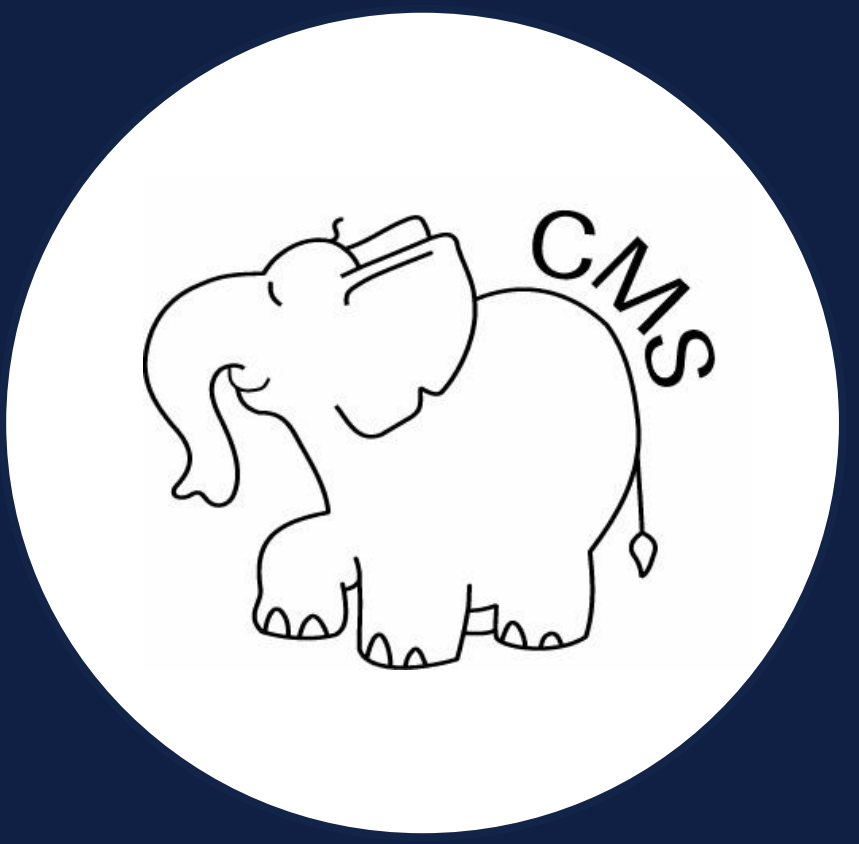# Formal and Informal Home Numeracy Activities: Linkages to Kindergarten Math Abilities

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INTRODUCTION

- Previous studies have identified mixed results regarding links between parents' use of home numeracy activities and children's math skills (Mutaf-Yildiz et al., 2020).

- These findings may be due to the specific type of home-based practices that were assessed.

- Researchers distinguish between formal and informal home numeracy activities (LeFevre et al., 2009).
  - *Formal* activities involve teaching math skills directly.
  - *Informal* activities include playing games or participating in activities that apply math principles.

- More research is needed to explore the unique relations between formal and informal home practices and children's mathematical skills in kindergarten.

AIMS & METHODS

This study had two primary aims:

1. To characterize parents' use of formal and informal home numeracy activities.

2. To explore associations between different types of home numeracy activities and children's math skills.

- Data for this study were drawn from a longitudinal project focused on children's memory and cognitive skills across the early elementary school years.

- Home measures were assessed using a questionnaire.

- Children's mathematical skills were assessed one-on-one by trained research assistants in the fall and spring of kindergarten.

PARTICIPANTS

- 78 children were recruited at kindergarten entry

- 35 boys, 43 girls

- Age at kindergarten fall assessment: 5.76 years (range = 4.93–6.47)

- 86% of primary caregivers held a bachelor's degree or higher

- European American
- Multiracial
- Asian American
- African American
- Unreported
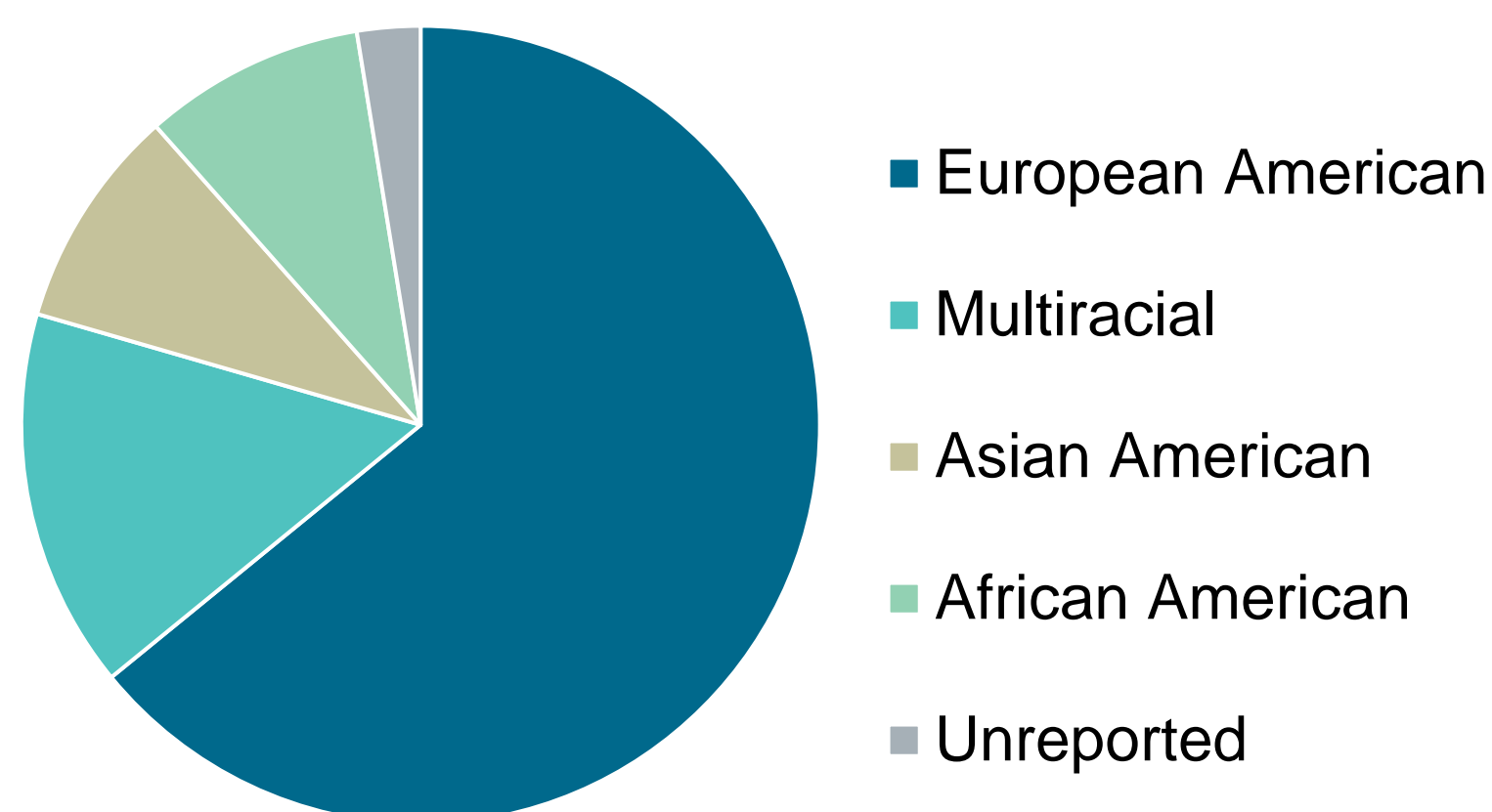
MEASURES

Parent Questionnaire

- A parent questionnaire assessed the frequency of home-based numeracy activities (LeFevere et al., 2009).

- Frequency was rated from did not occur (0), a few times a month (1), once a week (2), a few times a week (3), to almost daily (4).

Formal Activities	
Number Skills	Counting objects, sorting objects, counting down, identifying written numbers, printing numbers
Number Books	Using count the dot activities, using number activity books, reading number storybooks

Informal Activities	
Games	Playing card games, making collections, playing board games (with dice or spinners), being timed
Application Activities	Wearing a watch, measuring ingredients, using calendars or dates, talking about money, playing with calculators

- Parents reported their level of education. Range of 0 (no post high school) to 6 (advanced doctorate degree).

Woodcock Johnson Math Fluency

- Children were given 3 minutes to solve as many single-digit addition and subtraction problems as possible (Schrank et al., 2014). Scores reflect the total number of problems solved correctly during the test period.

Woodcock Johnson Math Calculation

- Children solved increasingly difficult math problems, which progressed from writing single-digit numbers to solving arithmetic equations (Schrank et al., 2014). The task concluded after six incorrect answers. Scores reflect the total number of problems answered correctly.

Math Problem Solving Task (MPS)

- Children were presented 10 single-digit addition problems. They were asked to provide the solution and then to explain how they solved each problem (Siegler & Jenkins, 1989).

- Answers were coded for accuracy and strategy (e.g., counting both addends, counting on, or decomposition).

- *Accuracy:* The total number of problems solved correctly.

- *Strategy Effectiveness:* The percentage of the 10 problems the children were able to accurately solve while employing an addition strategy.

DESCRIPTIVE STATISTICS

Home Measures

Variable	Min	Max	Mean	SD
Number Skills	0	4.00	2.30	1.12
Number Books	0	3.67	1.27	0.90
Games	0	4.00	1.79	0.95
Application Activities	0	3.40	1.47	0.84
Parent Education	0	6.00	4.55	1.52

- Parents' use of home numeracy activities ranged from did not occur to almost daily. On average, activities related to *number skills* were used the most frequently ($M = 2.30$, more than once a week) and *number books* the least ($M = 1.27$, a few times a month).

- The sample was drawn from a highly educated area. Mean parental education was 4.55 (some education beyond a bachelor's degree).

Correlations Among Home Measures

Variable	1	2	3	4	5
1. Number Skills	—				
2. Number Books	.61**	—			
3. Games	.43**	.43**	—		
4. Application Activities	.51**	.48**	.63*	—	
5. Parent Education	.12	-.04	.11	.25*	—

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

- The use of each of the four categories of home numeracy activities was significantly correlated.

- Parents' education level was only correlated with their use of application activities.
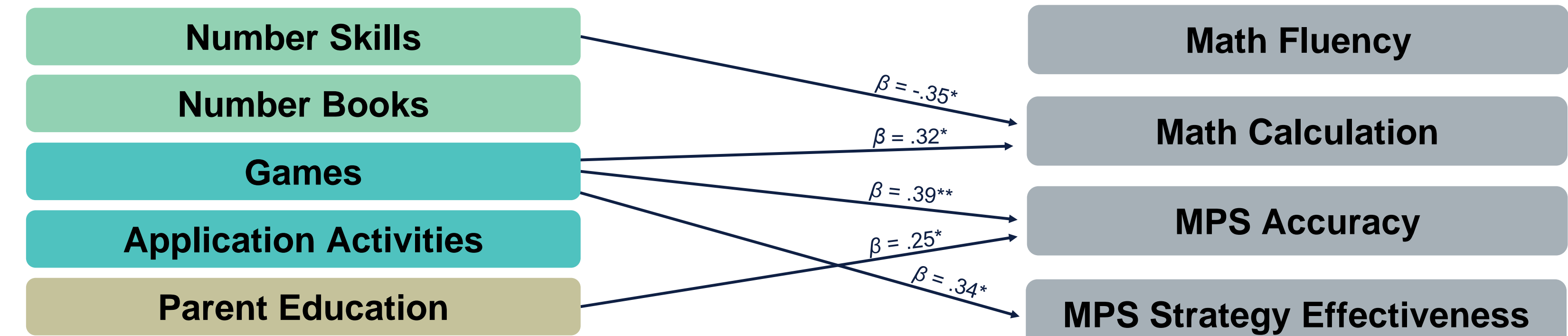
Child Measures

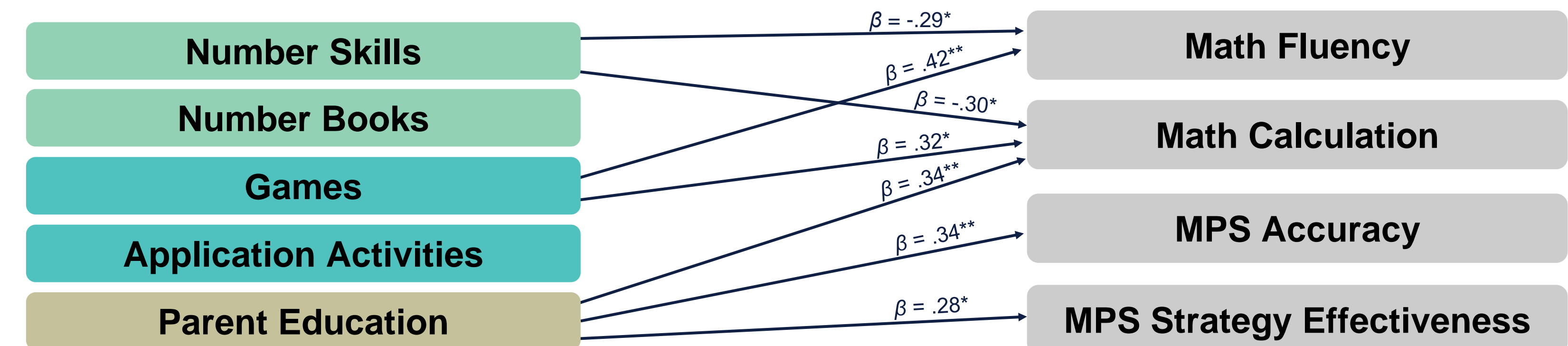| Variable	Min	Max	Mean	SD
Fall Math Performance				
Math Fluency	0	24.00	5.36	5.05
Math Calculation	0	17.00	7.22	4.99
MPS Accuracy	0	10.00	4.22	2.96
MPS Strategy Effectiveness	0	1.00	0.54	0.36
Spring Math Performance				
Math Fluency	0	45.00	13.55	8.81
Math Calculation	0	21.00	12.26	4.95
MPS Accuracy	0	10.00	7.01	2.72
MPS Strategy Effectiveness	0	1.00	0.79	0.26

- There was substantial variability in children's performance on all four mathematics outcomes.

- Children's mean scores on each measure increased between the fall and spring of kindergarten.

RESULTS

Fall Multiple Linear Regression Results

Predictors		Outcomes
Number Skills		Math Fluency
Number Books	$\beta = -.35*$	Math Calculation
Games	$\beta = .32*$	MPS Accuracy
Application Activities	$\beta = .39**$	MPS Strategy Effectiveness
Parent Education	$\beta = .25*$ $\beta = .34*$	

Spring Multiple Linear Regression Results

| Predictors		Outcomes
Number Skills	$\beta = -.29*$	Math Fluency
Number Books	$\beta = .42**$	Math Calculation
Games	$\beta = -.30*$ $\beta = .32*$	MPS Accuracy
Application Activities	$\beta = .34**$ $\beta = .34**$	MPS Strategy Effectiveness
Parent Education	$\beta = .28*$	

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

- Parents' use of *number skills* activities was **negatively** associated with children's calculation performance (at both timepoints) and fluency scores (in the spring).

- The frequency of mathematical *games* was **positively** related to all four math outcomes (either in the fall or spring of kindergarten). Parent education also **positively** predicted math outcomes.

- Neither *number books* nor *application activities* were significantly associated with children's mathematical skills in kindergarten.

DISCUSSION

- The results suggest that not all home-based numeracy activities are equally beneficial for children's academic performance.

- Informal home practices may better support children's math abilities than formal activities involving specific number skills.

- Some home numeracy practices may support specific math skills at school entry, whereas for other outcomes the benefits may only be evident at the end of the year.
  - For example, playing games was positively related to math problem-solving accuracy and strategy effectiveness at the *start of kindergarten*, but not to fluency scores until the *end of the year*.

- Future work could shed light on whether specific types of games are beneficial for children's developing math skills and how informal numeracy activities are related to growth in math skills.
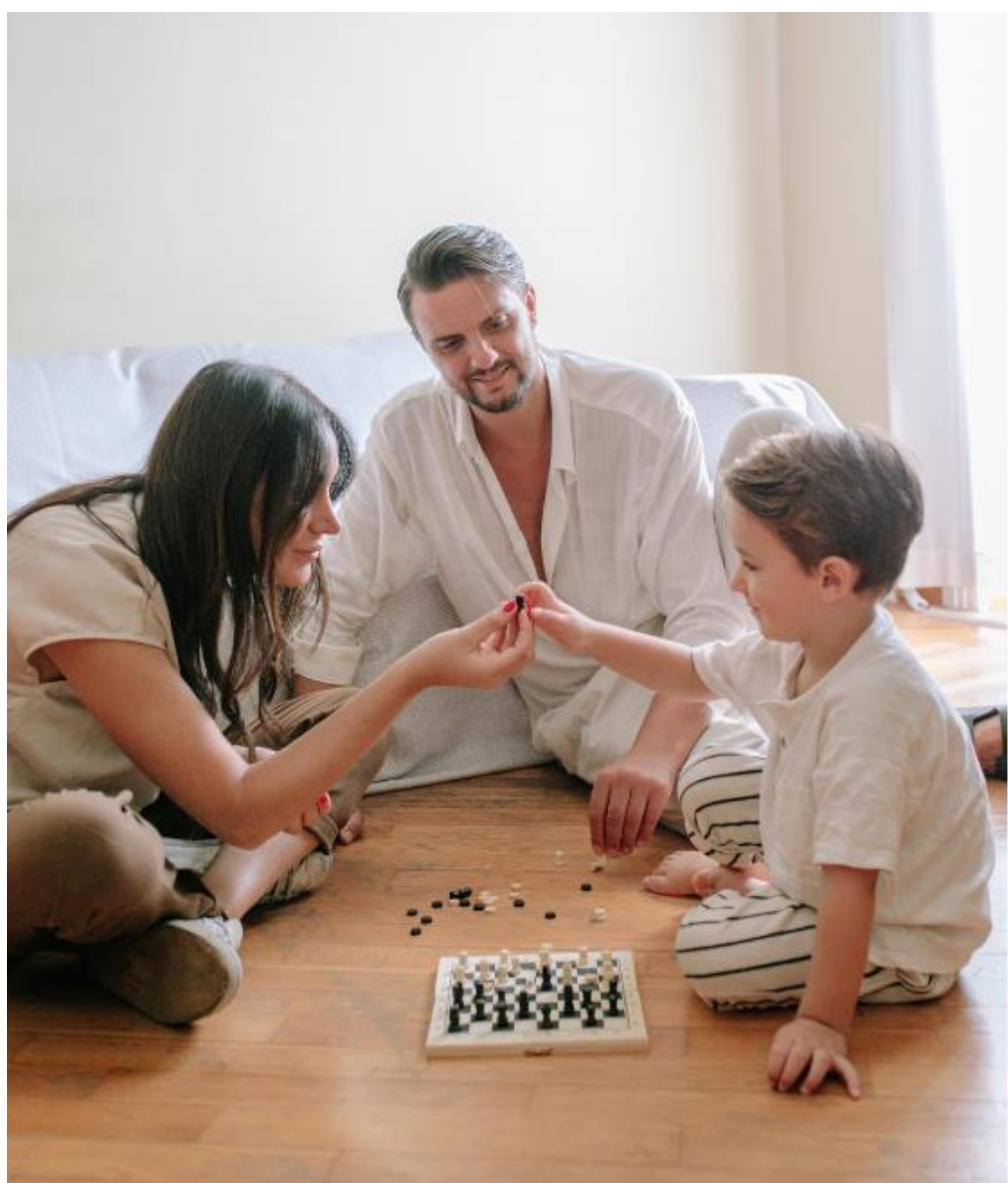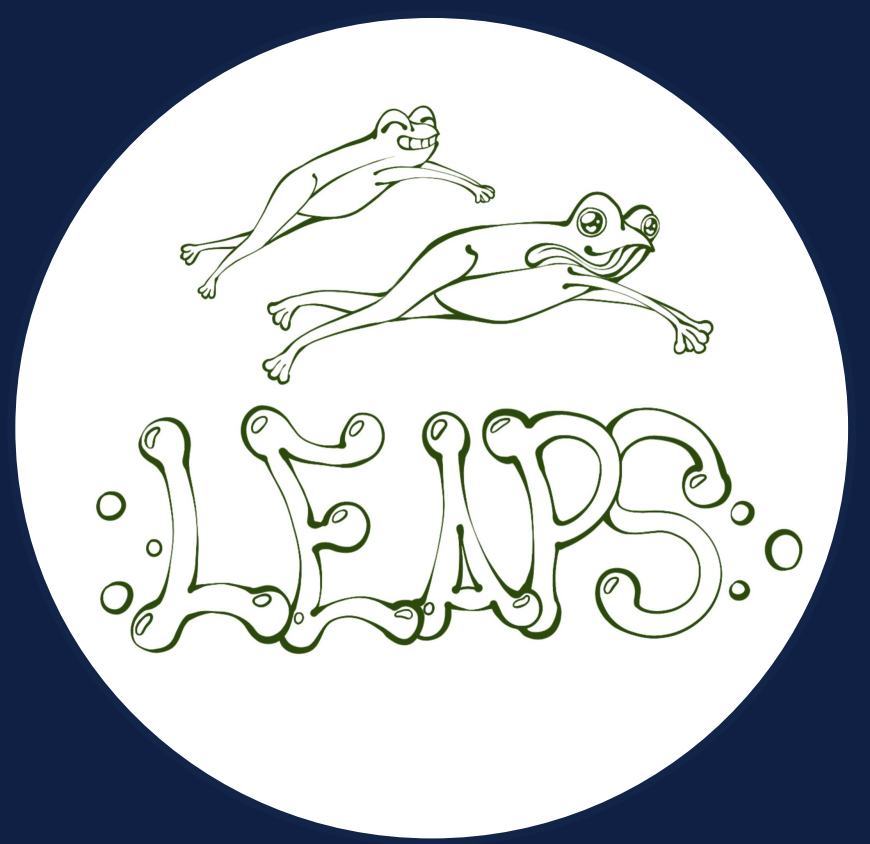

ACKNOWLEDGEMENTS

Exploring the Link Between Maternal Reminiscing and Executive Function: Implications for Children's School Readiness

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INTRODUCTION

- The preschool years are a particularly salient time for the development of core cognitive processes (Zelazo et al., 2003). Children's early socialization experiences also play an important role in preparing them for academic and socioemotional success (Sroufe et al., 2010).

- Executive function (EF) is a complex set of cognitive processes that are essential for goal-directed behavior and problem solving (Doebel, 2020) and support school readiness (Ahmed et al., 2019).

- Parents play an important part in children's learning and development through a number of ways.

- Research on maternal reminiscing has suggested that more elaborative conversational styles are related to the development of children's autobiographical memory, strategic memory, and other cognitive abilities (Langley et al., 2017; Fivush et al., 2006).
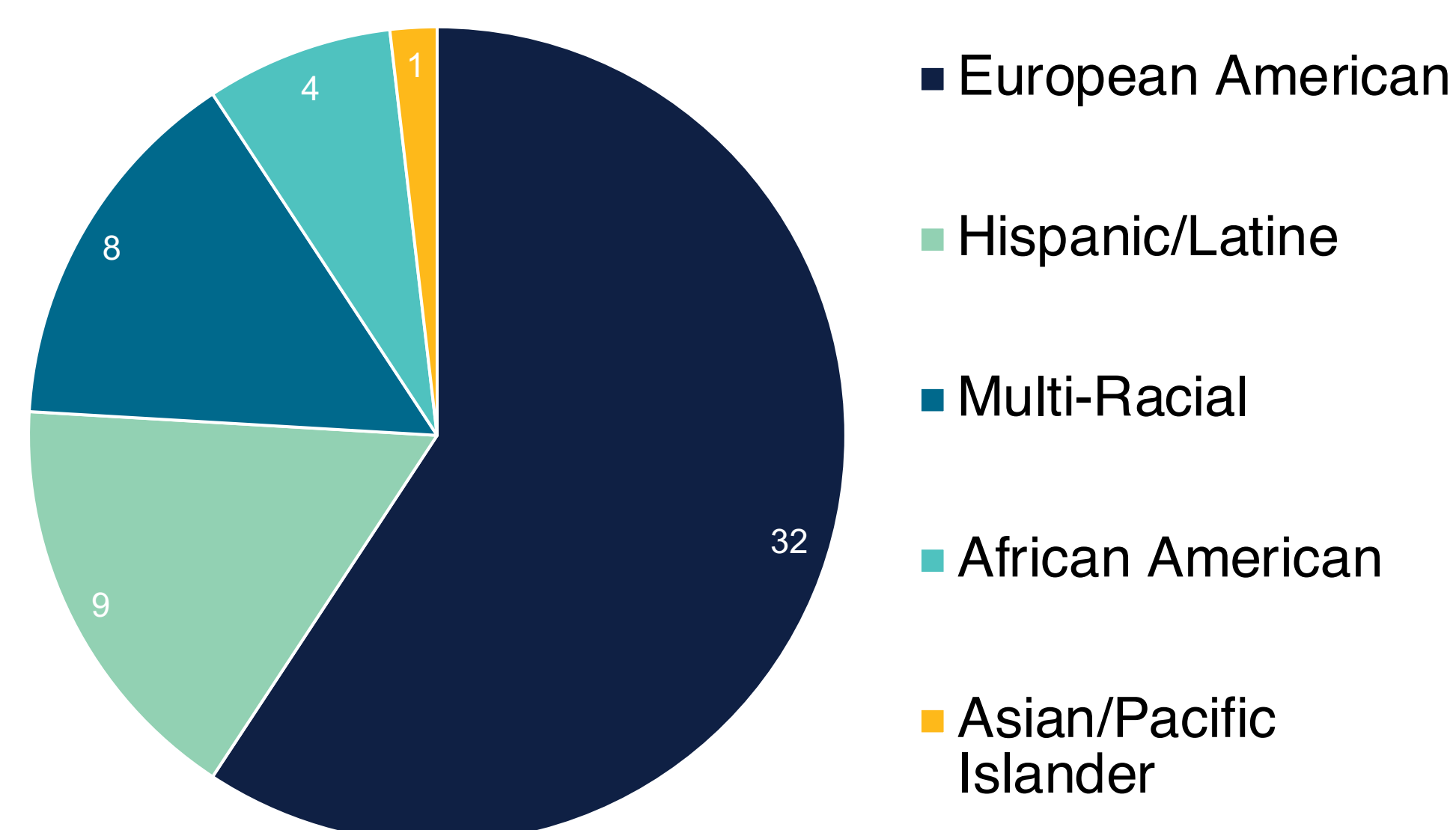
AIMS & METHODS

1. To examine the role of maternal reminiscing styles and children's executive function abilities in children's school readiness and academic achievement.

2. To determine if there is a unique contribution of maternal reminiscing styles and children's executive function abilities on children's school readiness and academic achievement.

Data for this study were drawn from a larger longitudinal study exploring self-regulation in early childhood.

PARTICIPANTS

- 54 mother-child dyads recruited from nine preschools in the southeastern United States

Pie chart values: 32, 9, 8, 4

- European American
- Hispanic/Latine
- Multi-Racial
- African American
- Asian/Pacific Islander

MEASURES

Maternal Reminiscing Elaborative Style

- Mothers and children discussed two shared experiences from the previous month.

- Mothers' speech was coded for the frequency of four types of speech across both events.

- A z-score was created for each code and then averaged to create a single composite (Langley et al., 2017).

Code	Definition
Elaboration	Statements/questions that provide the child with new information.
Associative Talk	Statements/questions not about the event but are related.
Confirmations	Statements that confirm or deny information provided by the child.
Metamemory Talk	Remarks about the process of remembering.

Executive Function

- Children completed a battery of four executive function assessments on a touch screen (Willoughby et al. ,2016). Tasks measured inhibitory control, working memory, and cognitive flexibility. For each task, they were given a score reflecting the percentage of correct responses.

- A composite score was created by averaging the children's scores across all four tasks.

Woodcock Johnson Letter Word Identification

- The Letter-Word Identification subtest assesses the ability to recognize and pronounce letters and words (Schrank et al., 2014).

- Scores reflect the number of correct responses.

Woodcock Johnson Applied Math Problems

- The Applied Math Problems subtest assesses one's ability to analyze and solve math problems (Schrank et al., 2014). .

- Scores reflect the number of correct responses.

Bracken School Readiness Assessment

- Children completed the BSRA, a standardized assessment that evaluates children on their foundational concepts of colors, letters, numbers/counting, sizes/comparisons, and shapes (Bracken, 2007).

- Scores reflect the number of correct responses across all subdomains.

DESCRIPTIVE STATISTICS

Variable	Min	Max	Mean	SD
Elaborative Style	-4.84	7.36	0.00	2.66
Executive Function	0.37	0.92	0.72	0.11
Parent Education	0	6.00	4.59	1.65
Bracken School Readiness	36.00	84.00	68.46	10.78
WJ Letter Word Identification	2.00	38.00	16.13	7.40
WJ Applied Math Problems	6.00	24.00	16.67	4.23

MULTIPLE LINEAR REGRESSION RESULTS

Variable	t	SE B	β	F	df	Adj. R²
Bracken School Readiness						
Overall Model				8.34	3	0.39
Elaborative Style	2.29	0.45	1.02*			
Executive Function	4.17	12.62	52.66**			
Parent Education	0.97	1.05	1.03			
WJ Letter Word Identification						
Overall Model				6.00	3	0.30
Elaborative Style	0.83	0.42	0.35			
Executive Function	3.85	11.90	45.80**			
Parent Education	0.99	0.99	0.98			
WJ Applied Math Problems						
Overall Model				4.20	3	0.22
Elaborative Style	2.58	0.19	0.49*			
Executive Function	0.94	5.39	5.04*			
Parent Education	2.13	0.45	0.96			

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

RESULTS

- Maternal elaborative style and children's executive function uniquely predicted children's school readiness scores after controlling for parents' education.

- Maternal elaborative styles and children's executive function were both uniquely and positively associated with children's applied problems achievement after controlling for parents' education.

- Only children's executive function was associated with children's letter-word achievement.

Path diagram:

Elaborative Style → Bracken School Readiness: $\beta=1.02^*$
Executive Function → Bracken School Readiness: $\beta=52.66^{**}$
Elaborative Style → WJ Applied Word Problems: $\beta=0.49^*$
Executive Function → WJ Applied Word Problems: $\beta=5.04^*$
Executive Function → WJ Letter Word identification: $\beta=45.80^{**}$
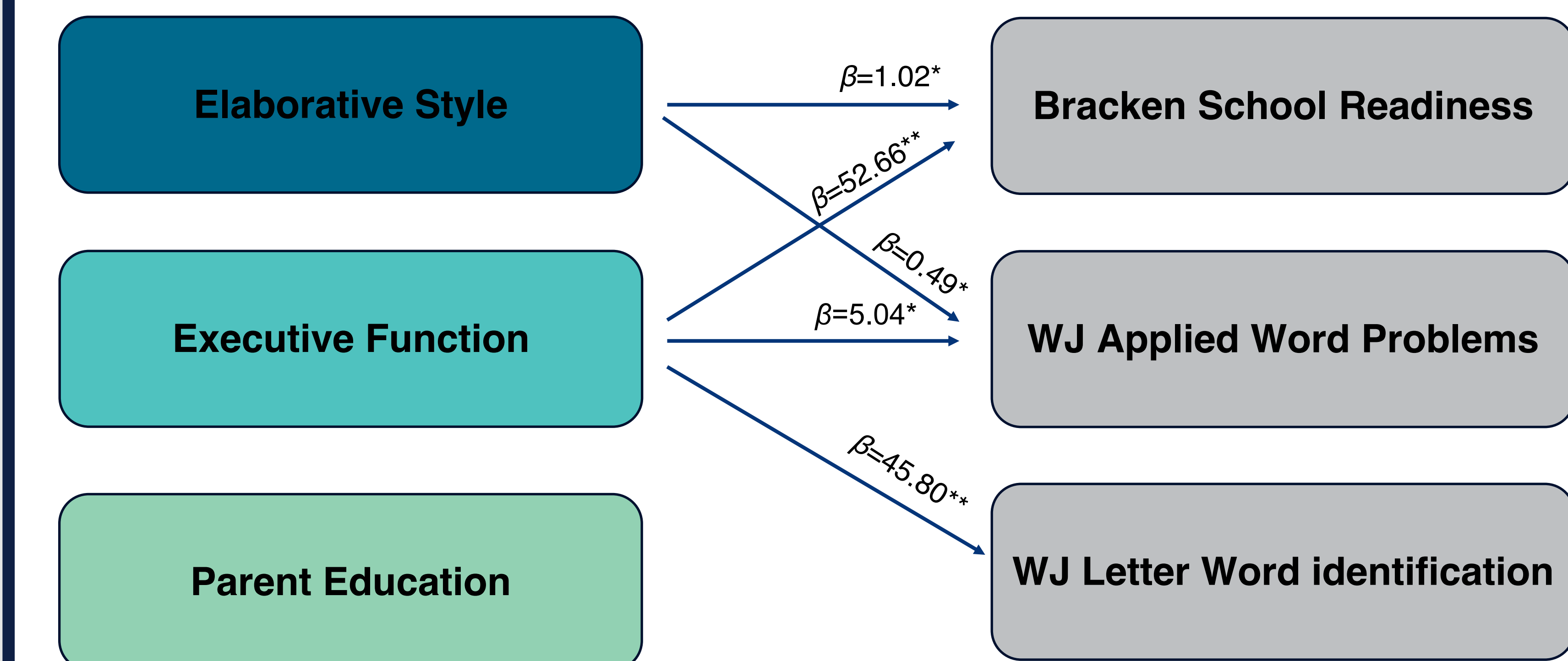
Parent Education

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

DISCUSSION

- High elaborative reminiscing styles may play an important role in children's school readiness and achievement above and beyond the effects of parents' education and children's executive function abilities

- Future research could address the role of reminiscing style of other individuals in the child's environment such as fathers, teachers, or other caregivers.

- Researchers should also explore how conversational exchanges in other contexts (e.g., preschools) support the development of EF and children's school readiness.
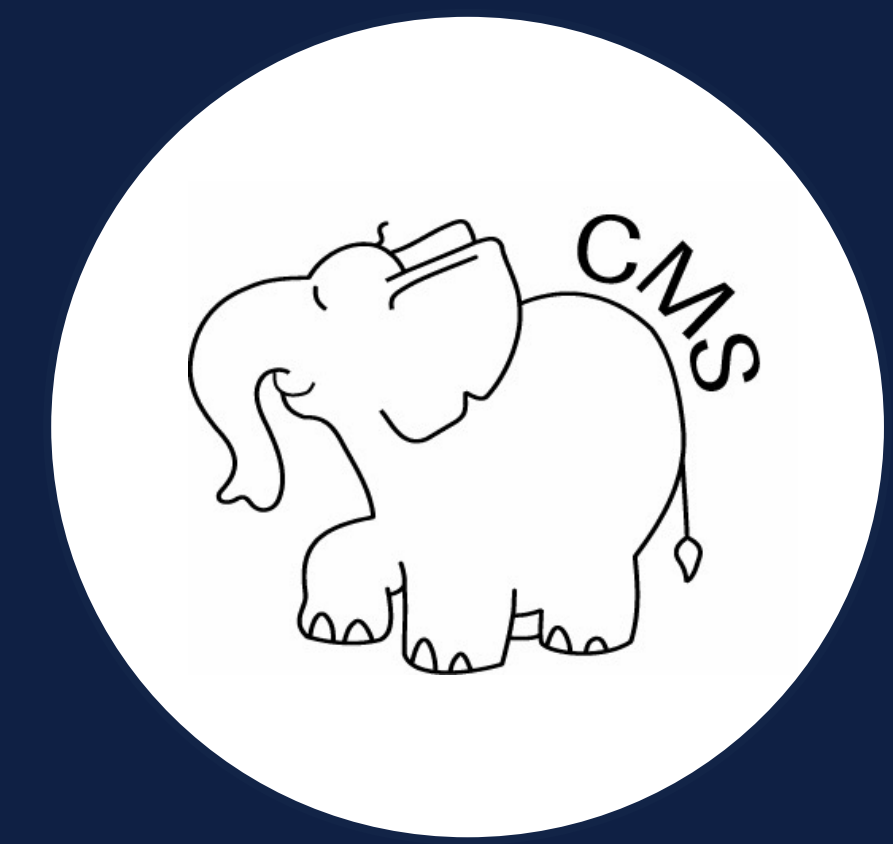
ACKNOWLEDGEMENTS

Memory in the Classroom: The Role of Kindergarten and First-Grade Teachers' Instructional Language

Amber E. Westover[1], Olivia K. Cook[2], Jennifer L. Coffman[1], and Peter A. Ornstein[3]

University of North Carolina at Greensboro[1], Florida State University[2], University of North Carolina at Chapel-Hill[3]

INTRODUCTION

- Across elementary school children improve in their use of deliberate memory strategies (Schneider & Ornstein, 2015).

- There are established linkages between early elementary classroom experiences and children's growth in these skills (see Ornstein & Coffman, 2020).

- Longitudinal studies indicate that teachers' use of Cognitive Processing Language (CPL) in kindergarten and first grade is predictive of children's use of strategic sorting (Coffman et al., 2008, 2025).

- No studies have explored how children's exposure to CPL across multiple school years—both uniquely and interactively—relates to the development of memory skills.

AIMS & METHODS

- This study was designed to explore the unique and interactive effects of children's exposure to CPL in both kindergarten and first grade on their strategic sorting.

- Data for this study were drawn from the first cohort of a longitudinal study of children's memory and cognitive skills during early elementary school.

- Child- and teacher-level measures were collected across kindergarten and first grade. Children were assessed using a battery of tasks three times each year.

PARTICIPANTS

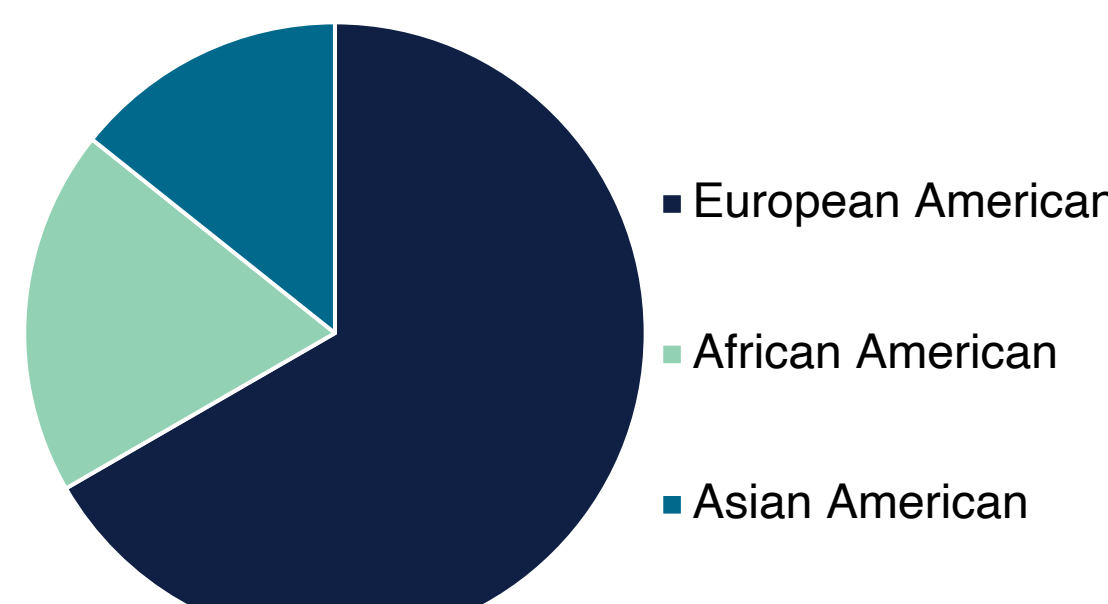Participants were drawn from 3 schools in 1 school district in a southeastern U.S. state.

Children

- 62 children
- 32 girls, 30 boys
- Average age at fall timepoint: 5 years 9 months (4y 11m – 6y 5m)

■ European American
■ Multiracial
■ Asian American
■ African American
■ Unreported
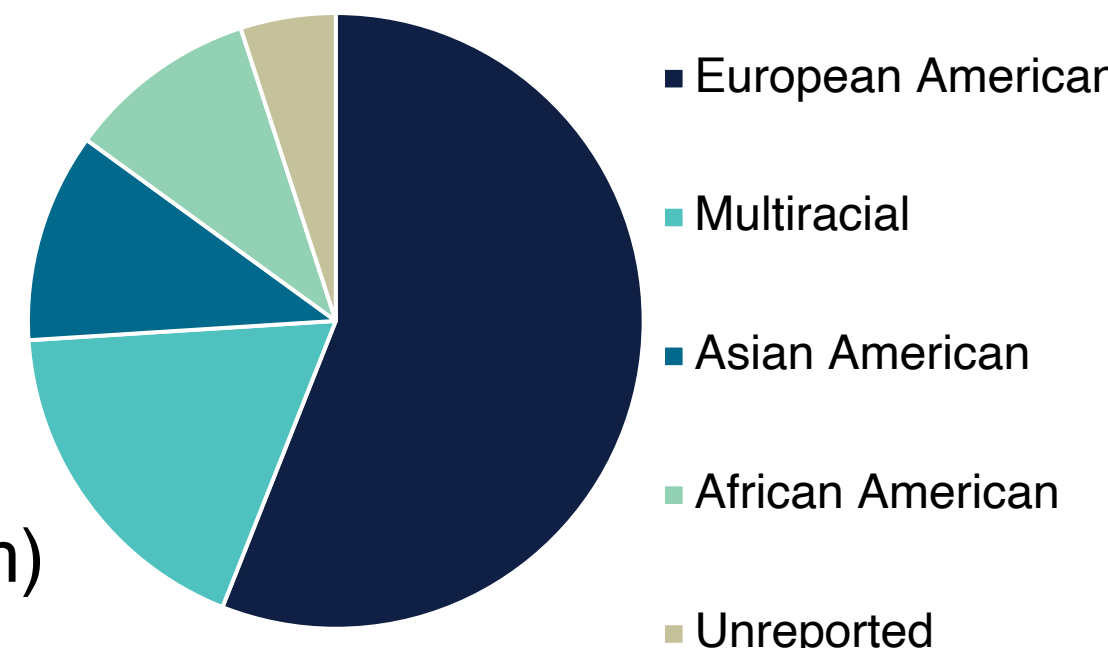
Teachers

- 10 kindergarten
- 11 first grade
- All female

■ European American
■ African American
■ Asian American

MEASURES

Free Recall with Organizational Training Task

- Children were asked to study and remember 16 drawings (4 categories; Moley et al., 1992).

- In the fall, both their baseline sorting and uptake of training (generalization) were measured.

- At the winter and spring timepoints, children completed a single trial with no strategy training.

- Strategic sorting was measured using an Adjusted Ratio of Clustering (ARC) score (Roenker et al., 1971). Scores range from 0 (chance sorting) to +1 (perfect sorting).

Attentional and Inhibitory Control

- Kindergarten teachers completed a subset of questions from the CBQ-SF (Putnam & Rothbart, 2006) rating children's attentional focusing and inhibitory control on 9 items from 0 (extremely untrue) to 6 (extremely true).

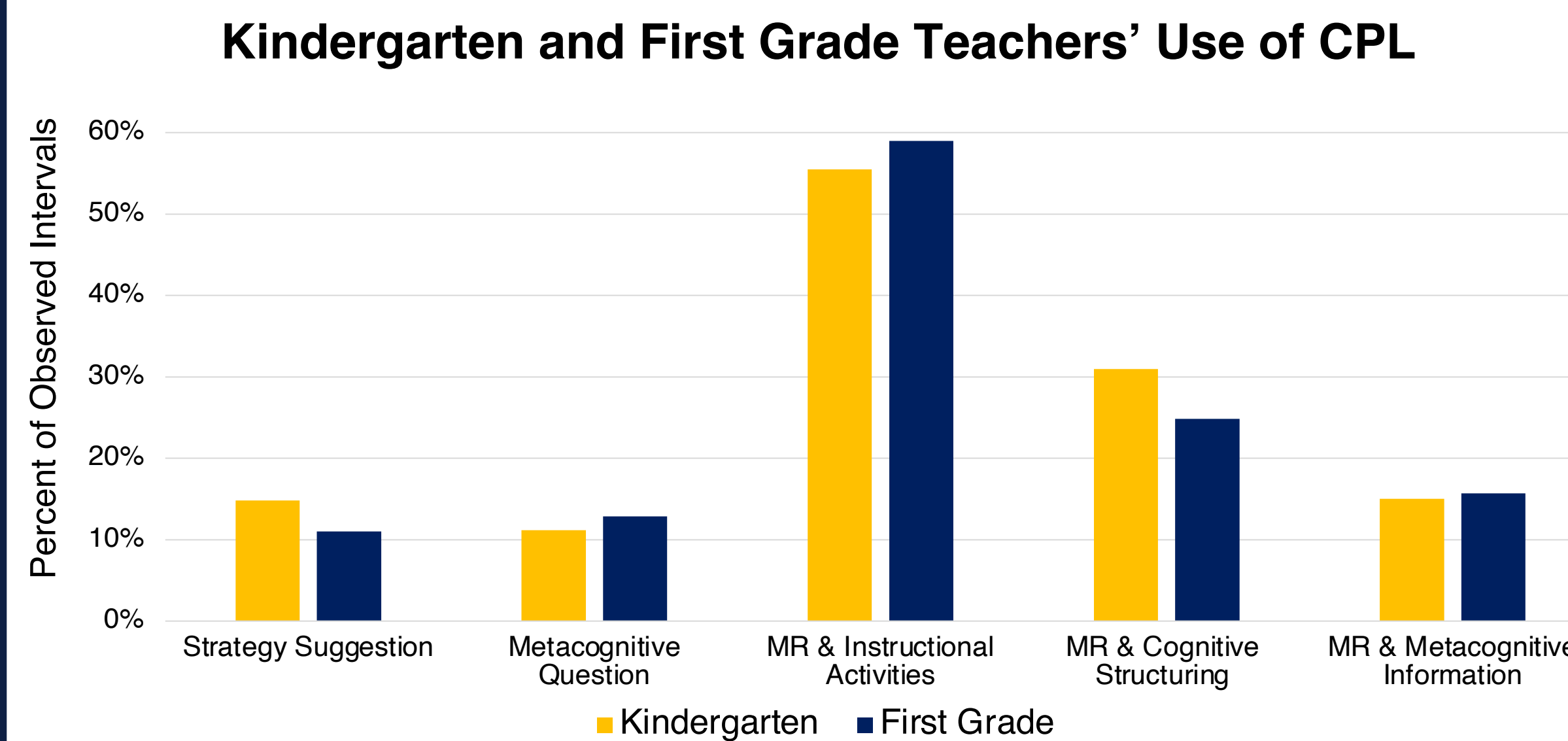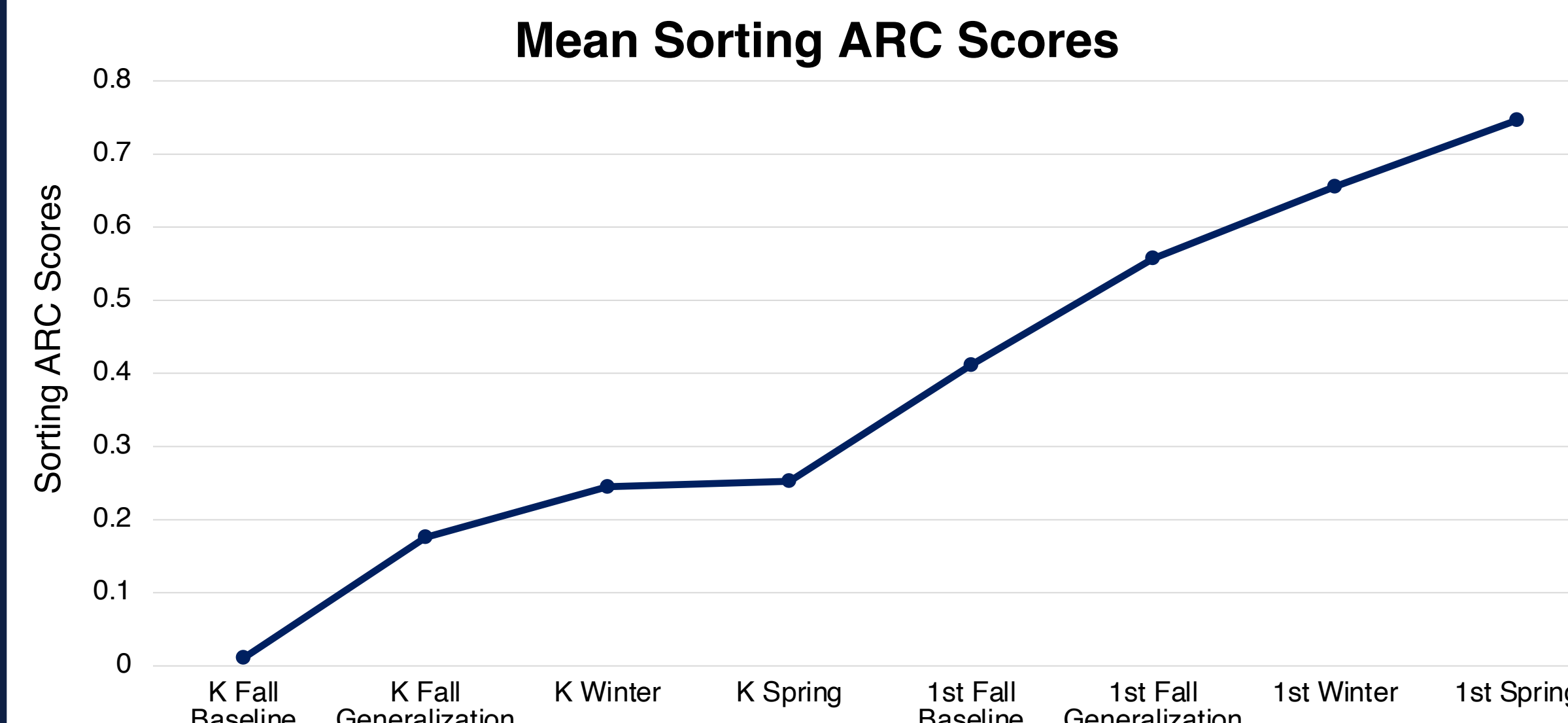- Scores reflect the average rating across all questions.

Cognitive Processing Language (CPL)

- A total of 120 minutes of whole-class instruction was videotaped and coded for the presence of 26 behaviors.

- A composite index of Cognitive Processing Language (CPL) was created using a subset of five codes:

Code	Definition
Strategy Suggestion	Recommending that a child adopt a procedure for remembering or processing information
Metacognitive Question	Requesting that a child provide a potential strategy, a utilized strategy, or rationale for a utilized strategy
Co-occurrence of Memory Requests and Instructional Activities	Requesting information from children's memory while also presenting instructional information
Co-occurrence of Memory Requests and Cognitive Structuring Activities	Requesting information from children's memory while simultaneously facilitating encoding and processing by focusing attention or organizing materials
Co-occurrence of Memory Requests and Metacognitive Information	Requesting information from children's memory while providing or soliciting metacognitive information

- A *T* score was calculated for each component using the grade-level mean and standard deviation. The five scores were then averaged to create a CPL composite index.
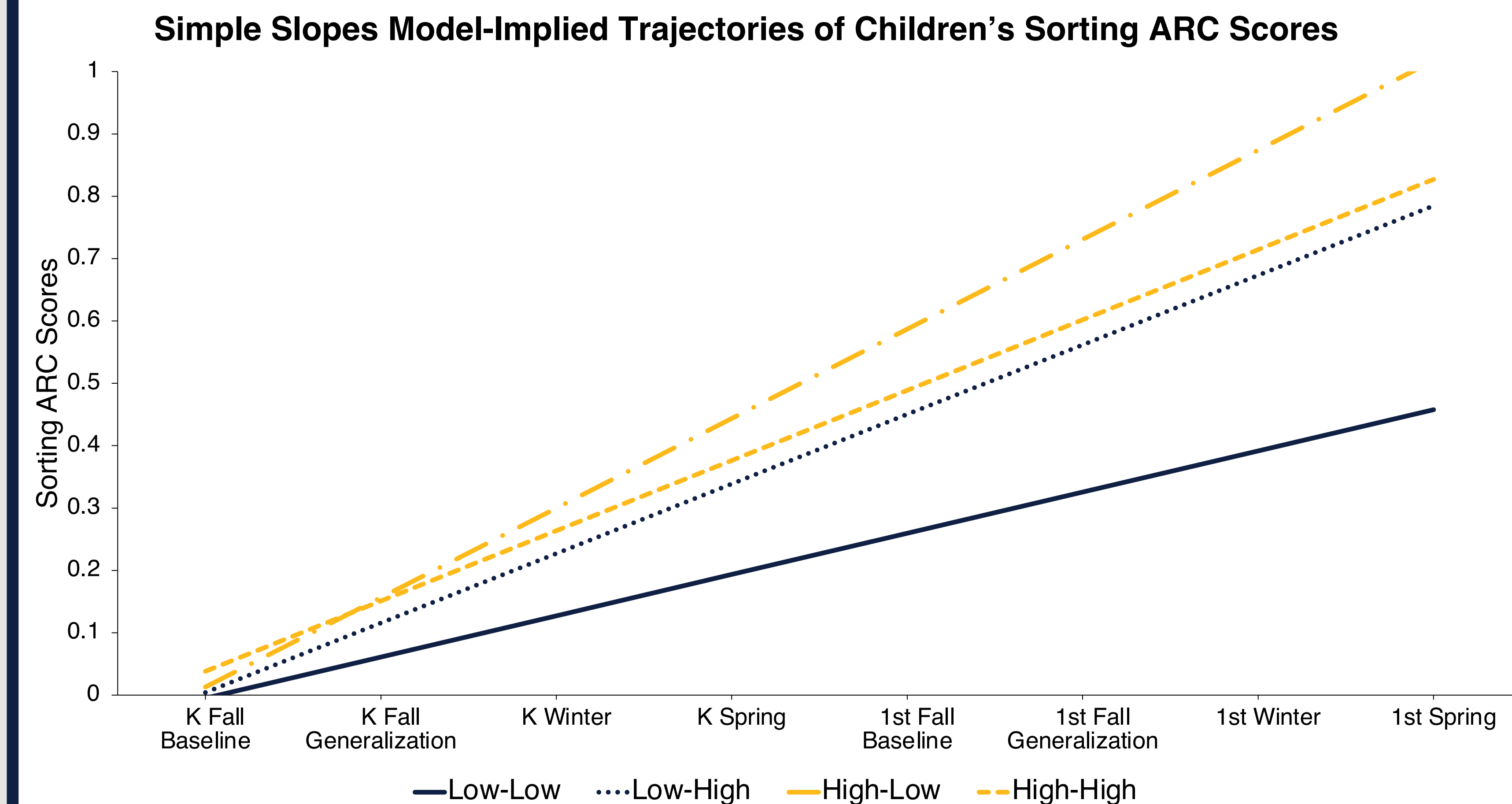
DESCRIPTIVE STATISTICS

Mean Sorting ARC Scores

Kindergarten and First Grade Teachers' Use of CPL

■ Kindergarten ■ First Grade

- Teachers' CPL ranged from $38.44 – 61.15$ ($M = 50$, $SD = 7.56$) in kindergarten and $38.88 – 60.12$ ($M = 50$, $SD = 6.61$) in first grade.

MULTILEVEL MODEL RESULTS

Parameter	Coefficient	SE	t/z	p	95% CI Lower	95% CI Upper
Fixed Effects						
Intercept	0.77	0.05	14.70	<.001	0.67	0.88
Slope	0.11	0.01	14.20	<.001	0.09	0.12
A/I Control	0.04	0.04	1.02	.31	-0.04	0.12
K CPL	**0.02**	**0.01**	**2.49**	**.02**	**0.004**	**0.04**
1st CPL	0.01	0.01	0.64	.53	-0.01	0.02
K CPL *1st CPL	**-0.003**	**0.001**	**-2.10**	**.04**	**-0.006**	**-0.0001**
A/I Control*Slope	0.004	0.01	0.72	.47	-0.01	0.02
K CPL*Slope	**0.003**	**0.001**	**2.27**	**.02**	**0.0004**	**0.01**
1st CPL*Slope	0.001	0.001	0.47	.64	-0.002	0.003
K CPL*1st CPL *Slope	**-0.0004**	**0.0002**	**-2.16**	**.03**	**-0.001**	**-0.00004**
Random Effects						
Intercept	0.13	0.03	4.13	<.001		
Slope	0.002	0.001	3.75	<.001		

- Children's experience with CPL in kindergarten, but not first grade, was a significant predictor of their intercept and slope.

- The interactive effect between kindergarten and first grade CPL, although small, was significant and negative for both outcomes.

SIMPLE SLOPES RESULTS

Simple Slopes Model-Implied Trajectories of Children's Sorting ARC Scores

—Low-Low ····Low-High —High-Low —High-High

Note. $+1 SD$ was used for the High and $-1 SD$ was used for the Low.

- Children who received two years of low levels of CPL instruction displayed the least strategic performance at the end of first grade and had the slowest rate of growth.

- Children exposed to high levels of CPL in kindergarten but low levels in first grade had the highest scores and made the fastest growth in these skills.

- For the other two CPL combinations, children used high levels of sorting at the end of first grade and showed similar rates of change across the two years.

DISCUSSION

- These findings underscore the importance of the timing of exposure to metacognitively rich instruction and suggest that exposure to higher levels of CPL may be most beneficial when received early (i.e., during kindergarten).

- The negative interaction effect also indicates that there is not an additive benefit of receiving higher levels of CPL instruction across two, consecutive school years.

- However, exposure to higher levels of CPL in first grade may be more beneficial for children who experienced lower levels of CPL in kindergarten.

- Future research should explore which specific components of CPL are particularly relevant for children's memory skills and how classroom experiences interact with child-level abilities.
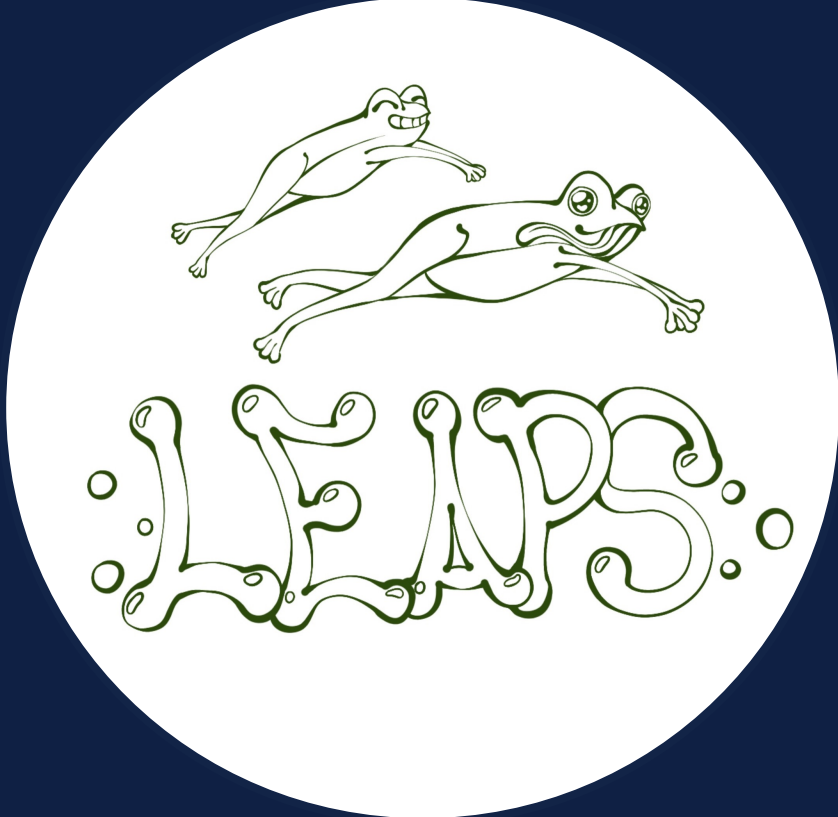
ACKNOWLEDGEMENTS

Remembering Together: Effects of Maternal Reminiscing on the Development of Child Attentional, Inhibitory, and Emotional Regulation

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INTRODUCTION

- Early childhood self-regulation is essential for school readiness (Blair & Raver, 2015).

- Self-regulation influences a range of outcomes including academic achievement, mental health, and social emotional development (Eisenberg et al., 2010).

- Maternal elaborative reminiscing may provide scaffolding for developing regulatory skills (Fivush & Sales, 2006).

- Exploring specific mechanisms that might support regulatory development could identify concrete strategies to help children prepare for kindergarten entry (Moffitt et al., 2011).

RESEARCH AIM

The primary research aim was to explore links between maternal reminiscing and child regulation—while controlling for maternal education—across three outcomes:

1. Inhibitory Regulation
2. Attentional Regulation
3. Emotional Regulation

METHODS

- Data were drawn from a longitudinal study exploring early childhood cognitive abilities and maternal reminiscing practices in both home and school settings.

- Child and maternal measures were collected in the fall and spring of the preschool year.

PARTICIPANTS

- 54 mother-child dyads (drawn from a larger study).

- Recruited from 9 preschools (6 private, 3 Head Start) in the Southeastern United States.

- The average level of maternal education was a master's degree.

- Student race or ethnicity was reported by parents: European American (n=32), Hispanic/Latine (n=9), Multi-Racial (n=8), African American (n=4), and Asian/Pacific Islander (n=1).

MEASURES

Head Toes Knees Shoulders (HTKS)

- HTKS is a child behavioral task measuring inhibitory control. Children were asked to respond oppositely to behavioral prompts.

- 20 trials with possible scores of 0-2. Total possible scores range from 0-40 (Ponitz et al., 2009).

Preschool Self-Regulation Assessment (PSRA)

- An assessor rated child self-regulatory abilities while completing a series of tasks.

- A composite score was averaged from 16 items. Possible scores ranged from 0-3, with higher scores indicating higher regulation (Smith-Donald et al., 2007).

Lock Box Task

- Children attempted to open a box containing a toy with keys that did not fit the lock.

- A global experimenter rating of child emotional regulation ranges from 0-4 (Goldsmith et al., 1995).

Maternal Education

- Parents reported their education on a scale of 0-6.

- 0 = high school or less, 6 = PhD, MD, JD etc.

Mother-Child Reminiscing Task (MRM)

- Mothers verbally guided children through remembering two shared novel events.

- Their conversation was coded for the frequency four types of maternal language across the two events:

Code	Definition
Elaboration	Statements/questions that provide the child with new information about the events.
Associative Talk	Statements/questions not about the event but are related.
Confirmations	Statements that confirm or deny information provided by the child.
Metamemory Talk	Remarks about the process of remembering.

- A z-score was created for each code, then a composite index was made by averaging the four z-scores (Langley et al., 2017).

- The index reflects a continuous range of reminiscing styles.

RESULTS

Descriptive Statistics

Variables	N	Min	Max	Mean	SD
MRM	54	-4.83	7.36	0	2.66
Maternal Ed	43	2.00	6.00	5.12	0.98
HTKS	51	0	36	19.25	11.42
PSRA	53	1.31	3.00	2.51	0.41
Lock Box	36	0	4.00	2.22	0.87

Correlations

Variable	1	2	3	4	5
1. HTKS	1.0	0.29*	-0.28	0.46**	-0.071
2. PSRA	0.29*	1.0	-0.16	0.32*	0.08
3. Lock Box	-0.28	-0.16	1.0	-0.02	-0.17
4. MRM	0.46**	0.32*	-0.02	1.0	0.02
5. Maternal Ed	-0.07	0.08	-0.17	0.02	1.0

*$p < .05$. **$p < .01$. ***$p<.001$

Multiple Regression: HTKS

Variable	B	SE B	β	R^2	ΔR^2
Step 1				0.005	0.005
Constant	22.99	10.46			
Maternal Ed.	-0.88	1.99	-0.07		
Step 2				0.26	0.25***
Constant	23.09	9.16			
Maternal Ed.	-0.68	1.74	-0.06		
MRM	2.55***	0.72	0.50***		

Note. HTKS=children's inhibitory control scores; MRM=maternal reminiscing score, *$p < .05$. **$p < .01$.***$p<.001$

Multiple Regression: PSRA

| Variable	B	SE B	β	R^2	ΔR^2
Step 1				0.006	0.006
Constant	14.32	3.12			
Maternal Ed.	0.08	1.92	0.008		
Step 2				0.10	0.09*
Constant	11.54	2.87			
Maternal Ed.	0.054	1.62	0.007		
MRM	0.32*	0.06	0.65*		

Note. PSRA=children's attentional control scores; MRM=maternal reminiscing score, *$p < .05$. **$p < .01$.***$p<.001$

Multiple Regression: Lock Box Task

Variable	B	SE B	β	R^2	ΔR^2
Step 1				0.03	0.03
Constant	9.87	2.87			
Maternal Ed.	-0.17	1.75	-0.05		
Step 2				0.06	0.03
Constant	8.65	2.42			
Maternal Ed.	-0.15	1.52	-0.04		
MRM	-0.07	0.07	-0.18		

Note. Lock Box Task=emotional regulation scores; MRM=maternal reminiscing score, *$p < .05$. **$p < .01$.***$p<.001$

RESULTS CONTINUED

MRM → HTKS β=0.50***

MRM → PSRA β=0.65*

Maternal Education

Lock Box Task

*$p < .05$, **$p <.01$
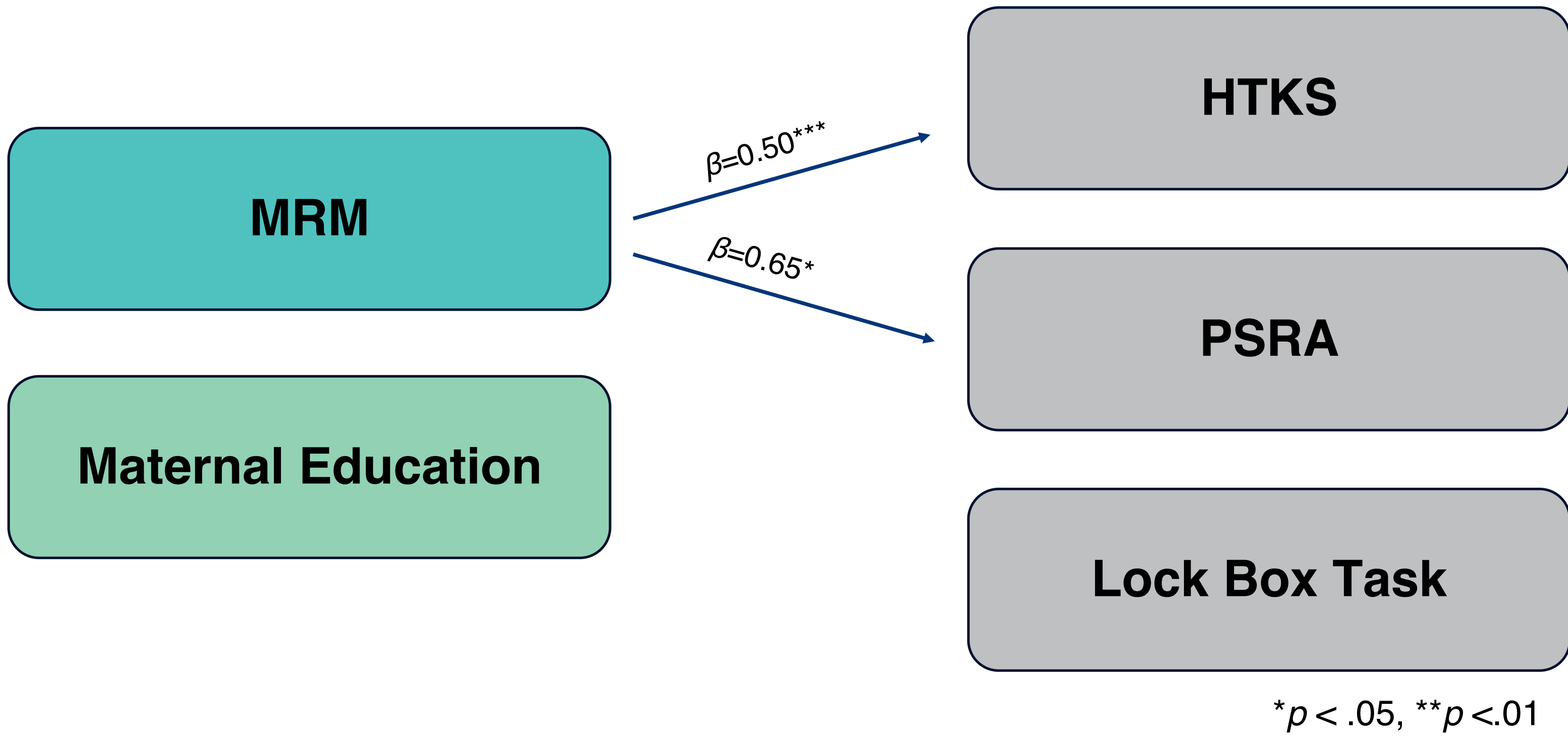
- Maternal education level was not predictive of child self-regulation outcomes.

- Maternal reminiscing is predictive of child attentional and inhibitory regulation.

- No link was found between maternal reminiscing and emotional regulation.

DISCUSSION

- Mother-child reminiscing may support the development of self-regulation in ways that will prepare children for entry into formal school.

- Future directions should include samples with more diverse cultural and SES representation.

- Longitudinal studies could track self-regulation and development over time in both home and school contexts.

- A focus on emotion-related reminiscing could highlight effects of emotion labeling and other emotion-related discussions during mother-child reminiscing exchanges.

- Exploring the role of fathers or other non-parental caregivers during reminiscing could also be beneficial.

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