Open Access Dissertations   Electronic Theses and Dissertations

2016-06-22

Measuring Motivation in Children Served by Head Start

Andres S. Bustamante

University of Miami, andres.bustamante5@gmail.com

Follow this and additional works at: https://scholarlyrepository.miami.edu/oa_dissertations

www.manaraa.com

UNIVERSITY OF MIAMI

MEASURING MOTIVATION IN CHILDREN SERVED BY HEAD START

By

Andres Sebastian Bustamante

A DISSERTATION

Submitted to the Faculty

of the University of Miami

in partial fulfillment of the requirements for

the degree of Doctor of Philosophy

Coral Gables, Florida

August 2016

www.manaraa.com

UNIVERSITY OF MIAMI

A dissertation submitted in partial fulfillment of

the requirements for the degree of

Doctor of Psychology

MEASURING MOTIVATION IN CHILDREN SERVED BY HEAD START

Andres Sebastian Bustamante

Approved:

_____
Daryl B. Greenfield, Ph.D.
Professor of Psychology

_____
Amanda Jensen-Doss, Ph.D.
Associate Professor of
Psychology

_____
Rebecca Shearer, Ph.D.
Associate Professor of Psychology

_____
Brian Doss, Ph.D.
Associate Professor of
Psychology

_____
Batya E. Elbaum, Ph.D.
Professor of Teaching and Learning

_____
Guillermo Prado, Ph.D.
Dean of the Graduate School

BUSTAMANTE, ANDRES SEBASTIAN   (Ph.D., Psychology)
Measuring Motivation in Children Served by Head Start.   (August 2016)

There is a well-established achievement gap between children from low income families and their middle to high income counterparts. One avenue towards narrowing the achievement gap is improving domain-general school readiness skills, such as motivation, persistence, and preference for challenge which support learning regardless of content area. Motivation orientation, one example of a malleable domain-general construct, encompasses two approaches at opposite ends of a continuum: mastery and performance motivations. The former is characterized by viewing failure as an opportunity for growth, while the latter views failure as a confirmation of a low innate ability level. Interventions targeting motivation orientation have successfully improved academic outcomes in older children; however, attempts to downwardly extend this research to early childhood have yielded mixed results due to the absence of developmentally appropriate measures. This study evaluated a newly developed measure of motivation orientation named the *Computer Administered Battery of Observed Motivation (CABoOM)* which was specifically designed to be sensitive and appropriate for pre-school children from low-income families. Results suggest that CABoOM is sensitive, test-retest reliable, and response process valid for children served by Head Start. While CABoOM did significantly predict gains in approaches to learning, and science school readiness across the year, the relationships were in the negative directions which is the opposite of the original hypothesis. Further research is required to

understand these counterintuitive relationships and provide additional evidence for predictive and concurrent validity. A valid and reliable measure of motivation orientation would allow for evaluation of early childhood interventions aiming to close the school readiness achievement gap by targeting this powerful domain-general skill.

Keywords: Motivation, low-income, school readiness, preschoolers

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

Chapter 1

Introduction

Early interventions aimed at preschoolers from low-income families are a rare combination of social justice and economically savvy investment. Low-income communities have disproportionately high rates of school dropouts, incarceration, and violent crime. Costs of funding early childhood education in low-income communities pale in comparison to the costs of later interventions, such as grade retention, special education, job training, convict rehabilitation programs, tuition subsidies, and expanded police presence (Heckman, 2006; Yoshikawa, Weildand, Brooks-Gunn, Burchinal, Espinosa, et al. 2013). It is estimated that for every dollar spent on early childhood and development programs, seven to eight dollars are saved at the societal level (Reynolds, Temple, Robertson & Mann, 2002). Additionally, research has demonstrated that quality early childhood programs can diminish the negative effects of living in poverty and improve subsequent life outcomes (Lee & Burkam, 2002; Shonkoff & Phillips, 2000).

Head Start is our nation's largest and most comprehensive program for addressing the school readiness needs of children from low-income families. Head Start serves over one million children per year and is committed to utilizing research to inform classroom practices (Office of Head Start, 2013). Research highlights the importance of fostering teachable and malleable school readiness skills for children from low-income families, especially those that impact multiple school readiness domains. These skills, often referred to as domain-general, contribute to learning in multiple domains of school readiness and have been shown to predict academic attainment (Li-Grinning, 2007; McClelland et al., 2007). Currently, the evaluation of interventions and programs to

1

improve young at-risk children's, domain-general motivation skills are limited by the lack of reliable and valid measures to assess these domain-general skills.

The Education Development Center (EDC) recently received a grant from the National Science Foundation (NSF) to examine the effects of motivation orientation on a preschool mathematics curriculum (Grant #1348564, 2013, Jessica Young, P.I.). However, the first step of their research process is to evaluate new ways to measure motivation in preschool children because there is dearth of reliable and valid measures to assess motivation in preschool age children. This study assessed the reliability and validity of the Computer Administered Battery of Observable Motivation (CABoOM), a newly developed measure of motivation orientation designed specifically for use with preschool aged children served by Head Start.

Motivation Orientation

Motivation orientation is a domain-general construct that has been shown to relate to attention, persistence, and academic outcomes (Brown, 2009; Turner & Johnson, 2003). Carol Dweck's (2006) "Mindset" theory defines two types of behavior patterns that characterize how children approach challenges and how they rationalize setbacks and failures during challenging tasks. One approach, typically referred to as mastery motivation, holds that intelligence is malleable and independent of one's intrinsic ability; everyone has the potential to improve and excel in any area with proper preparation and effort. Therefore, when mastery motivated children encounter a challenging task they view it as a chance to improve themselves and expand their abilities. Children with a mastery motivated orientation embrace challenges, persist in the face of setbacks, view effort as a path to mastery, and utilize the feedback of others (Cain & Dweck, 1995).

The alternative approach, referred to as a performance motivation, holds that intelligence is a fixed trait determined by innate ability level. Children with this approach believe they should stick to the areas they are gifted in and avoid areas where they are not naturally adept. Therefore, when these children encounter a challenging task they evaluate their initial performance (failure or success) as a reflection of their fixed, innate ability. Children with a performance motivated orientation avoid challenges, are discouraged by setbacks, view effort as a lack of intelligence, and are not able to successfully incorporate feedback from others (Cain & Dweck, 1995).

At the time Dweck and colleagues were formulating the definitions of mastery and performance motivation, the prevailing view was that the helpless motivational patterns at the root of the performance motivated orientation did not emerge until late childhood (Dweck, 1991). For this reason the language used to describe these two behavior patterns was intended for older children and may not be appropriate for preschoolers. Subsequently, in the context of preschool, mastery motivation was defined as the willingness to embrace challenging tasks, self-motivating statements, a focus on effort and strategies, persistence, and high expectations for future performance success. Conversely, performance motivation was defined as avoidance of challenging tasks, negative self-attributions of ability, lack of persistence, and low expectations for future performance success (Smiley & Dweck, 1994). Now that the conceptual framework of motivation orientation has been downwardly extended, research is needed to support the efficacy of this framework, and its relationship to school readiness among young children from low-income families. One way to provide this support is to explore motivation orientation in relation to classic developmental theory.

Motivation Orientation and Developmental Theory

A mastery motivated orientation can be seen as adaptive through multiple theoretical lenses. According to Vygotsky, children learn the most when they are challenged within their "zone of proximal development" (Vygotsky, 1978). Children rely on adults or older peers to guide their learning in the zone of proximal development. The optimal process involves more knowledgeable individuals encouraging children to operate at the upper limits of their current zone, and scaffolding the learning process by assisting the child in using more advanced cognitive techniques than the child is able to use independently. The child will eventually master these new cognitive processes and conquer increasingly difficult developmental tasks, first with the help of someone more knowledgeable and then on their own (Vygotsky, 1978). Given the attitude towards failure and the preference for challenge associated with the mastery motivated orientation, it is reasonable to assume that children who embody this approach will be more receptive to scaffolding, and more likely to embrace challenges on the upper end of their "zone of proximal development" than children who utilize a performance motivated orientation.

Although adults and more advanced peers play a large role in development, autonomous exploration is also a critical component. Piaget's constructivist theory considers a child's exploration of their environment essential for development because they search for new knowledge and reorganize their mental schemas based on the information they attain (Piaget & Inhelder, 1969). This exploration gives them a new perspective of their world and allows for developmental growth (Piaget, 1983). Children who utilize a mastery motivated orientation are more likely to explore their environment

and seek novel situations because they view them as learning opportunities, whereas children who utilize a performance motivated orientation may be more apprehensive about exploring new areas due to their desire to avoid failure. The benefits of a mastery motivated orientation have been documented in an array of age groups (Dweck, 2008) and this study seeks to extend this research to a vulnerable population. The newly developed measure being evaluated in this study aims to allow for examination of the benefits and malleability of motivation orientation in at risk young children.

Malleability of Motivation Orientation

Motivation orientation has been shown to be malleable and responsive to intervention. Blackwell, Trzesniewski and Dweck (2007) conducted an 8-week intervention aimed at instilling mastery motivation in an ethnically diverse, largely low-income, sample of middle school children. A significant increase in endorsement of mastery motivation from pre- to post-intervention was observed in the experimental group, but not in the control group. Additionally, children in the control group who endorsed performance motivation experienced a decline in grades that is commonly observed during the transition to middle school (Gutman & Midgley, 2000). Conversely, children in the experimental group who switched from performance to mastery motivation benefited from the largest gains in their grades pre- to post-intervention. A separate longitudinal study divided 373 children entering middle school into two groups based on their motivation orientation and recorded their math grades for two years. The group that endorsed mastery motivation saw steady improvements across the two year span, and the group that endorsed performance motivation experienced small declines at each time point (Blackwell, Trzesniewski & Dweck, 2007).

While interventions among middle-school children have shown great promise, their methods may not be appropriate for preschool children. The aforementioned intervention, by Blackwell and colleagues, was centered largely on neurobiology and focused on showing children that the brain makes new neural connections during the learning process. Thus, indicating that intelligence is malleable and challenges should be met with enthusiasm instead of fear. This type of biological approach may be too complex and beyond the cognitive ability of a preschooler. However, conducting developmentally appropriate mastery motivation interventions in preschool children is a realistic possibility.

Evidence suggests that motivation orientation is associated with the amount and style of praise children receive (Dweck, 2006). Research indicates that praising a child for their ability (e.g. "you're so smart" or "you're so talented") after success can reinforce the notion of contingent self-worth, because if success indicates intelligence, failure must be indicative of a lack of intelligence. The mastery motivated approach is to praise children for their effort and preparation (e.g. "you must have tried really hard" or "you spent a lot of time getting ready for this") after success.

Children ranging from pre-school to fifth grade praised for intelligence have been shown to display less task persistence, less task enjoyment, more low-ability attributions, and worse task performance than children praised for effort (Kamins & Dweck, 1999; Mueller & Dweck 1998). Research on motivation suggests that preschoolers already have an internalized investment in either their achievement or in the process of learning and this investment or process can determine how children approach challenging tasks (Burhans & Dweck, 1995; Ames, 1992; Gilmore, Cuskelly & Purdie, 2003). Therefore,

this study aimed to validate a developmentally appropriate measure of motivation orientation that can be used to evaluate the efficacy of interventions developed specifically for preschoolers from low-income families.

Motivation Orientation in Preschoolers

Numerous studies have examined the construct of motivation orientation in low-income and middle-income samples of preschool children. These studies have shown positive relationships between mastery motivation and other valuable skills, such as persistence in the face of challenge, attention, task engagement, and reduced negative self-evaluations of ability (Brown, 2009; Burhans & Dweck, 1995; Bustamante & Greenfield, *under revised review*; Cain & Dweck 1995, Day, 2012; Day & Burns, 2011; Smiley & Dweck, 1994). However, these studies report inconsistent distributions of mastery vs. performance motivated children despite using the same direct assessment of motivation orientation [the Mastery Motivation Puzzle Task (MMPT)]. These inconsistencies may indicate that the MMPT which was used to assess motivation orientation is not reliable or valid for use with preschoolers from low-income families.

Studies conducted with preschoolers from middle- to high-income families consistently report approximately 60% of children endorsing a mastery motivated orientation (Cain & Dweck, 1995; Herbert & Dweck, reviewed in Burhans & Dweck, 1995; Smiley & Dweck, 1994). However, in contrast, studies with preschoolers from low-income families report more inconsistent findings ranging from approximately 50% of children endorsing a mastery motivated orientation (Brown, 2009; Day & Burns, 2011), up to 77% of children endorsing this orientation (Bustamante & Greenfield, *under revised review*; Day, 2012).

During the MMPT children are given three consecutive unsolvable puzzles and must move along to the next puzzle once the two-minute time limit to solve each puzzle is reached. The fourth puzzle they are given is solvable and they are allowed as much time as they need to complete it. Children are then shown all four puzzles and are asked which one they would like to try again. The assumption is that children will remember that they failed to solve the first three puzzles and solved the fourth puzzle and will now choose one of these puzzles solely based on either their success (indicating performance motivation) or failure (indicating mastery motivation) with these puzzles.

To date, only one study has examined the reliability of the MMPT (Smiley & Dweck, 1994), which is the only direct assessment of mastery motivation available for preschool children. Bustamante & Greenfield (*under revised review*) examined the test-retest reliability of the MMPT, and its ability to predict gains in science and language outcomes across the school year in a sample of 332 children attending Head Start preschools. The Cohen's Kappa statistic (K= .392, *p* < .001), suggested low reliability, and there was no difference between the mastery and performance motivated children in their gains of science and language skills over the preschool year.

Additionally, to measure concurrent validity, Bustamante & Greenfield (*under revised review*) examined the MMPT as it related to the Learning-to-Learn Scale (LTLS; McDermott, Fantuzzo, Warley, Waterman, Angelo, et. al, 2011), an established teacher rating measure of approaches to learning, a conceptually related construct, among preschoolers from low-income families (McDermott, Fantuzzo, Warley, Waterman, Angelo, et. al, 2011), and found no significant relationships. The low level of reliability and complete lack of predictive and concurrent validity calls into question the

developmental appropriateness of the MMPT for preschoolers from low-income families. The ability to identify early intervention methods that aid in closing the academic achievement gap is contingent upon access to developmentally appropriate measures for children from diverse backgrounds and levels of family income (Fantuzzo, McDermott, Manz, Hampton, & Burdick, 1996).

Direct Assessment of Motivation Orientation

The vast majority of cognitive constructs exist on a continuum and motivation orientation is not likely to be an exception. Generally, certain children are highly motivated to take on challenges and persist in the face of setbacks, while others waiver back and forth depending on the circumstances, and some children shy away from challenges altogether. The dichotomous nature of the MMPT is limited in assessing a range of motivation orientation because it divides children into only two groups. Thus, critical variation between children is being lost and this lack of sensitivity is likely limiting our understanding of motivation orientation in early childhood populations. The CABoOM employs a paradigm similar to the MMPT to measure three critical features of motivation orientation, persistence, preference for challenge, and attitudes towards failure. However, unlike the MMPT, the CABoOM yields a continuous outcome ranging from 0 to 7 on each of the three assessments which are combined into a total score ranging from 0 to 21, which increases the sensitivity of the measure. In addition to having improved sensitivity, the CABoOM was developed to be more developmentally appropriate for preschoolers from low-income families.

During the MMPT, children choose from four different puzzles and three of them indicate mastery motivation while the fourth indicates performance motivation. If

children were selecting which puzzle they wanted to try for a second time at random, their choice would appear to be mastery motivated 75% of the time. This number closely reflects the results of the two most recent studies utilizing this measure (Bustamante & Greenfield, *under revised review*, 77% mastery; Day, 2012, 76% mastery). The most recent study had a sample size three times larger than any study to date utilizing the task (Bustamante & Greenfield, *under revised review*). The CABoOM adapts the procedure of the previous paradigm to mitigate these concerns.

Instead of asking children, who are still developing basic cognitive abilities, to remember four different puzzles and their performance on them, the CABoOM reduces the cognitive demand. After each trial with the CABoOM (e.g. "sling shot" game, "escape the grid" game, or memory matching game), children are asked if they would like to "try that one again" or "try one that is easier." Thus, children only make decisions about stimuli that they just completed with their success or failure with that task visible to them, greatly reducing the demands on their working memory. Additionally, by explicitly stating that they can either "try again" or "try one that is easier", we can be more confident that their decision is based on the difficulty level of the task. In addition, each task looks substantially less difficult than the one before it (i.e. for the memory game, there are fewer cards to match). This was not the case in the MMPT, in which each puzzle had the same number of pieces.

The CABoOM also reduces specific task bias by utilizing various tasks, as opposed to only puzzles. This ensures that previous experience with a given task does not drive the child's decisions; for example, if a particular child is highly skilled with puzzles, they might be more likely to persist compared to a task with which they have

less experience. In addition to increased sensitivity and reduced developmental demand, the CABoOM is delivered on touch screen laptops, an innovative and appealing format for early childhood assessment (Clements, Greenfield, Landry, & Sarama, 2015).

Advantages of Computer-Based Assessments

Computer-based assessments offer many advantages over the traditional pencil and paper format. First, presenting an assessment on a touch screen laptop computer increases excitement and engagement for children being assessed on a given task (Greenfield, 2015). Second, computer based assessment decreases assessor bias and ensures that each child is administered the task in an identical fashion. Third, less time is required to train staff in administration, which saves researchers time and money (Willoughby, Blair, Wirth & Greenberg, 2010). Fourth, computerized scoring eliminates the time, cost, and potential error involved in manual data entry.

The ease of use and automated scoring of the computer-based format facilitates its large scale dissemination. The CABoOM automatically generates output files with children's scores, which allows teachers and researchers alike to receive immediate feedback about children's motivation orientations upon administration. Furthermore, computer based assessments also reduce initial and replacement costs of paper, ink, pencils, puzzles, and other raw materials required for assessment.

Current Study

To ensure that preschool children from low-income families enter kindergarten equipped with the skills to succeed, domain-general and malleable skills that bolster school readiness must be identified. This study aimed to address the lack of developmentally appropriate and reliable measures of motivation orientation, a domain-

general and malleable skill, for young children. In pursuit of this aim, a computer-based direct assessment of motivation orientation was developed. The CABoOM was derived from previous literature and is intended to be appropriate for use in low-income ethnically diverse samples of preschool children.

This study assessed the test retest reliability and the response process validity of the CABoOM, as well as, concurrent and predictive validity by examining associations with approaches to learning and gains in school readiness outcomes from the beginning to the end of the Head Start year (i.e. early science, language, and approaches to learning skills). Until valid and reliable measures of motivation orientation exist, motivation orientation cannot be understood and incorporated into the development of early intervention efforts, and its potential for narrowing the school readiness achievement gap will remain untapped.

Hypotheses

Aim 1: Examine the reliability, sensitivity, and response process validity of a newly developed direct assessment of motivation orientation for preschoolers from low-income families. It was hypothesized that the CABoOM would exhibit strong test retest reliability with inter-class correlations (ICC's) above .80, and scores would be normally distributed with a wide range of variability, indicating a sensitive measure. Additionally, children's ability to comprehend the instructions of the CABoOM was evaluated as response process validity is a necessary step in ensuring the developmental appropriateness of a measure. It was hypothesized that more than 90% of the children in the study will demonstrate understanding of the language required to complete the CABoOM (i.e. "easier" and "harder").

Aim 2: Examine the concurrent validity of the CABoOM through its relationship to approaches to learning. It was hypothesized that the CABoOM would display concurrent validity by having a significant relationship to the established and conceptually similar construct of approaches to learning.

Aim 3: Examine the predictive validity of the CABoOM by predicting gains in school readiness outcomes (i.e. early science, language, and approaches to learning skills) across the preschool year. It was hypothesized that the CABoOM would display predictive validity by predicting spring scores in early science, language, and approaches to learning skills, while controlling for respective fall scores.

Chapter 2

Method

Participants

This study was conducted in collaboration with Miami-Dade County Head Start. The final sample consists of 316 children, across 35 classrooms, in 9 Head Start Centers. Mean age of children was 51.38 months (range = 37.9 to 62.7) and 52.5 percent of children were female (n=166). The retest sample consists of 60 children randomly selected after stratifying for age and gender. Mean age of children was 52.7 months (range = 40.7 to 61.6) and 55 percent of children were female (n=33). Although racial and ethnic demographic data was not able to be obtained in the current sample the children were stratified by age and gender, then chosen at random, thus, it is expected that children are representative of the local population. Based on data previously collected in Miami-Dade County Head Start preschools, it is estimated that the majority (~60%) of participants are African-American, a substantial minority are Hispanic (~38%), and a small minority are identified as Caucasian, Asian, or other ethnicity (2%).

Procedure

Date of birth and gender of all children were obtained through center records. If a child could not be assessed due to chronic absenteeism, behavior, lack of English proficiency, etc., another child was randomly selected from the alternate list. To ensure that proper protocol was followed and that all assessments were administered reliably, all staff were trained and evaluated on each measure prior to data collection. Non-computerized data was verified in the field by a team leader, and then double verified by

a graduate student prior to being entered into the database. Ten percent of the data was double entered and re-verified.

During the 2014-2015 school year direct assessments of all school readiness outcomes (early science and language) were collected along with a teacher rating scale of approaches to learning in the fall and spring in order to allow for the examination of gains across the year. Data for the newly developed measure of motivation orientation was collected twice in the spring (once on the whole sample and a second time within two weeks on a subset of 15% of the sample) to allow for assessing test retest reliability. Trained research assistants administered direct assessments to children in a quiet space outside of the classroom and children received stickers for their participation.

Measures

Science. Lens on Science assessment (Lens; Greenfield, 2015) is a computer-adaptive, IRT-based direct assessment of science knowledge and process skills. This assessment was specifically designed to detect growth in the Head Start population. Items were created based on a review of preschool and kindergarten state and national standards as well as current preschool science curricula. The assessment was designed to cover a range of difficulty appropriate for Head Start preschoolers, as well as a range of science practice skills, cross-cutting concepts and science content from "life science," "earth and space sciences," "technology and engineering" and "physical and energy sciences".

Children sit in front of a touch-screen monitor and given headphones to listen to prompts instructing them to respond. A trained researcher supervises the test administration process. An IRT ability score is obtained in approximately fifteen minutes

with the administration of approximately 35 – 40 items using an adaptive format. The assessment currently contains an item bank of 498 items calibrated using the dichotomous Rasch model scaled to have a mean item difficulty of zero and unit-logit metric. Item difficulties (b-parameters) range from -2.7 to 4.4, with 80% of items having difficulty values between -1.40 and 1.42. The item-measure correlation (correlation between the item and the ability estimate) exceeds .20 for 87% of items, and exceeds .30 for 65% of items, reflecting effective discrimination of the items in the bank and evidence of a common trait measured by the items of the assessment. For a sample of 1,753, 3 to 5 year old students attending the Miami-Dade Country Head Start program, the average standard error of the Rasch ability estimate was 0.31 (on the unit-logit metric), which corresponds to a reliability of .87 (Greenfield, 2015).

Language. The Preschool Computerized Language Assessment (PCLA; Golinkoff, Hirsh-Pasek, & De Villiers, 2011) is a 48-item direct assessment designed to measure language development in vocabulary and grammar for 3 to 6 year old children. The PCLA utilizes a touch-screen laptop on which children indicate their answer choices by touching a picture. Interactive, cartoon-like animations are used to keep children engaged in the assessment which measures children's language products (i.e. word knowledge and grammar) and ability to use language process (i.e. strategies for learning new language). Items were developed by experts in child language development under a 4 year grant from the Institute of Education Science (IES; Grant # R305A110284 "*Using Developmental Science to Create a Computerized Preschool Language Assessment;*" Roberta Golinkoff, P.I.) and this measure has been administered to children served by Head Start. The PCLA takes approximately 25 minutes to complete and does not require

specially trained personnel as children only need adult supervision to complete the assessment (Golinkoff, Hirsh-Pasek, & De Villiers, 2011). The PCLA has displayed strong test-retest reliability, r (29) = .923, $p < .001$, as well as, convergent validity by significantly correlating with the Picture Peabody Vocabulary Test (PPVT-4; Dunn & Dunn, 2007), r (22) = .714, $p < .001$, and the Preschool Language Scale (PLS-5; Zimmerman, Steiner, & Pond, 2011), r (23) = .782, $p < .001$, after controlling for age (Pace, Yust, De Villiers, Iglesias, Wilson, Golinkoff, & Hirsh-Pasek, 2014).

Approaches to learning. The Learning-to-Learn Scales (LTLS; McDermott, Fantuzzo, Warley, Waterman, Angelo, Gadsden, & Sekino, 2011) is a measure of approaches to learning and learning related behaviors specifically designed to detect growth in Head Start populations. The LTLS is a teacher-completed scale with 55 items rated on a three point Likert scale ("consistently applies"; "sometimes applies"; "does not apply"). Teachers are asked to answer questions thinking about each child's behaviors during the past month. Exploratory factor analyses revealed a general factor as well as seven dimensions: Strategic Planning, Effectiveness Motivation, Interpersonal Responsiveness in Learning, Vocal Engagement in Learning, Sustained Focus in Learning, Acceptance of Novelty and Risk, and Group Learning. This measure has been shown to have external validity and concurrent validity when compared with the cognitive subscales scores of the Learning Express, other norm-referenced tests, in addition to high empirical reliability of .97 (McDermott et al., 2011).

Motivation orientation. The Computer Administered Battery of Observable Motivation (CABoOM) was used to assess motivation orientation. The CABoOM consists of three tasks ("sling shot", "escape the grid", and memory matching game) all

administered in identical fashion on a touch screen laptop computer. The paradigm builds off previous work that utilized unsolvable puzzles to assess children's motivation orientation (Smiley & Dweck, 1994), but is designed to be more sensitive and developmentally appropriate for preschool aged children from low-income families. Assessment takes place over two sessions within a week. During the first session participants complete a pretest version of all three tasks ("sling shot", "escape the grid", and memory matching game) to establish baseline ability, the amount of time taken by the child to complete each task is recorded, with higher times being indicative of lower task ability. Additionally, children are displayed pictures of two puzzles (one with many pieces and the other with very few) and asked to "touch the puzzle that is easier" then they are displayed two additional puzzles and are asked to "touch the puzzle that is harder." Correct answers served as evidence for response process validity.

During the second session of the battery the three games are administered, one of which is the memory matching game (see Figure 1). The memory matching game has pairs of cards with corresponding images on them. Each time a child selects a card, it turns over so the child can see the image (see Figure 1). After selecting the first card, children are allowed to select a second card. If that second card has a different image than the first, both cards flip back over, but if it has the same image, both cards disappear from the board. The goal is to make all of the matches and clear the board. There are three versions of the memory matching game varying in difficulty: the first memory game has 24 cards and is unsolvable because certain cards do not have matches. Participants are given the instruction "here are some cards with animals, try to remember where they are and find their match." Participants are allowed to engage with the game for 60 seconds

and are then told "Time's up. Next time try to make all the matches. Would you like to try that one again or would you like to try one that is easier?" At this point the child makes their decision and either attempts the 24 card game for a second time or move on to a 16 card game, which is also unsolvable. If the child selects the 16 card game they are allowed to work on it for 60 seconds and again are told "Time's up. Next time try to make all the matches. Would you like to try that one again or would you like to try one that is easier?" Again they have the option to try the 16 card game for a second time or move on to an 8 card game which is solvable. Once children select the 8 card game, the correct cards are available to them and they are given as much time as they need to make all the matches, which ensures success. After completing the 8 card game they are told "Great job! You made all the matches. Would you like to try that one again or would you like to try one that is harder?" If children choose to try the 8 card game, they are again given as much time as they need to complete it. If they choose to attempt the 16 card game, they are given 60 seconds and are again told "Time's up. Next time try to make all the matches. Would you like to try that one again or would you like to try one that is easier?"

Each time children choose to "try again" after failing an unsolvable game or "try one that is harder" after completing the solvable game, they are given a score of one for that trial. Each time they choose to "try one that is easier" after failing an unsolvable game or "try again" after completing the solvable game they are given a score of zero for that trial. Each child was administered seven memory matching games thus scores will range from 0-7 on this portion of the CABoOM.

Next children are administered the "escape the grid". Escape the grid is a game in which there is a golden brick that children must remove from a box by sliding it out with their finger. However, there are squares that can also be moved, which block the golden brick's path to the exit (see Figure 2). There are three escape the grid tasks varying in difficulty: Hard (unsolvable), medium (unsolvable), and easy (solvable). The same protocol from the memory matching portion described above is followed yielding a score from 0-7.

Finally, children are administered the "sling shot" tasks. The sling shot game is one where children use their finger to sling shot a ball into a tower, and the goal of the game is to knock the tower over (see Figure 3). The three versions of the sling shot game vary in difficulty by adjusting the distance between the ball and the tower, as well as, the size of the tower. Again the first two towers are unsolvable and the third is solvable. The same protocol from the previous two tasks is followed yielding another score from 0-7. Scores from the three subsections are combined to make a total score that can range from 0-21, this decision to aggregate the sub-scores into a total score was supported by an adequate Cronbach's Alpha of .68 in the current sample. Each session of the CABoOM takes approximately 20 minutes.

Chapter 3

Results

     Aim 1: Examine the reliability, sensitivity, and response process validity of a newly developed direct assessment of motivation orientation for preschoolers from low-income families. Descriptive statistics are presented in Table 1, and correlations among study variables are presented in Tables 2 and 3. The ICC for CABoOM was .863 indicating strong test retest reliability. Scores on CABoOM ranged from 0 to 18 with a mean of 5.32 and a standard deviation of 3.30 (N=316). The retest sample ranged from 0 to 16 with a mean of 3.27 and a standard deviation of 3.80 (N=60). CABoOM data were examined for skewness and kurtosis and both values fell within an acceptable range [skewness = .568 (std. error = .137), kurtosis = .463 (std. error = .273)]. For a histogram of all CABoOM total scores (see Figure 4). Additionally, 3 children were not able to demonstrate an understanding of the language used in the task (i.e. demonstrating the knowledge of colors and the words "easier" and "harder"). Those children were not administered the assessment and were subsequently excluded from the study. Thus, in the current sample all participating children showed response process validity.

     Aim 2: Examine the concurrent validity of the CABoOM through its relationship to approaches to learning. Hierarchical Linear Modeling (HLM) was employed to examine aim 2 using the software HLM 7 (Raudenbush et. al, 2011). The unconditional model indicated that 40% of the variance in approaches to learning was at the child level (level-1), while 57% of the variance in approaches to learning was at the classroom level (level-2). Additionally, only 3% of the variance was at the school level (level-3), thus, due to the small amount of variance at level 3 a 2-level model was utilized

for these analyses. A model with only the covariates demonstrated that gender and pretest CABoOM completion time were both significant predictors of spring approaches to learning (ATL). Thus, those covariates were retained in the final model shown below:

Level-1 Model

$$ATL\_Spring_{ij} = \beta_{0j} + \beta_{1j}*(CABoOM_{ij}) + \beta_{2j}*(Gender_{ij}) + \beta_{3j}*(PretestTime_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$

In this model CABoOM concurrently predicted approaches to learning [$\beta_1 = -.270$ (.101), $p = .011$] in the negative direction controlling for gender and pretest CABoOM completion time (see Table 4).

Aim 3: Examine the predictive validity of the CABoOM by predicting gains in school readiness outcomes (i.e. early science, language, and approaches to learning skills) across the preschool year. Again, aim 3 analyses were conducted within an HLM framework. The unconditional model indicated that 95% of the variance in science scores was at the child level while nearly 5% of the variance was at the classroom level (level-2). Additionally, less than 1% of the variance was at the school level (level-3), so again a 2-level model was utilized for these analyses. A model with only covariates demonstrated that fall science scores and pretest CABoOM completion time significantly predicted spring science scores. Thus, those covariates were retained for the final model shown below:

Level-1 Model

$$ScienceSpring_{ij} = \beta_{0j} + \beta_{1j}*(CABoOM_{ij}) + \beta_{2j}*(ScienceFall_{ij}) + \beta_{3j}*(PretestTime_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$

CABoOM significantly predicted spring science [β_1 = -.042 (.021), p = .047] in the negative direction controlling for fall science scores and pretest CABoOM completion time (See Table 5).

For language scores 98% of the variance was at the child level, approximately 2% of the variance was at the classroom level (level-2). While less than 1% of the variance was at the school level (level-3), thus a 2-level model was again utilized for these analyses. Fall language scores and pretest CABoOM completion time were significant predictors of spring language and were retained as covariates in the final model shown below:

Level-1 Model

$$LanguageSpring_{ij} = \beta_{0j} + \beta_{1j}*(CABoOM_{ij}) + \beta_{2j}*(LanguageFall_{ij}) + \beta_{3j}*(PretestTime_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$

CABoOM did not significantly predict spring language scores [β_1 = -.238 (.184), p = .205] controlling for fall language and pretest CABoOM completion time (See Table 6).

Again, 40% of the variance in approaches to learning was at the child level, 57% at the classroom level, and 3% at the school level, so a 2-level model was utilized. Fall approaches to learning and pretest CABoOM completion time were significant predictors of spring approaches to learning and were retained as covariates in the final model shown below:

Level-1 Model

$$ATL\_Spring_{ij} = \beta_{0j} + \beta_{1j}*(CABoOM_{ij}) + \beta_{2j}*(ATL\_Fall_{ij}) + \beta_{3j}*(PretestTime_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$

CABoOM significantly predicted spring approaches to learning [β_1 = -.184 (.066), p = .009] in the negative direction controlling for fall approaches to learning and pretest CABoOM completion time (See Table 7).

Chapter 4

Discussion

In this study a newly developed computerized direct assessment of motivation orientation (CABoOM) was evaluated for its reliability and validity in a sample of preschoolers served by Head Start. The measure displayed a wide range (0 to 18) of normally distributed scores, strong test retest reliability, and excellent response process validity. However, it failed to demonstrate concurrent validity in the hypothesized direction as it significantly related to a teacher rating of approaches to learning in the opposite of the predicted direction. Higher CABoOM scores were associated with lower approaches to learning scores. Similarly, it did not demonstrate predictive validity in the hypothesized direction as it significantly predicted end of the year science and approaches to learning scores in the opposite of the predicted direction with higher CABoOM scores associated with smaller gains in science and approaches to learning. Additionally, there was no relationship between CABoOM and language gains across the school year.

It is encouraging that CABoOM captures variability, showed strong test retest reliability, and is understandable to preschoolers from low-income families. However, more research is warranted to explore the unexpected direction of its concurrent and predictive relationships to school readiness outcomes. There are several potential explanations for the unexpected direction of the relationships observed in this study. One explanation could stem from the assumption of a linear relationship between motivation orientation and school readiness outcomes. By imposing a linear model it is assumed that a maximum score of 21 on CABoOM should relate to the highest school readiness scores

25

and a minimum score of 0 should relate to the lowest. However, it may be the case that extremes on either end of the spectrum are non-adaptive for children in a learning environment. CABoOM scores were squared and cubed in order to test for quadratic and cubic relationships and neither provided better model fit nor did they change the direction of the coefficients.

While not having enough motivation could cause children to shy away from challenges and prevent them from engaging in new experiences, the other extreme could result in children accepting challenges that are not developmentally appropriate and not adjusting their approach when necessary. There may be a great benefit in the ability to recognize a challenge that is within ones zone of proximal development and avoid those challenges that are beyond it. If this was indeed the case a more moderate score would reflect a child that is willing to attempt a difficult task but is thoughtful about adjusting the difficulty when they have made several unsuccessful attempts. Often the most successful strategy while pursuing a difficult goal is not to endlessly persist, but instead break the goal down into smaller more manageable components. This theory however, operates under another assumption that may be driving these unexpected relationships.

Currently the CABoOM total score is generated by summing all instances that a child persists on a difficult task or increases difficulty after success on an easy task. Utilizing the CABoOM total score to predict outcomes assumes that the cumulative amount of persistence is the most important factor when it could be that a specific response pattern is more predictive of school readiness. Perhaps there is a certain approach that allows children to attempt novel tasks and persist when appropriate, while at the same time recognizing when they are engaged with a challenge that is beyond their

current ability level allowing them to disengage, alleviate frustration, and protect their confidence. Different profiles of children's response patterns may exist in the data which would allow for examination of differences between groups.

For example, one group of children may begin highly persistent attempting the most difficult task repeatedly until they get overly frustrated and choose not to persist for the remainder of the task. Alternatively, other children may attempt the most difficult task a few times then move down in difficulty to regain confidence and reengage with more challenges once they have experienced some success and mastered the easier tasks. These two groups of children could receive similar total scores on CABoOM when in reality their approaches are vastly different and could relate differently to school readiness outcomes. Another factor that could be contributing to the significant negative relationships found in this study is the praise children received during the task.

Previous research suggests that praise is a highly salient factor in children's motivation orientation (Dweck, 2006; Kamins & Dweck, 1999; Mueller & Dweck 1998). During the CABoOM the only way to receive praise is to complete the easiest version of the task as the medium and difficult versions cannot be completed in the allotted time. It is possible that the praise delivered during the assessment for the easiest task was too salient and outweighed the desire to take on challenges for the highest achieving children, which would also explain the low mean of CABoOM scores (M=5.32, Std. Dev=3.30).

It could be the case that the children most driven by praise are the highest achieving as they may be more likely to engage and comply with the teacher in hopes of receiving praise. This would provide those children more opportunities to interact with

and receive feedback from the teacher and build school readiness skills. Conversely, children who are more indifferent to praise may spend less time pursuing the teacher's attention and complying with teacher directives, thus getting less interaction and feedback from teachers and other adults. This phenomenon would explain the significant negative relationships between CABoOM scores and school readiness outcomes as an excessive pursuit of praise would lead to repetition of the easiest version of each task resulting in a very low CABoOM score.

Limitations and Future Directions

The above theories are purely speculative as children's reasons for persisting and moving up or down in difficulty level remain unknown. Future research should aim to explore children's thought processes while navigating the decisions during CABoOM administration. One potential approach is to conduct qualitative interviews during the assessment that may shed light into the logic behind children's decisions. By asking children to explain each decision they make, patterns may emerge to support a particular theory as to why children who score lower on CABoOM seem to have higher gains from the beginning to the end of the year in school readiness outcomes. It could be the case that CABoOM is tapping into some other construct separate from motivation orientation, and qualitative interviews may offer insight as to what that construct may be.

Additionally, data collection issues limit the ability to evaluate the CABoOM to the extent that was originally proposed. The proposal of this study included two time-points of CABoOM data collection, one in the beginning of the school year and one at the end. However, unforeseen bugs and glitches on the software development end prevented

the first round of data collection from taking place. These types of setbacks are very common when developing novel computerized assessments and unfortunately this setback precluded the ability to examine several potentially interesting aspects of children's performance on CABoOM. The original analytic plan included examination of change across the school year in children's motivation orientation. These analyses would have provided insight into the stability of motivation orientation and if gains in motivation orientation are predictive of gains in other readiness outcomes. Future research should aim to collect CABoOM at the beginning and the end of the school year to examine its ability to capture gains and what factors predict and are predicted by those gains.

Chapter 5

Conclusion

The goal of CABoOM is to increase our understanding of young children's responses to failures and setbacks. Failure is an inevitable piece of the learning process, and learning occurs during failure and setbacks. In a healthy school environment, children will be faced with new learning challenges on a daily basis. No child will succeed on their first attempt; thus, all children will experience failure. How children deal with this failure has important implications for their academic outcomes. When failure is embraced as a critical component of the learning process, children will be more likely to seek out challenging tasks, and measure their success in how much they have learned, both key components of mastery motivation. However, when there is a fear of failure, children will be more likely to shy away from challenges, and measure their success only in the outcomes of the tasks they choose to attempt. Preschool is a time of rapid growth in science and language skills and children must be prepared for the many setbacks and challenges they will encounter. To best prepare children for school and life success, interventions that specifically target domain general skills like motivation orientation must be developed.

Results from this study suggest that more research is warranted to develop sensitive and reliable measurement of motivation orientation among preschool children from low-income families. Such measurement is necessary to evaluate the efficacy of interventions targeting adaptive motivational strategies, and currently CABoOM is the only measure developed for this at-risk population. Sensitive and reliable measurement of motivation orientation will allow for identification of children utilizing maladaptive

motivational strategies so that they may be targeted by interventions, thus mitigating the risk that they enter kindergarten far behind their peers. Furthermore, domain-general and malleable skills like motivation orientation are ideal targets for intervention because they translate across all readiness areas and relate to academic success in later grades (Li-Grinning, 2007; McClelland et al., 2007).

Given the school readiness achievement gap between children from low- and middle-income families, identifying skills that directly influence gains in school readiness outcomes is a critical step. Results from this study suggest that CABoOM is reliable in this population, however, further support for validity is needed which may be obtained from a more qualitative approach that utilizes interviewing during the task to uncover the reasons behind children's choices. Future research that demonstrates a link between motivation orientation and school readiness outcomes would provide strong justification for the development, implementation, and dissemination of interventions targeting this domain-general construct. This study represents an important step within a programmatic research agenda to support and develop adaptive motivational strategies that will set children up for success in preschool, grade school, and beyond.

References

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84,* (3), 261-271.

Blackwell, L., Trzesniewski, K., & Dweck, C.S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78,* 246-263.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development*, *78*(2), 647-663.

Brown, E. D. (2009). Persistence in the face of academic challenge for economically disadvantaged children. *Journal of Early Childhood Research, 7* (2), 173-184.

Burhans, K., & Dweck, C. S. (1995). Helplessness in early childhood: The role of contingent worth. *Child Development, 66,* 1719-1738.

Bustamante, A. S., & Greenfield, D. B. Motivation orientation and school readiness in children served by Head Start. *Manuscript under revised review in Early Education & Development.*

Cain, K. M., & Dweck, C. S. (1995). The relation between motivational patterns and achievement cognitions through the elementary school years. *Merrill-Palmer Quarterly, 41,* 25-52.

Chang, F, & Burns, B. M. (2005). Attention in preschoolers: Associations with effortful control and motivation. *Child Development, 76,* 247-263.

Clements, D., Greenfield**,** D.B., Landry, S.H. & Sarama, J., (2015). Assessment and evaluation using technology. *Contemporary Perspectives in Early Childhood Education*, Charlotte, N.C.: Information Age Publishing. Chapter 15.

Day, C. A. (2012). Achievement motivation and self-evaluative emotions in preschool children from low-income families. *Dissertation submitted to the faculty of the College or Arts and Sciences of the University of Louisville.*

Day, C. A., & Burns, B. M. (2011). Characterizing the achievement motivation orientation of children from low- and middle-income families. *Early Education and Development, 22,* (1), 105-127.

Dunn, L. M., & Dunn, D. M. (2007). Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4).

Dweck, C. S. (1991). Self-theories and goals: Their role in motivation, personality, and development. In R. A. Dienstbier (Ed.), *Nebraska symposium on motivation, 1990* (199-235). Lincoln: University of Nebraska Press.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York, NY: Ballantine Books.

Dweck, C. S. (2008). Mindsets and math/science achievement. *Prepared for the Carnegie Corporation of New York-Institute for Advanced Study Commission on Mathematics and Science Education.* www.opportunityequation.org

Fantuzzo, J. W., Gadsden, V. L., & McDermott, P. A. (2011). An integrated curriculum to improve mathematics, language, and literacy for Head Start children. *American Educational Research Journal, 48*(3), 763-793.

Fantuzzo, J. W., McDermott, P. A., Manz, P. H., Hampton, V. R., & Burdick, N. A. (1996). The Pictorial Scale of Perceived Competence and Social Acceptance: Does It Work with Low-Income Urban Children? *Child Development, 67*(3), 1071-1084.

Fantuzzo, J. A., Perry, M. A., McDermott, P. A. (2004). Preschool approaches to learning and their relationship to other relevant classroom competencies for low-income children. *School Psychology Quarterly, 19,* (3), 212-230.

Gilmore, L., Cuskelly, M., & Purdie, N. (2003). Mastery motivation: Stability and predictive validity from age's two to eight. *Early Education & Development, 14*(4), 411-424.

Golinkoff, R., Hirsh-Pasek, K., & De Villiers, J. (2011) IES; Grant # R305A110284. *Using Developmental Science to Create a Computerized Preschool Language Assessment.*

Gutman, L. M., & Midgley, C. (2000). The role of protective factors in supporting the academic achievement of poor African American students during the middle school transition. *Journal of Youth and Adolescence, 29,* 223-248.

Greenfield, D.B. (2015). Assessment in early childhood science education. In K. Trundle, & M. Saçkes (Eds.), *Research in early childhood science education.* Chapter 16, 353-380. Springer Publishing: New York, NY.

Greenfield, D. J., & Penfield, R. (2009). IES; Grant # R305A090502. *Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children*. University of Miami, Coral Gables, FL.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children.* Baltimore, MD US: Paul H Brookes Publishing.

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science, 312*(5782), 1900-1902.

Kamins, M. L., Dweck, C. S. (1999). Person versus process praise and criticism: Implications for contingent self-worth and coping. *Developmental Psychology, 35*(3), 835-847.

Krull, J. L., & MacKinnon, D. P. (2001). Multilevel modeling of individual and group level mediated effects. *Multivariate Behavioral Research*, *36*(2), 249-277.

Lee, V. E., & Burkam, D. T. (2002). *Inequality at the starting gate: Social background differences in achievement as children begin school*. Washington, DC: Economic Policy Institute.

Li-Grinning, C. P. (2007). Effortful control among low-income preschoolers in three cities: Stability, change, and individual differences. *Developmental Psychology, 43,* 208-221.

Maas, C. J., & Hox, J. J. (2004). Robustness issues in multilevel regression analysis. *Statistica Neerlandica*, *58*(2), 127-137.

Magnuson, K., & Duncan, G. (2006). The role of family socioeconomic resources in the black-white test score gap among young children. *Developmental Psychology, 25,* (5)*,* 787-793.

McClelland, M. M., Cameron, C. E., Conner, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43,* 947-959.

McDermott, P. A., Fantuzzo, J. W., Warley, H. P., Waterman, C., Angelo, L. E., Gadsden, V. L., & Sekino, Y. (2011). Multidimensionality of teachers' graded responses for preschoolers' stylistic learning behavior: The learning-to-learn scale. *Educational and Psychological Measurement* 71: 148

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75,* (1), 33-52.

National Assessment of Educational Progress (2009). The Nation's Report Card: Trial Urban District Assessment Reading 2009 Retrieved July 5, 2012, from http://nces.ed.gov/nationsreportcard/pdf/dst2009/2010459.pdf

Nayfeld, I., Fuccillo, J., & Greenfield, D. B. (2013). Executive functions in early learning: Extending the relationship between executive functions and school readiness to science. *Learning and Individual Differences, 26,* 81-88.

Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental Science, 10,* 464-480.

Office of Head Start (OHS): Program Information Report (PIR). U.S. Department of Health and Human Services (HHS). Administration for Children and Families (ACF). (2013). http://eclkc.ohs.acf.hhs.gov/hslc/data/pir

Pace, A., Yust, P., De Villiers, J., Iglesias, A., Wilson, M., Golinkoff, R., & Hirsh-Pasek, K. (2014). Evaluating the Reliability and Validity of a Computer-Based Language Assessment. Poster presentation at the annual American Speech-Language Hearing Assosication (ASHA) meeting. Orlando, FL.

Piaget, J. (1983). Piaget's theory. In P. H. Mussen (Ed.), *Handbook of Child Psychology, 4th edition.* Vol. I, (pp. 294-356). New York, NY: Wiley. (Original work published in 1970).

Piaget, J., & Inhelder, B. (1969). *The psychology of the child.* New York, NY: Basic Book, Inc.

Raudenbush, S.W., Bryk, A.S, & Cheong, Y.F., Congdon, R.T. & Du Toit M. (2011). HLM 7 for Windows [Computer software]. Lincolnwood, IL: Scientific Software International, Inc.

Reynolds, A. J., Temple, J. A., Robertson, D. L., & Mann, E. A. (2002). Age 21 cost-benefit analysis of the Title I Chicago child–parent centers. *Educational Evaluation and Policy Analysis,* 24, 267-303.

Shonkoff, J. P., & Phillips, D. A. (Eds.). (2000). *From neurons to neighborhoods: The science of early childhood development.* Washington, DC: National Academy Press.

Smiley, P. A., Dweck, C. S. (1994). Individual differences in achievement goals among young children. *Child Development, 65,* 1723-1743.

Spybrook, J., Bloom, H., Congdon, R., Hill, C., Martinez, A., Raudenbush, S., & TO, A. (2011). Optimal design plus empirical evidence: Documentation for the "Optimal Design" software. *William T. Grant Foundation. Retrieved on November*, *5*, 2012.

Turner, L. A., & Johnson, B. (2003). A model of mastery motivation for at-risk preschoolers. *Journal of Educational Psychology, 95,* (3), 495-505.

Vygotksy, L. S. (1978). *Mind in society: The development of higher mental processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Trans.). Cambridge, MA: Harvard University Press. (Original work published in 1930).

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Predictions of school outcomes based on early language production and socioeconomic factors. *Child Development, 65* (2), 606-621.

Welsh, J. A., Nix, R. L., Blair, C., Bierman, K. L., & Nelson, K. E. (2010). The development of cognitive skills and gains in academic school readiness for children from low-income families. *Journal of Educational Psychology, 102,* (1), 43-53.

Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength & Conditioning Research*, *19*(1), 231-240.

Willoughby, M. T., Blair, C. B., Wirth, R. J., & Greenberg, M. (2010). The measurement of executive function at age 3 years: psychometric properties and criterion validity of a new battery of tasks. *Psychological Assessment*, *22*(2), 306.

Young, J. & Reed, K. (2014). NSF; Grant # 1348564. *Scaffolding mastery motivation: Testing a theoretical model of teacher practice and preschoolers' mathematics learning.* Education Development Center (EDC), Waltham, MA.

Yoshikawa, H., Weiland, C., Brooks-Gunn, J., Burchinal, M., Espinosa, L., Gormley, W., Ludwig, J.O., Magnuson, K.A., Phillips, D.A., & Zaslow, M.J. (2013). *Investing in our future: The evidence base for preschool education.* Policy brief, Society for Research in Child Development and the Foundation for Child Development.

Zigler, E. F., & Bishop-Josef, S. J. (2006). The cognitive child vs. the whole child: Lessons from 40 years of Head Start. In D. G. Singer, R. M. Golinkoff, & K. Hirsh-Pasek (Eds.), *Play = learning: How play motivates and enhances children's cognitive and social emotional growth* (pp. 15-35). New York, NY: Oxford University Press.

Zimmerman, I. L., Steiner, V. G., & Evatt Pond, R. (2011). Preschool Language Scales, Fifth Edition (PLS-5).
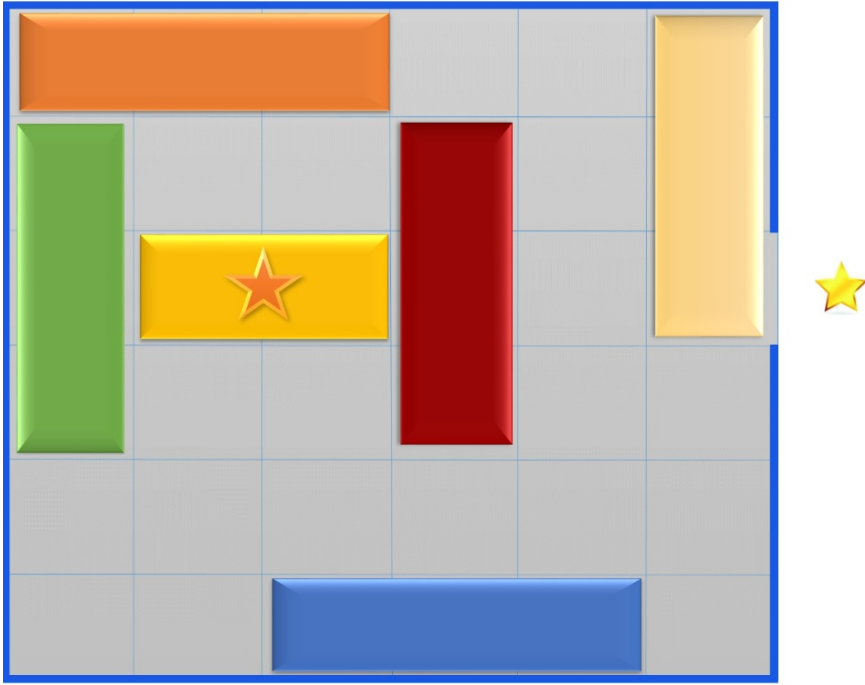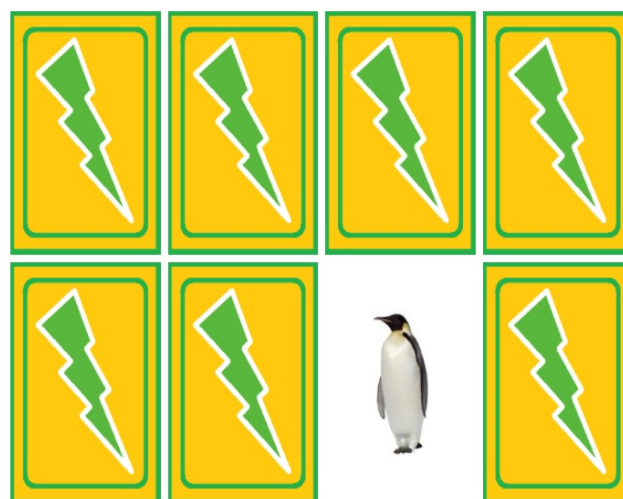
Figure 1

Figure 2

Figure 3
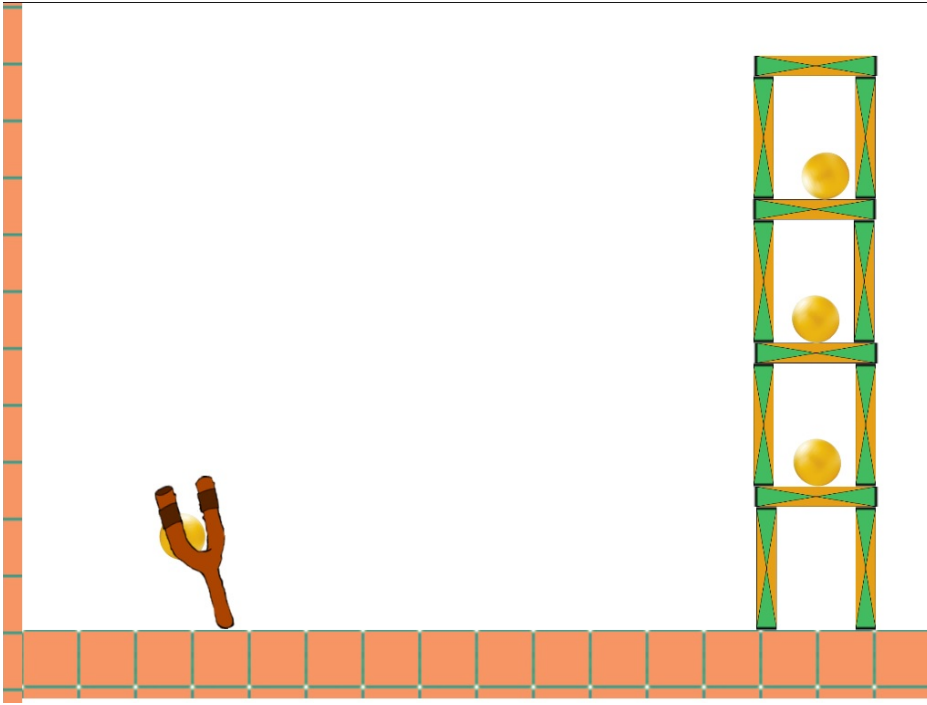
Figure 4

Histogram

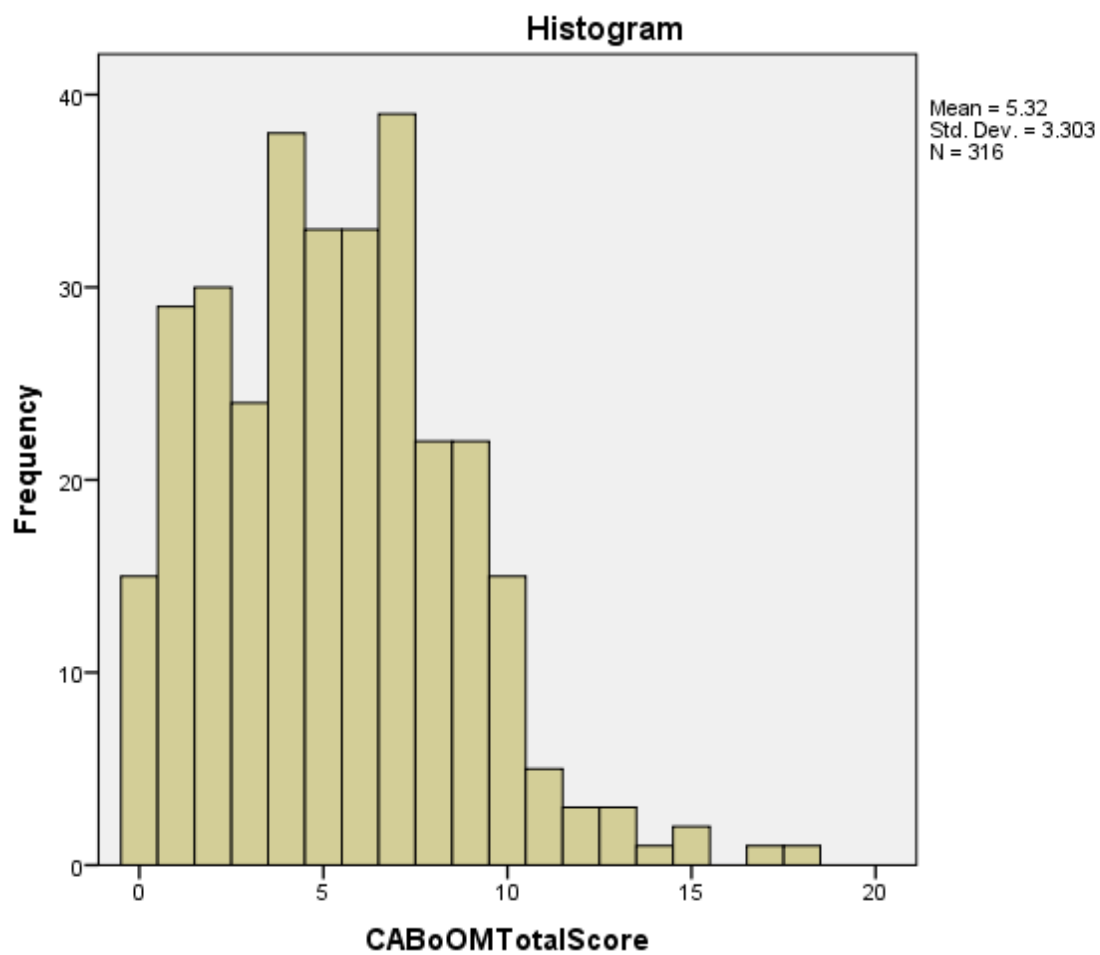Mean = 5.32
Std. Dev. = 3.303
N = 316

Table 1

Descriptive Statistics for CABoOM Total, Retest, and Subgame Scores, Science, Language, Approaches to Learning, Age, and Pretest CABoOM Completion Time.

Variable	N	Minimum	Maximum	Mean	Std. Deviation
CABoOM Total Score	316	0	18	5.32	3.30
CABoOM Retest Score	60	0	16	3.27	3.80
Escape the Grid Sum	316	0	6	1.73	1.26
Matching Game Sum	315	0	7	1.92	1.52
Sling Shot Sum	316	0	7	1.68	1.49
Retest Escape the grid Sum	60	0	6	1.06	1.39
Retest Matching Game Sum	60	0	6	1.23	1.57
Retest Sling Shot Sum	60	0	7	.89	1.64
Fall Science	276	-2.69	2.16	-.09	.84
Spring Science	302	-2.58	3.00	.48	.96
Age	281	37.9	62.7	51.38	6.95
Approaches to Learning Fall	279	35.74	75.05	58.48	9.24
Approaches to Learning Spring	299	38.37	75.05	58.81	8.62
Language Fall	303	209	377	275.49	27.40
Language Spring	274	213	384	294.67	30.16
Pretest Escape the Grid Time	316	4	600	97.53	84.65
Pretest Matching Game Time	316	14	217	48.53	28.08
Pretest Sling Shot Time	316	2	322	48.33	46.71
Pretest Total Time	316	28	809	194.39	113.86

Table 2

Bi-Variate Correlations between CABoOM Total and Retest Scores, Science, Approaches to Learning (ATL), Language, Age, Gender, and CABoOM Pretest Completion Time.

	CABoOM Total	CABoOM Retest	Science Fall	Science Spring	ATL Fall	ATL Spring	Lang. Fall	Lang. Spring	Age	Gender	CABoOM Pretest
CABoOM Total	1										
CABoOM Retest	.76**	1									
Science Fall	-.17**	.02	1								
Science Spring	-.21**	-.06	.53**	1							
ATL Fall	-.08	-.16	.22**	.19**	1						
ATL Spring	-.09	-.33*	.23**	.25**	.57**	1					
Lang. Fall	-.13*	.01	.43**	.48**	.17**	.13*	1				
Lang. Spring	-.16*	-.06	.36**	.44**	.17**	.20**	.60**	1			
Age	-.24**	-.26	.53**	.42**	.20**	.39**	.01	.01	1		
Gender	-.16**	-.18	.11	.16**	.14**	.17**	.04	.06	.07	1	
CABoOM Pretest	.03	-.04	-.31**	-.15**	-.10	-.12*	-.07	-.02	-.36**	.01	1

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

Table 3

Bi-variate Correlations between CABoOM Total Score and the Total Score of Each of the 3 Sub-Games.

	CABoOM Total	Escape the Grid Total	Memory Matching Total	Slingshot Total
CABoOM Total	1	.716**	.796**	.801**
Escape the Grid Total	.716**	1	.355**	.379**
Memory Matching Total	.796**	.355**	1	.446**
Slingshot Total	.801**	.379**	.446**	1

*p < .05, **p < .01

Table 4

Hierarchical Linear Model using CABoOM Total Score to predict Spring Approaches to Learning controlling for Gender and Pretest CABoOM Completion Time.

Fixed Effect	Coefficient	Std. Error	*t*-ratio	Approx. *d.f.*	*p*-value
Intercept	59.047	1.470	40.174	33	<.001
CABoOM Total Score	-.270	.101	-2.678	33	.011
Gender	2.241	.643	3.484	229	<.001
CABoOM Pretest Completion Time	-.008	.003	-2.713	229	.007

Table 5

Hierarchical Linear Model using CABoOM Total Score to predict Spring Science controlling for Fall Science and Pretest CABoOM Completion Time.

Fixed Effect	Coefficient	Std. Error	*t*-ratio	Approx. *d.f.*	*p*-value
Intercept	.753	.124	6.087	33	<.001
CABoOM Total Score	-.042	.021	-2.061	33	.047
Fall Science	.598	.061	9.833	192	<.001
CABoOM Pretest Completion Time	.001	.001	1.153	192	.250

Table 6

Hierarchical Linear Model using CABoOM Total Score to predict Spring Language controlling for Fall Language and Pretest CABoOM Completion Time.

Fixed Effect	Coefficient	Std. Error	*t*-ratio	Approx. *d.f.*	*p*-value
Intercept	42.660	5.944	7.177	32	<.001
CABoOM Total Score	-.238	.184	-1.294	32	.205
Fall Language	.625	.062	10.008	194	<.001
CABoOM Pretest Completion Time	-.001	.005	.206	194	.837

Table 7

Hierarchical Linear Model using CABoOM Total Score to predict Spring Approaches to Learning controlling for Fall Approaches to Learning and Pretest CABoOM Completion Time.

Fixed Effect	Coefficient	Std. Error	*t*-ratio	Approx. *d.f.*	*p*-value
Intercept	35.374	4.654	7.601	32	<.001
CABoOM Total Score	-.184	.066	-2.774	32	.009
Fall Approaches to Learning	.425	.071	5.984	195	<.001
CABoOM Pretest Completion Time	-.009	.004	-2.209	195	.028