES children. Nevertheless, their scores were lower on almost all tasks. This is specifically interesting given that it opens the door for some questions regarding the results of previous research. Diamond has shown that the older the child is the better his/her performance is in the working memory tasks (Diamond & Taylor, 1996; Gerstadt, et al., 1999). However, given that the children in the Diamond studies were homogeneous, belonging to middle to upper-middle class homes, this might explain why that conclusion has been reached. Such a conclusion may not be true for the lower SES children because of the nature of the environment in which they live. Children belonging to lower SES families are less exposed to stimuli that could help them enhance their language and cognitive abilities (e.g., Guo & Harris, 2000).

One of the main reasons children belonging to higher SES families performed better than children belonging to lower SES families could be due to the difference in the style as well as the quality of interaction that takes place between the mothers and their children. To illustrate, higher SES mothers substitute new words for the same thing. In other words, they are capable of

providing their children with an amount of variation in language that would help them grow their language ability (e.g., Hoff-Ginsberg, E., 1994, Hoff, E., 2003).

Comparing the settings in which the tasks were conducted for this study, the lower SES group may have had a better chance to concentrate in the tasks, given that they were assessed in a remote, quiet room, compared with the setting in which the higher SES group were assessed, that is, a hallway with pedestrian traffic. However, the lower SES still scored lower on the working memory tasks. Perhaps the group differences would have been even greater if the higher SES children had been assessed in a setting comparable to that of the lower SES children.

No gender differences were found among the participants of the study. This was somewhat surprising especially with regard to the language assessment test. Research in neurobiology suggests that males and females are different due to slight differences in brain development (Berger, 1998). More specifically, preschool girls outperform boys on word production measures (Bornstein & Haynes, 1998) and on length and structure of narratives (Haden, Haine, & Fivush, 1997). Thus, a larger sample size might have indicated some gender differences.

### *Implications of the Study*

In a recent study conducted at an early Head Start Program, it was shown that children's scores on the language assessment test (PPVT) were negatively correlated with age of entry into Head Start (Papero, 2004). In other words, the younger the child joined the program, the higher his/her score was ( $r = -.28, p = .04$ ). Age of children's admission ranged from 2 months to 59 months in that study. This suggests that the earlier a child joins a quality child care program (Head Start, in this example), the better we expect his/her score might be with the regard to cognitive and language assessment. Moreover, parenting programs could be designed for lower

SES families to stress the importance of language. However, given the fact that such parenting programs might not be easily accessible for many target families, early admittance into a high quality preschool program like Head Start could be a good approach to let children be exposed to different stimuli that might, in turn, enhance their cognitive and language abilities.

In one of the latest studies that focused on child care in poor communities, it was shown that children who were in center care scored higher on basic language and cognitive proficiency tests when they were compared with children who were in home day care or children who were cared for by a family member, even after controlling for child's age and mother's educational level (Loeb, Fuller, Kagan, & Carrol, 2004). This also supports the need for high quality center care for children belonging to lower income families. It appears, however, that this care needs to start early in life (Papero, 2004).

The present study sheds light on some of the main cognitive abilities that might affect children's later academic achievement. In other words, children's scores on these types of WM and language tasks could be a good predictor of their ability to later cope with higher cognitive demands in their academic lives. Therefore, educators and policy makers should emphasize the importance of the children's developing language and memory skills during the preschool years.

## References

- Adams, A. M., & Gathercole, S. E. (1995). Phonological working memory and speech production in preschool children. *Journal of Speech and Hearing Research, 38*, 403-414.
- Baddeley, A. D. (1986). *Working memory*. New York: Oxford University Press
- Baddeley, A.D., Gathercole, S.E. & Papagno, C., (1998). The phonological loop as a language learning device, *Psychological Review, 105*, 158-173.
- Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. Bower (Ed.), *Recent Advances in Learning and Motivation*, Vol. 8. New York: Academic Press.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.
- Barone, P., & Joseph, J. P. (1989). Prefrontal cortex and spatial sequencing in macaque monkey. *Experimental Brain Research, 78*, 447-464.
- Bornstein, M. H., & Haynes, O. M. (1998). Vocabulary competence in early childhood: Measurement, latent construct, and predictive validity. *Child Development, 69*, 654-671.
- Brooks-Gunn, J., Duncan, G. J., & Aber, J. L. (1997). *Neighborhood poverty: Context and consequences for children, Vol. I*. New York: Russell Sage Foundation.
- Caughy, M. O., DiPietro, J. A., & Strobino, D. M. (1994). Day-care participation as a protective factor in the cognitive development of low income children. *Child Development, 65*, 457-471.
- Cohen, J. D., Perlstein, W. M., Braver, T. S., Nystrom, L E., Noll, D. C., Jonides, J. & Smith, E. (1997), Temporal dynamics of brain activation during a working memory task. *Nature, 386*, 604-608.

- DeBaryshe, B.D. (1993). Joint picture-book reading correlates of early oral language skill. *Journal of Child Language, 20*, 455-461.
- DeGarmo, D. S., Forgatch, M. S., & Martinez, C. R. (1999). Parenting of divorced mothers as a link between social status and boys' academic outcomes: Unpacking the effects of socioeconomic status. *Child Development, 70*, 1231-1245.
- Diamond, A. (1995). Evidence of robust recognition memory early in life even when assessed by reaching behavior. *Journal of Experimental Child Psychology, 59*, 419- 456.
- Diamond, A., Kirkham, N., Amso, D. (2002). Conditions under which young children can hold two rules in mind and inhibit a prepotent response. *Developmental Psychology, 38*, 352-362.
- Diamond, A., Prevor, M., Callender, G., & Druin, D.P. (1997). Prefrontal cortex cognitive deficits in children treated early and continuously for PKU. *Monographs of the Society for Research in Child Development, 62*, 1-205.
- Diamond, A. & Taylor, C. (1996). Development of an aspect of executive control: Development of the abilities to remember what I said and to "Do as I say, not as I do." *Developmental Psychobiology, 29*, 315-334.
- Duncan, J. (1986). Disorganization of behavior after frontal lobe damage. *Cognitive Neuropsychology, 3*, 271-290.
- Dunn, L. M. & Dunn, L.M. (1997). *Peabody Picture Vocabulary Test (3<sup>rd</sup> ed.)*. [Test Materials]. Circle Pines, MN: AGS Publishers.
- Fuster, J. M., & Alexander, G. E. (1971). Neuron activity related to short-term memory. *Science, 173*, 652-654.

- Gathercole, S. E., Pickering, S. J., Ambridge, B., & Wearing, H. (2004). The Structure of Working Memory From 4 to 15 Years of Age. *Developmental Psychology, 40*, 177-190.
- Gathercole, S.E., Willis, C.S., Emslie, H., & Baddeley, A.D. (1992). Phonological memory and vocabulary development during the early school years: A longitudinal study. *Developmental Psychology, 28*, 887-898.
- Gerstadt, C., Hong, Y., & Diamond, A. (1994). The relationship between cognition and action: Performance of 31/2-7 year old children on a Stroop-like day-night test. *Cognition, 53*, 129-153.
- Goldman-Rakic, P.S. (1987). Circuitry of primate prefrontal cortex and the regulation of behavior by representational memory. *Handbook of Physiology, 5* (1), 373-417.
- Guo, G. & Harris, K. (2000). The mechanisms mediating the effects of poverty on children's educational achievement. *Demography 37*, 431-447.
- Haden, C. A., Haine, R. A., & Fivush, R. (1997). Developing narrative structure in parent-child reminiscing across the preschool years. *Developmental Psychology, 33*, 295-307.
- Hart, B. & Risley, T. (1992). American parenting of language-learning children: Persisting differences in family-child interactions observed in natural home environments. *Developmental Psychology, 28*, 1096-1105.
- Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore: Paul H. Brookes.
- Haveman, R., & Wolfe, B. (1994). *Succeeding generations: On the effects of investments in children*. New York: Russell Sage Foundation.
- Heath, S. B. (1989). The learner as culture member, In M.L. Rice & R. L. Schiefelbusch (Eds.). *The teachability of language*. (pp. 333-350). Toronto.

- Heath, S. (1990). The children of Track ton's children. In J.W. Stigler, G. Herdt & R.A. Shweder, (Eds.) *Cultural Psychology: Essays on comparative human development* (pp. 496-519). Cambridge.
- Hoff, E. (2002). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*, 1368-1378.
- Hoff-Ginsberg, E. (1986). Function and structure in maternal speech: Their relation to the child's development of syntax. *Developmental Psychology, 22*, 155-163.
- Hoff-Ginsberg, E. (1994). Influences of mother and child on maternal talkativeness. *Discourse Processes, 18*, 105-117.
- Kubota, K., & Niki, H. (1971). Prefrontal cortical unit activity and delayed cortical unit activity and delayed alternation performance in monkeys. *Journal of Neurophysiology, 34*, 337-347.
- Lacroix, V., Pomerleau, A, Malcuit, G., Séguin, R., & Lamarre, G. (2001). Développement langagier et cognitif de l'enfant durant les trois premières années en relation avec la durée des vocalisations maternelles et les jouets présents dans l'environnement: Étude longitudinale auprès de populations à risqué. *Canadian Journal of Behavioural Science, 33*, 65-76.
- Linver, M. R., Brooks-Gunn, J., & Kohen, D. E. (2002) Family processes as pathways from income to young children's development. *Developmental Psychology, 38*, 719-734.
- Loeb, S., Fuller, B., Kagan, S. L., & Carrol, B. (2004). Child Care in Poor Communities: Early Learning Effects of Type, Quality, and Stability. *Child Development, 75*, 47-65.
- Luria, A. R. (1966). *Higher Cortical Functions in Man*. Tavistock, London.
- Luria, A. R. (1973). *The Working Brain*. New York: Basic Books.

- McLoyd, V. C. (1990). The impact of economic hardship on Black families and children: Psychological distress, parenting, and socioemotional development. *Child Development, 61*, 311-346.
- Miller, E. K., Erickson, C. A., & Desimone, R. (1996). Neural mechanisms of visual working memory in prefrontal cortex of the macaque. *Journal of Neuroscience, 16*, 5154–5167.
- NICHD Early Child Care Research Network. (1997). Poverty and patterns of child care. In J. Brooks-Gunn & G. Duncan (Eds.), *Consequences of Growing up Poor* (pp. 100-131). New York: Russell-Sage.
- Papero, A. L. (2004). *Developmental outcome in preschoolers: Interrelations among maternal depression, perceived social support, and child's age of entry into Head Start*. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.
- Petrides, M. E. (1991). *Functional specialization within the dorsolateral frontal cortex for serial order memory*. Proc. R. Soc. London B 246:293–298.
- Rogoff, B. & Mistry, J. (1990). The social and functional context of children's remembering. In Fivush, & Hudson, J. A. (Ed). *Knowing and remembering in young children. Emory symposia in cognition, Vol. 3.* (pp. 197-222). Cambridge: Cambridge University Press.
- Scarborough, H.S., Dobrich, W., & Hager, M. (1991). Preschool literacy experience and later reading achievement. *Journal of Learning Disabilities, 24*, 508-511.
- Schuele, C. M. (2001). Socioeconomic influences on children's language acquisition. *Journal of Speech-Language Pathology & Audiology, 25*, 77-88.
- Senechll, M., & Cornell, E. H. (1993). Vocabulary acquisition through shared reading experiences. *Reading Research Quarterly, 28*, 360-374.

- Shallice, T. (1988). *From Neuropsychology to Mental Structure*. Cambridge Univ. Press, Cambridge, UK.
- Smith, L, Fagan, J. F. & Ulvund, S. E. (2002). The relation of recognition memory in infancy and parental socioeconomic status to later intellectual competence. *Intelligence*, 30, 247-259.
- Stuss, D. T. (1984). Neuropsychological studies of the frontal lobes. *Psychological Bulletin*, 95, 3-28.
- Terrisse, B., Roberts, D. S. L., Palacio-Quintin, E., & MacDonald, B. E. (1998). Effects of parenting practices and socioeconomic status on child development. *Swiss Journal of Psychology*, 57, 114-123.
- Votruba-Drzal, E., Coley, R. L., & Chase-Lansdale, P. L. (2004). Child Care and Low-Income Children's Development: Direct and Moderated Effects. *Child Development*, 75, 296-312.
- Wolfe, C. D., & Bell, M. A. (2004). Working memory and inhibitory control in early childhood: Contributions from EEG, temperament, and language. *Developmental Psychobiology*, 44, 68-83.

Table 1

*Summary of Group Comparisons: Means (S.D.)*

Variables	Lower SES Group	Higher SES Group	F	<i>p-value</i>
Mean of MomsEdyr n=30	11.47 (1.7)	16.80 (1.0)	106.41	<.001
Mean age of children n=30	4.80 (.6)	4.35 (.5)	4.57	.041
Day/Night %correct n= 29	78.12 (15.4)	85.83 (15.9)	1.74	.198
Yes/Night %correct n= 26	55.75 (25.8)	86.45 (17.0)	12.34	.002
WM combined %correct n= 30	65.80 (19.1)	85.20 (12.9)	10.67	.003
Tapping %correct n=21	80.00 (27.1)	84.70(14.3)	.25	.62
PPVT Standard Score n=30	95.66 (12.6)	118.26 (12.4)	24.63	<.001

Table 2

*Intercorrelations between the variables of interest in the study*

Variable	1	2	3	4	5	6	7
1. Age	--	-.31	.02	-.001	.01	.17	-.40*
2. MomsEdyr		--	.23	.48*	.47**	.42	.67**
3. Day/Night			--	.43*	.77**	.33	.43**
4. Yes/No				--	.91**	.12	.45*
5. WM(combined)					--	.25	.55**
6. Tapping						--	.12
7. PPVT St							--

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

Table 3

*Analysis of the proposed mediational model*

	$\beta$	R	R <sup>2</sup>	t	p-value
<b>Path A</b>					
DV: WM combined					
IV: MomsEdyr	.47	.47	.22	2.80	.009
<b>Path B</b>					
DV: PPVT					
IV: MomsEdyr	.67	.67	.45	4.77	<.001
<b>Path C</b>					
DV: WM combined					
IV: PPVT	.44	.57	.32	2.05	.05
<b>Path D</b>					
DV: WM combined					
IV: MomsEdyr	.18	.57	.32	.83	.42

*Note:* Paths C and D were tested in the same regression equation.

Table 4

*Analysis of the alternative mediational model*

	$\beta$	R	R <sup>2</sup>	t	p-value
<b>Path A</b>					
DV: PPVT					
IV: MomsEdyr	.67	.67	.45	4.77	<.001
<b>Path B</b>					
DV: WM combined					
IV: MomsEdyr	.47	.47	.22	2.80	.009
<b>Path C</b>					
DV: PPVT					
IV: WM combined	.31	.72	.52	2.05	.051
<b>Path D</b>					
DV: PPVT					
IV: MomsEdyr	.53	.72	.52	3.49	.002

*Note:* Paths C and D were tested in the same regression equation.

### Figure Captions

*Figure 1:* A diagram illustrating the relationship between the three main constructs of the study: language mediates the relationship between home environment and prefrontal functioning.

*Figure 2:* Illustration of the cards used for the Day/Night Stroop task. Subjects were instructed to say “night” when shown the card with the sun and to say “day” when shown the card with the moon.

*Figure 3:* One example of the Language Assessment Test (PPVT-III): The researcher said: “touch cow” and then scored the child’s response as either correct or incorrect depending on his/her response.

*Figure 4:* A diagram illustrating the beta weights ( $\beta$ ) and the p-values from the regression equations performed to test the proposed hypothesis.

*Figure 5:* A diagram illustrating the beta weights ( $\beta$ ) and the p-values from the regression equations performed to test the alternative hypothesis.

Figure 1

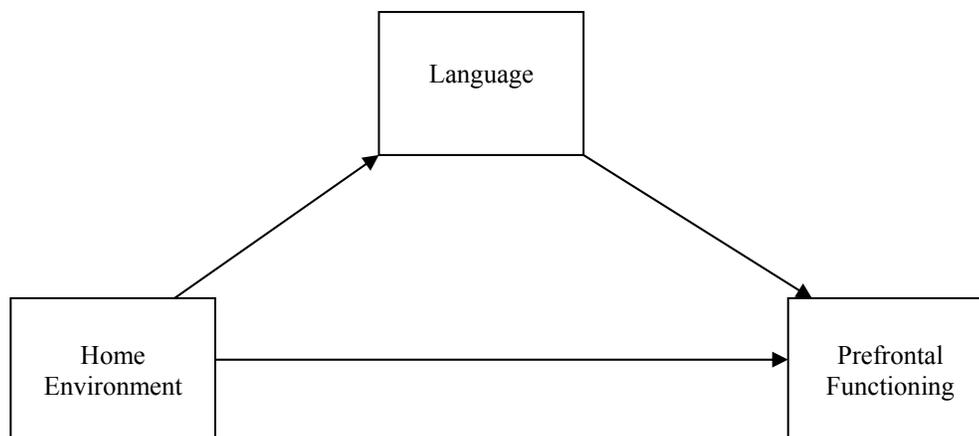


Figure 2

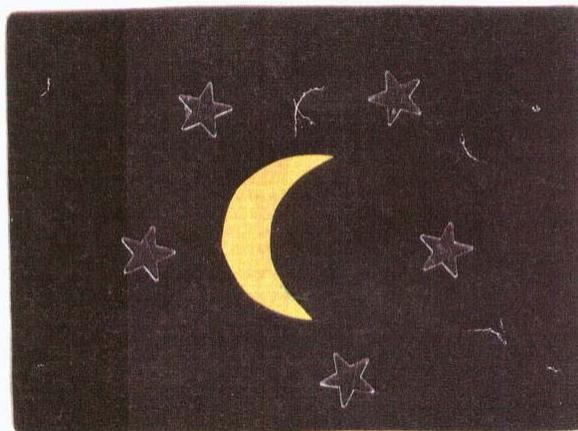
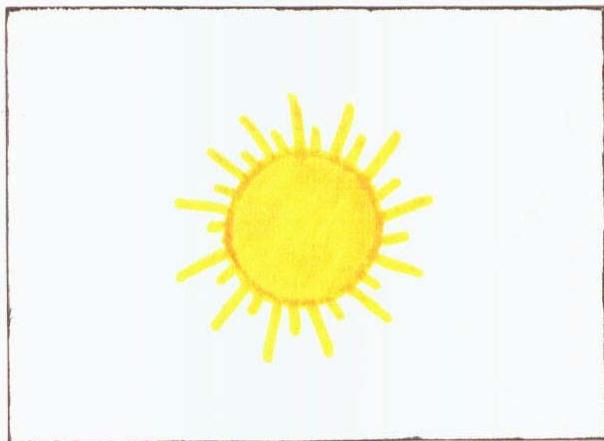


Figure 3

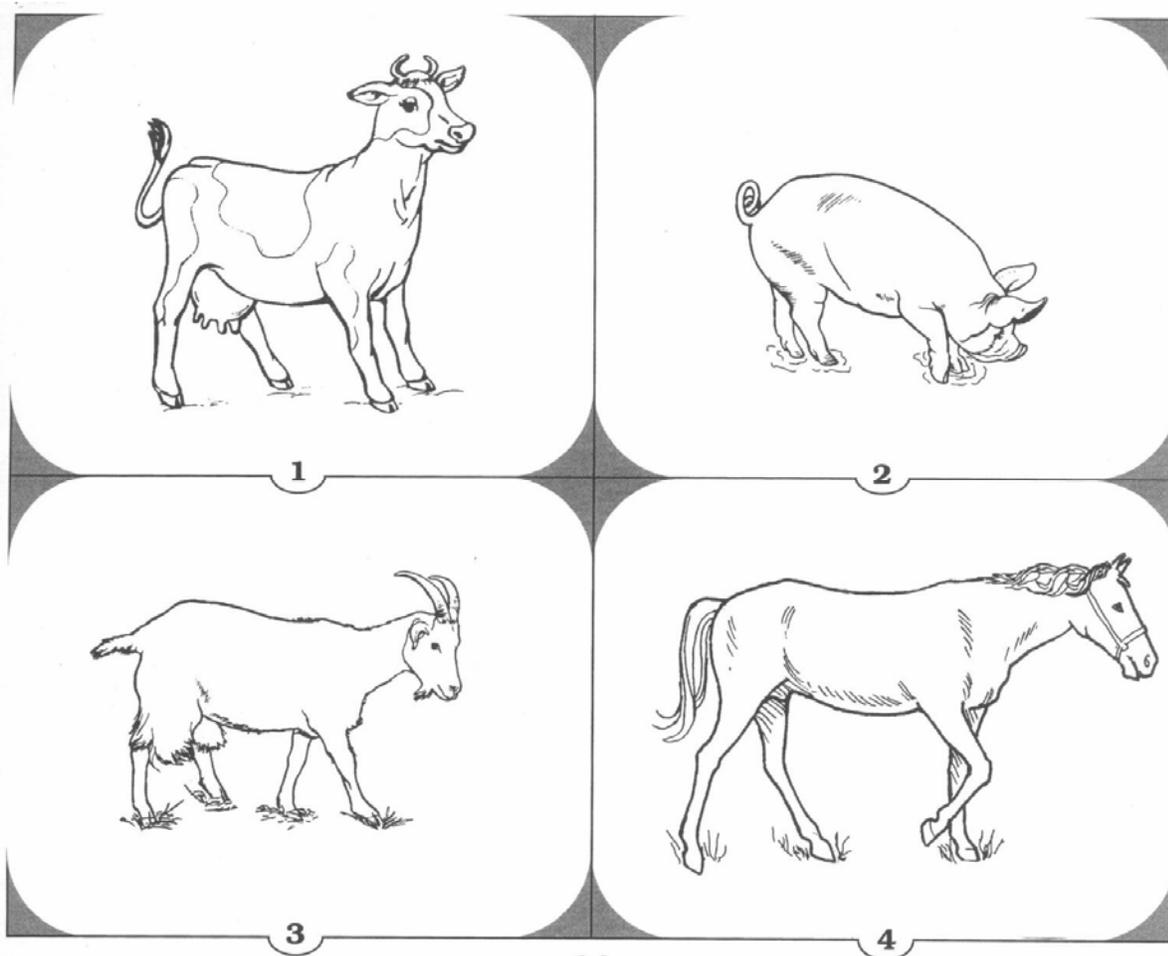


Figure 4

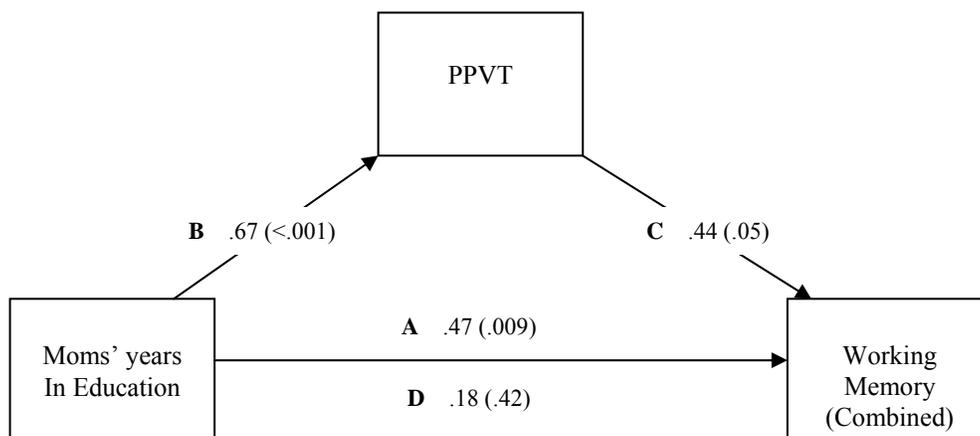


Figure 5

