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Children enter kindergarten with a variety of experiences and skills. In this transition to formal school, they are expected to adapt quickly to new demands such as remembering specific pieces of information, knowing when to retrieve this information, and understanding how to use this information to complete specific tasks. These skills have been referred to as children's *deliberate memory* skills and are thought to serve children's long term academic success. However, limited research has focused on specific aspects of children's everyday contexts that play a role in the development of these skills – such as adult-to-child language exchanges in home and school settings. Therefore, the goals of the current study were to (a) understand the role of children's every day, lived experiences such as parent–child reminiscing and teacher–child linguistic exchanges (i.e., *cognitive processing language* in classrooms) on the initial acquisition and sustained use of mnemonic strategies across the kindergarten and first-grade years, and (b) describe the *interplay* between individual-level factors – such as other components of children's cognition – and these adult-to-child scaffolding practices on children's memory development.

Drawing on a sample of 79 children nested in 10 kindergarten classrooms, children's deliberate memory skills were assessed at 6 timepoints from kindergarten entry to the end of first grade. Kindergarten teachers' instruction was recorded using GoPro cameras during regular mathematics and language arts lessons; these recordings were subsequently coded for the prevalence use of *cognitive processing language* (Coffman et al., 2008; 2019). Parent–child dyads took part in a parent-child reminiscing task in which they were asked to reminisce about two recent events. Conversations were coded for parents' *elaborative reminiscing style* (Reese et al., 1993; Langley et al., 2017). Finally, children's executive function and self-regulation skills were assessed during the kindergarten year using the Dimensional Change Card Sort Task (Zelazo, 2006) and the Head Toes Knees Shoulders Task, (Ponitz et al., 2009; McClelland et al., 2014) respectively. Results from a series of growth curve models using a multilevel modeling framework revealed significant predictors of children's deliberate memory skills at the start of kindergarten and at the end of first grade, as well as of the *rate* at which changes in these skills occurred as a function of home-, school-, and individual-level factors. First, although children of parents with high levels of elaborative reminiscing entered kindergarten with higher levels of deliberate memory skills, it was children who had parents who used lower levels of elaborative reminiscing who developed more rapidly over the course of the kindergarten and first grade years. Second, children who were exposed to teachers who used higher levels of cognitive processing language (CPL) in kindergarten developed strategic sorting skills *more rapidly* over the course of first grade and ended the year with higher levels of deliberate strategy use than their peers who were exposed to lower levels of cognitive processing language. Finally, for children with lower self-regulation skills, those exposed to higher levels of CPL in kindergarten evidenced higher levels of deliberate strategy use at the end of first grade than their peers who were exposed to lower levels of CPL. Taken together, these findings provide insight to the role of parent-child and teacher-child processes on the development of children's deliberate memory skills during the first two years of elementary school. Strengths, limitations, and future directions for researchers and educators are discussed.

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EFFECTS OF HOME-, SCHOOL-, AND INDIVIDUAL-LEVEL FACTORS ON CHILDREN'S DELIBERATE MEMORY DEVELOPMENT IN ELEMENTARY SCHOOL

by

Olivia K. Cook

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CHAPTER I: INTRODUCTION

Children enter kindergarten with a variety of experiences and skills. In this transition to formal school, they are expected to adapt quickly to new demands such as remembering specific pieces of information, knowing when to retrieve this information, and understanding how to use this information to complete specific tasks. For this reason, developmental scientists have examined children's *deliberate memory* skills, specifically their ability to successfully employ mnemonic strategies in service of remembering (see Best & Folds-Bennet, 2021, for a review)—as these skills are thought to underlie learning and problem-solving across the lifespan, in both academic and "real world" contexts. Children as young as 2 years old can use rudimentary memory strategies (Deloache et al., 1985) and their use of rehearsal and organizational strategies for remembering information has been shown to increase dramatically as they progress through school contexts (Ornstein, 1978). Indeed, a rich literature has suggested that age-related changes in children's cognition may not be the only contributor to the refinement of these skills (Bjorklund et al., 2009; Schneider & Ornstein, 2019). Paired with extensive research that highlights individual differences between children, key findings from research primarily conducted in the 20th century have set the stage for a new line of inquiry today: *what external factors may contribute to the development of children's memory development?*

Only recently have deliberate memory researchers worked towards examining contextual factors that may play a role in children's development. Foundational research in deliberate memory was conducted primarily in laboratory-based settings and focused on comparing age-related differences in children's memory cross-sectionally. It has since been suggested that, from a *developmental science* perspective, that contemporary studies examining children's memory development should provide both a characterization of children's intra-individual change in skills over time and the identification of possible mediators that could account for observed change in memory performance (Ornstein & Coffman, 2020). In order to do this, the simultaneous application of *information processing* theories of human cognition and *social constructivist* theories (that can account for the socialization of cognition) is necessary for extending the deliberate memory literature. In an important commentary on the current state of the deliberate memory literature at the time, Ornstein and Haden (2001) encouraged memory researchers to utilize perspectives of social constructivism (e.g., Vygotsky, 1978; Rogoff, 1981) to understand how cognition may develop as a function of *context*. Since then, two literatures have been merged to shed light on contextual predictors of memory development in early childhood: the work of Ornstein, Coffman, and colleagues has focused primarily on examining the role of *formal learning* environments – such as teachers' instructional language – and the work of Haden and colleagues has focused on the role of *informal* learning environments – such as parent–child conversations at home. Accordingly, the proposed study draws upon both literatures to inform hypotheses about children's memory development.

The first line of inquiry, focused on the role of the formal school experience (for a review, see Ornstein & Coffman, 2020), has demonstrated observational and experimental linkages between first-grade teachers' instructional language and longitudinal differences in children's deliberate memory skills across elementary school. This program of research was informed originally by cross-cultural studies that underscored the role of the Western-style formal school experience (e.g., Scribner & Cole, 1978; Wagner, 1979) as well as studies that employed a school-cut off design in order to delineate between age-related and broad schooling effects on children's cognition (e.g., Morrison et al., 1995). However, these foundational studies provided little information about what *specific aspects* of the schooling experience were relevant for children's skilled remembering. Therefore, Coffman and colleagues (2008) introduced a way to characterize elementary school teachers' memory-relevant scaffolding during whole-group instruction – known as *Cognitive Processing Language* (CPL). Although differences between teachers' CPL could account for differences in children's development of skills over time, existing studies were limited to questions of development spanning from first to fourth grade. Therefore, the work of Haden and colleagues – focused on informal learning through parent–child conversations – is important in terms of shedding light on children's memory during an earlier developmental period, prior to formal school entry.

This parallel literature on parent–child conversations about jointly experienced past events, otherwise known as mother–child reminiscing, has examined the ways in which parents scaffold children's episodic, autobiographical memory development (Fivush, Haden, & Reese, 2006). Indeed, a rich literature has documented linkages between parents' elaborative reminiscing style (e.g., providing factual details about past events, asking open-ended questions to children) and the level of detail that children recall about these events through both observational and experimental approaches (see Fivush et al., 2006, for a review). From the understanding that (a) deliberate and autobiographical memory share similar underlying processes of encoding, storage, and retrieval (Ornstein et al., 2006) and (b) both domains of memory are thought to be supported by adult-to-child talk, blending these two literatures has been identified as a clear next step for researchers.

Besides the work of Coffman, Ornstein, and colleagues, and that of reminiscing researchers like Haden, relatively little is known about how children's every day, lived experiences shape their cognitive development (Rogoff, 2018; Dahl, 2017). Except for one study (see Langley et al., 2017), researchers have yet to examine linkages between parent–child reminiscing and children's deliberate memory skills. Moreover, two gaps in the deliberate memory literature persist: (a) understanding the role of children's everyday, lived experiences such as parent–child reminiscing and teacher–child linguistic exchanges (i.e., cognitive processing language in classrooms) on the initial acquisition and long-term sustained use of mnemonic strategies across the kindergarten and first-grade years, and (b) describing the *interplay* between individual-level factors – such as other components of children's cognition – and these adult-to-child scaffolding practices on children's memory development. Therefore, three primary research questions will be posed to address these gaps:

1) How do children's deliberate memory skills develop across the kindergarten and first grade year as a function of their parents' early elaborative reminiscing style?

2) How do children's deliberate memory skills develop across the kindergarten and first grade year as a function of their kindergarten teachers' Cognitive Processing Language?

3) How is the association between teachers' CPL and children's deliberate memory skills moderated by children's self-regulated learning skills?

The current study aims to (a) draw upon two parallel literatures to provide a holistic understanding of children's memory development during the transition to formal school, (b) follow recommendations currently posed by deliberate memory scientists surrounding appropriate methodologies and lines of inquiry, and (c) model the use of a developmental theory that can examine the interplay of contextual and individual factors on children's development over time: Urie Bronfenbrenner's bioecological model of human development – otherwise known as the Process, Person, Context, Time (PPCT) model (Bronfenbrenner & Morris, 2006).

CHAPTER II: THEORETICAL FRAMEWORK

In 2001, Ornstein and Haden published a synthesis of research on memory development and commentary in *Current Directions in Psychological Science,* that 20 years later, is viewed as a touchstone in cognitive developmental science. In this publication, Ornstein and Haden (2001) referred to Flavell's (1971) symposium in which he posed the question, "What is memory development the development of?" Although this question ignited a vein of research that aimed to characterize age-related changes in memory skills, Ornstein and Haden (2001) argued that studies up until that point had examined children's *memory* development rather than the *development* of memory due to the mechanistic nature of the methods employed at the time. Later accepted as the new standard for work conducted in the 21st century, it was acknowledged that from a developmental-science perspective (e.g., Cairns, Elder, & Costello, 1996), the study of development requires longitudinal data and multilevel analyses that bridge methods and paradigms (e.g., information processing and social constructivism). With specific regard to studying the development of memory it has been recommended that studies include, "(a) a detailed characterization of children's skills at different ages, (b) an assessment of developmental change within individuals over time, and (c) an effort to identify mediators that can plausibly account for the observed changes in skill," (Ornstein & Coffman, 2020, p. 445).

In line with these suggestions, the proposed study aims to combine methodological approaches across paradigms and draws upon multiple theoretical perspectives, including information processing theory, social constructivist theory, and the bioecological model of human development. Therefore, the following chapter aims to provide a summary of theoretical perspectives traditionally applied in the deliberate memory literature, the recent extension of this literature to consider social constructivist approaches, and the suggested use of Urie Bronfenbrenner's Bioecological Model in the study of children's cognitive development.

The Use of Theory in Memory Development Literature

In the beginning of the 1960s, the study of developmental change in children's memory skills emerged as its own discipline separate from that of traditional psychology. Indeed, studies on children's memories can be found dated back to the origination of the scientific study of psychology at the end of the nineteenth century (Miller, 2014). However, the late arrival of studying the *development* of children's memory may be due in part to theoretical beliefs about the nature of memory as well as methodological limitations specific to research with children at the time. In the first decade of this new scientific discipline, memory development research was influenced by the information processing approach that was used to provide a detailed picture of age-related differences in children's memory skills (Schneider & Ornstein, 2015). In Newell and Simon's (1961) article in *Science*, it was argued that from an information processing perspective, humans were much like computers, or machines, that took information in a limited sensory storage, processed that information for short-term storage, and transferred that information to long-term storage where it could be later retrieved when needed. From here, the way in which "machines" could operate was further explored through a series of studies by memory researchers—highlighting predictors of information processing capacity such as processing speed as well as mediators between capacity and performance (i.e., memory strategies). Lines of inquiry examining the use of memory strategies to remember semantic information (e.g., rehearsal, organizational sorting and clustering) would later serve as the foundation for contemporary research on children's deliberate memory development.

One hypothesis grounded in information processing theory explored by developmental scientists was the idea that children's deliberate memory improves because their "capacity" to remember increases. Toward the end of the 20th century, researchers examined specific nonstrategic factors that could account for differences in memory performance, such as the *speed* of information processing (Dempster, 1985). Findings had highlighted that the amount of time needed to name or recognize to-be-remembered items decreased with age and this higher processing speed was subsequently linked with a larger memory capacity (Spring & Capps, 1974; Keating & Bobbitt, 1978; Case et al., 1982). The nature of these studies can be exemplified by one in which 5-year-old children were compared to adults in the rate of identifying stimuli (Chi, 1977). Unsurprisingly, children required more time to identify or recognize to-be-remembered stimuli and remembered fewer stimuli in recall. Today, the use of information processing terms such as "processing speed" and "capacity" are not used as frequently, and due to a more nuanced understanding of children's cognitive development, these terms have been augmented by constructs such as attentional control, higher-order thinking skills, and metacognitive understanding. However, these theoretically based findings have continued to serve as a foundation for questions today: *what individual-level factors may support or deter memory performance?*

By the 1970s, a consensus had been reached after the "cognitive revolution" in experimental psychology (see Miller, Galanter, & Pribram, 1960) that suggested that the development of memory could be viewed as reflecting changes in strategies – such as the use of rehearsal, organization, elaborations – (software in an information processing machine) and changes in the structures of memory stores (hardware) (e.g., Morrison, Holmes, & Haith, 1974; Ornstein, Naus, & Liberty, 1975). Despite the volume of research illustrating normative developmental change in children's memory skills (see Schneider & Ornstein, 2015 for a review), limited research has explored developmental variability in deliberate memory as a function of contextual factors. Because of this, the broader generalizability of these findings is unknown—a major limitation in the deliberate memory literature (Baker-Ward & Ornstein, 2014). Indeed, the emergence of this psychological subfield and growing acceptance of the information processing views of cognition were supported by a mechanistic worldview (Goldhaber, 2000).

In a separate but parallel literature, children's autobiographical memory—or the ability to encode, retrieve, and express personally experienced memories in narrative form—has been studied from a contextualist worldview (Goldhaber, 2000). Stemming from Nelson's (1986) work on children's "scripts", or generic representations in permanent memory that reflect rapidly acquired knowledge of everyday routines, a subsect of the memory literature formed that examined episodic and eventually autobiographical memory development emerged (Baker-ward & Ornstein, 2014). By understanding everyday experiences that scaffold the development of this type of memory (i.e., mother–child reminiscing conversations), this area of the literature uses a social constructivist lens to describe variability in developmental change over time (Vygotsky, 1978; Fivush, 2011).

It has been acknowledged continuously over the past 20 years that despite the extensive and widely applied research on children's deliberate, strategic memory (researched in laboratory settings) and the rapidly growing work on children's personal experiences observed in "the real world", there has been very little coordination between these literatures to provide a clear model for children's memory development (Baker-Ward, 1999; Ornstein & Staneck, 1998; Ornstein & Haden, 2001; Haden, 2021). For this reason, the next step for contemporary developmental scientists is to adopt more holistic and contextualized theories of human development (Rogoff, 2003; Rogoff, Dahl, & Callanan, 2018) that can allow for the simultaneous investigation of universal human characteristics and varied developmental niches. One theory that allows for this nuanced examination of human development is Urie Bronfenbrenner's bioecological theory.

A Theory of Human Development: The Bioecological Model

Before delving into the propositions and key components of Bronfenbrenner's bioecological model, it is important to distinguish Bronfenbrenner's theory as a theory of humans' developmental change over time. Indeed, researchers have expressed the need for transitioning from the practice of studying "*memory* development" to one that emphasizes "the *development* of memory", an endeavor that requires a multi-leveled approach and an integration of information processing and sociocultural perspectives (Ornstein & Haden, 2001; Haden, 2021). Bronfenbrenner's bioecological model, formerly referred to as the theory of human ecology, is a possible framework for memory researchers that considers the concerns raised by Ornstein and Haden (2001) and fits within a contextualist paradigm (Tudge, 2008). The parameters of contextualist theories such as this specify that emergent developmental outcomes are products of synergistically related factors that cannot be separated from one another (Pepper, 1942; Goldhaber, 2000). Despite Bronfenbrenner's highly cited (1979) book that emphasized contextual influences on development, the bioecological theory has since been expanded to include elements of person characteristics, proximal processes, context, and time (Bronfenbrenner, 1995). In its most mature form, the bioecological model is referred to as the PPCT model—reflecting the four key elements of *process, person, context,* and *time*—specified by Bronfenbrenner and Morris (2006).

One of the principal components of Bronfenbrenner's PPCT model is the first P, or *proximal processes*. Notably the most important element of the model, proximal processes are often referred to as "the engines of development" (Bronfenbrenner & Evans, 2000) as they encompass particular forms of interaction between individual and environment. Bronfenbrenner refers to proximal processes as every day and frequent interactions between the developing person of interest and another person, object, or symbol (Bronfenbrenner & Morris, 2006). These interactions are thought to be reciprocal in nature and become increasingly more complex over time (Bronfenbrenner & Morris, 1998). Moreover, the direction, form, and power of these proximal processes are directly influenced by the remaining components of the PPCT model—person, context, and time. Some common examples of proximal processes discussed by Bronfenbrenner are feeding or comforting a baby, playing with a young child, child–child activities, group or solitary play, and performing complex tasks (Bronfenbrenner & Morris, 2006). Within the context of autobiographical memory development, a particularly salient process for children's memory development is parent–child conversations about shared past events, or mother–child reminiscing (Reese, Haden, & Fivush, 1993). In the deliberate memory literature, salient processes that scaffold deliberate memory outcomes, such as strategy use and recall, can include teacher–child interactions and conversations (proximal processes with another person) as well as children's interactions with materials and activities that regularly challenge and support deliberate memory skills (proximal processes with objects or symbols).

The second component of the PPCT model is the second P, or the role of *person* characteristics on the power, direction, and form of proximal processes. Types of person characteristics include *demand characteristics* (e.g., skin color, facial appearance, gender, degree of attractiveness), *resource characteristics* (e.g., past experiences, skills or abilities, physical and/or mental health), and *force characteristics* (e.g., motivation, persistence, responsiveness to others) (Tudge, Merçon-Vargas, & Payir, 2022). As outlined in Proposition 2 of Bronfenbrenner and Morris's (2006) publication, proximal processes are systematically impacted as a joint function of the characteristics of the *developing person of interest* and the environment. In the deliberate memory literature, the importance of individual-level factors on the development of deliberate remembering can be traced back to Flavell's (1971) symposium entitled "What is Memory Development the Development of?" This symposium opened up a new vein of research focused on understanding the role of cognitive resources relative to the functions of memory, particularly strategy use (Ornstein & Schneider, 2019). Even then, researchers recognized that individual factors—such as motivation, prior knowledge, and metamemory—in combination with contextual factors—such as task demands and situational conditions—likely contribute to the effectiveness of children's strategy use and their developmental trajectories (e.g., Bjorklund, 1990; Schneider & Ornstein, 2015). Today, this area of inquiry remains relatively unexplored but now has the potential to be empirically tested through contemporary research design and advanced statistical analyses previously unavailable.

Although listed third in the acronym PPCT, *context* is arguably the first term that comes to mind when the name Bronfenbrenner is mentioned—so much so that many researchers have treated the bioecological model as solely that of contextual influence on development (Tudge et al., 2009; 2016). Indeed, the initial phase of Bronfenbrenner's development of the bioecological model defined multiple levels of context. At the center of these levels of context is the *microsystem:* the immediate environment in which individuals exist and engage in proximal processes (e.g., the home, school, or work environment). The *mesosystem* is the second level of context that describes the interaction between two microsystems (e.g., relations between home and school on a developing child) (Bronfenbrenner, 1999). The third level of context is the *exosystem*. Contrary to popular belief, the exosystem does not surround the micro- and mesosystem and it is not the context in which the individual is situated, but rather that of those who interact with the individual are located (e.g., for a developing child, this would be a parent's workplace). Finally, the *macrosystem* refers to values, beliefs, practices, and access to resources—all of which indirectly influence proximal processes. The investigation of contextual influence on children's memory performance in the deliberate memory literature can be illustrated by a number of studies examining conditional differences between laboratory-based memory tasks on children's recall performance. One study by Ornstein & Corsale (1979) highlighted that during a sort-recall task, when third graders were instructed to sort items into meaning-based groups (but unaware they would need to remember the items for later recall), they remembered more items than their peers who were instructed to form random groupings and were explicitly told that they would need to remember the items. Third graders in the meaning-making group recalled as many items as did seventh graders in the study, indicating that specific situational conditions can play a significant role in children's memory performance. Researchers in the deliberate memory field have used foundational studies such as this, paired with cross-cultural work highlighting the role of formal school on children's memory and broader cognitive skills (Scribner & Cole, 1978; Wagner, 1978), to inform a new line of research that examines specific aspects of the classroom environment that are relevant for children's memory development (see Coffman & Cook, 2021 for a review).

The remaining letter in PPCT stands for *time* and Bronfenbrenner delineated it as being comprised of three types: micro-, meso-, and macrotime. Macro time refers to "the changing expectations and events in larger society, both within and across generations, as they affect and are affected by, processes and outcomes of human development over the life course," (Bronfenbrenner & Morris, 2006, p. 796). Microtime and mesotime both relate to proximal processes in that microtime refers to the "continuity and discontinuity in ongoing episodes of proximal processes," (Bronfenbrenner & Morris, 2006, p. 796). Whereas mesotime refers to the frequency and regularity with which developing individuals engage in proximal processes (e.g., over the course of days, weeks, and years). In order for an everyday interaction to constitute an effective proximal process, the interaction must occur on fairly regular basis over extended periods of time (Bronfenbrenner & Morris, 2006).

The references to "continuity and discontinuity (i.e., change)" made by Bronfenbrenner and Morris (2006) mirror that of suggestions made by memory researchers about minute-by-minute development (i.e., microtime) in the domain of autobiographical memory. Two key components of mother–child reminiscing practices are *repetitions* (repeating information previously established in the conversation) and *elaborations* (statements/questions that add or request for more information about a shared event) (Reese, Haden, & Fivush, 1993). Additionally, key components of Coffman and colleague's (2008) cognitive processing language—cognitive structuring language used by teachers—include components of both referring to past events or children's existing knowledge paired with new to-be-learned information. In both the deliberate and autobiographical memory literatures, proximal processes that carry *continuity and change* over time are particularly relevant for solidifying and building upon children's memories and knowledge. In this light, Bronfenbrenner and Morris's (2006) definition of development as "the phenomenon of continuity and change in the biopsychosocial characteristics of human beings," (p. 793) is reflected in memory literature.

Use of PPCT Model in the Current Study

Thoroughly documented by Tudge and colleagues (2009; 2016), Bronfenbrenner's PPCT model has been heavily misused and inappropriately applied by developmental researchers since its inception. Bronfenbrenner himself relied on discussions of other scholars' work to illustrate his ideas rather than applying the PPCT model to his own research. Because of this, there remains limited understanding of how operationalize tenets of his theory correctly. Following other publications seeking to clarify Bronfenbrenner's theory and research model (e.g., Merçon-Vargas et al.,2020; Tudge et al., 2009, 2016; Xia et al., 2020), the work of Navarro and colleagues (2022) provided an accessible and practical guide to the design, implementation, and analysis of PPCT research studies. Despite their rigorous analysis of the literature and clear recommendations, *it is important to acknowledge that the current study does not claim to apply Bronfenbrenner's PPCT model in its entirety*. Rather, in order to follow the recommendations of memory researchers, clear parallels are drawn between Bronfenbrenner's contextualist approach to understanding human development and current directions in studying the development of children's memory.

The reason for this decision is clear given a limitation of the memory literature: how do we distinguish *context* from *process*? The need for studying contextual influences on deliberate memory outcomes originates from the understanding that cognitive structuring activities influence the depth of which information is processed (Craik & Lockhart, 1972). Additionally, it has been suggested that memory requests and the provision of strategy suggestions and metacognitive information from an adult can play a role in children's encoding of information, retrieval, or both (Schneider & Pressley, 1997). These factors have since been observed within the context of teachers' instructional language in elementary school classrooms (Coffman et al., 2008; Ornstein, Grammer, & Coffman, 2010; Coffman et al., 2019). However, it is unclear if teachers' instructional language would be classified as a *process* or an aspect of *context.* A similar limitation is present in the autobiographical memory literature—focused on examining aspects of children's everyday experiences, such as mother–child reminiscing conversations, that have shown to play a significant role in children's memory development (see Fivush et al., 2006 for a review). In the instance of mother–child reminiscing, it is clear that parent–child conversations are proximal processes, *but is the complexity and variation in language used by a parent not also indicative of the context in which a child is situated?*

The question of process vs. context has also recently been discussed in the early childhood education (ECE) literature, in that while structural factors of preschool settings have not been linked to children's outcomes (Brunsek et al., 2017; Gordon et al., 2013; Weiland et al., 2013), indicators of direct, quality interactions between teachers, children, and peers have been positively linked with children's social-emotional and cognitive skills (Sylva et al., 2006; Brunsek et al., 2017). ECE researchers have since reached the conclusion that the uncertainty behind inconsistent linkages between classroom quality measures, such as the widely-used Classroom Assessment Scoring System (CLASS; Pianta et al., 2008) and the ECERS-R (Harms et al., 1998), and children's emergent cognitive outcomes, may be due in part to combining measures of structural quality – something not often linked to child skills – with measures of process quality (Burchinal, 2018). With an understanding that proximal processes serve as the "engines of development" at the forefront of the PPCT model, (Bronfenbrenner & Evans, 2000, p. 118), researchers such as McDoniel and colleagues (2022) and Rojas and colleagues (2021) have since called for improvements in classroom quality assessments to reflect *processes* that play a role in the development of specific skills.

Despite ECE researchers and developmental scientists agreeing that ongoing proximal process are the drivers of developmental change in children's cognitive skills, such as deliberate memory, even process-level measures of children's everyday experiences are sometimes misaligned with the proper operationalization of Bronfenbrenner's PPCT model. For example, recommended by Navarro et al. (2022), based on Bronfenbrenner and Morris's (2006) definition, proper measurement of proximal processes should capture a) progressing complexity, b) duration and frequency, and c) interactional reciprocity. Of the two process-level measures that will be utilized in this study – the mother–child reminiscing task and kindergarten teachers' cognitive processing language – none of the three criteria listed above will be met. Nevertheless, these teacher–child and parent–child language exchanges are thought to be representative of the everyday proximal processes that children take part in during their first year of formal school. This examination of more than one proximal process on children's development, each nested within their own microsystem, is similar to Bronfenbrenner's conceptualization of the mesosystem, or the interaction between two microsystems.

A second parallel between the PPCT model and the current study is the examination of *person* characteristics on the power, direction, and form of proximal processes. There are clear factors that have been identified by deliberate memory scientists that are thought to impact the development of certain skills. For example, Siegler, (1991) argued that age-related difference in the quality of children's thinking depends on a) the types of information they encounter (familiarity vs. novelty), b) how much of the information they are able to hold in memory, and c) the tools they have to use this information to achieve a particular goal. All three of these person-level components present in Siegler's (1991) statement can be classified as *resource* characteristics. Specifically, regarding components (b) and (c), individual factors that children have at their disposal to hold information in memory and achieve a particular goal can be considered memory-adjacent cognitive skills, such as executive function and self-regulation. Indeed, these higher-order cognitive processes are thought to serve children's goal-directed behavior and have been linked with academic success (Allan et al., 2014; Jacob & Parkinson, 2015). One hypothesized mechanism for this association is that children with higher executive function and self-regulation skills are better able to engage in goal-directed behavior (Hoffman et al., 2012) and adapt to environmental stimuli in the service of a specific goal (McClelland et al., 2015). With this in mind, it can be hypothesized that children with higher executive function and self-regulation skills are better able to take advantage of teachers' instructional language than their peer of lower skill levels. Accordingly, the proposed study will parallel Proposition 2 in Bronfenbrenner and Morris (2006) through the examination of the interplay of child-level factors, such as executive function and self-regulation skills, on the direction and strength (effect) of teacher–child interactions as they support children's deliberate memory skills.

The third and final parallel between the current study and Bronfenbrenner's PPCT model is the consideration of *time*. Given that relatively little is known about longitudinal and intra-individual change in children's memory (Ornstein & Haden, 2001; Haden, 2021), the proposed study aims to parallel concepts of micro- and mesotime as defined by Bronfenbrenner and Morris (2006). Mentioned previously, as microtime refers to continuity and discontinuity within proximal processes, the current study's observational assessments of teacher–child and parent–child interactions allow for the understanding of moment-by-moment differences in the ways in which adults are scaffolding children's processing of information. Indeed, discussed further in Chapter 4, variations in the structure of teachers' cognitive processing language arise from the way in which different language components are paired together every 30 seconds, rather than the general occurrence of these components across a given lesson. Moreover, the consideration of mesotime is apparent through assessing children longitudinally, across two academic years. However, it is once again important to highlight that the proposed study is not assessing the development of proximal processes over time, but rather the assumed ongoing role that teacher–child and parent–child interactions play in children's deliberate memory skills over time.

This final parallel, regarding time, brings to light an important reminder for developmental scientists: the use of the bioecological model is *not always the best option* for researchers, as it is not as all-encompassing as once thought to be in the field of developmental science. Following the suggestions of memory researchers (Ornstein & Haden, 2001; Haden, 2021), the *bridging* of contextualist and mechanistic perspectives may assist in the progression of developmental science by a) considering intersections of process, context, and other individual-level factors over time on children's deliberate memory skills and b) building upon and acknowledging a rich literature based in information processing theories of cognition. Indeed, a core question posed by the current study aims to understand the role of *timing of exposure* to teachers' cognitive processing language in kindergarten as we follow children through the end of first grade. However, assessing the potential impact of proximal processes *after* they have occurred is not a primary goal of Urie Bronfenbrenner's PPCT model – it is however, one of deliberate memory researchers.

CHAPTER III: LITERATURE REVIEW

The Development of Children's Deliberate Memory

Early research examining children's deliberate memory that was conducted during the 1970s focused on individual differences in memory performance as well as understanding information processing aspects of memory (e.g., capacity and processing speed) (see Schneider & Ornstein, 2019, for a review). Studies during this time highlighted age-related differences in children's recall performance, but the factors that contributed to these differences were not well understood. A reorientation toward understanding children's *strategy use* in service of deliberate remembering occurred when Flavell (1970) suggested that there was a *mediation deficiency* in young children's deliberate remembering: although children attempted to use strategies, doing so was not associated with higher levels of recall. Additionally, there were instances in which children failed to produce a strategy altogether in situations that would otherwise facilitate recall, termed as a *production deficiency*. Later in the mid-1990s, the use of the term *utilization deficiency* would also enter the memory research lexicon, describing short transitional periods between when children acquire a new strategy but struggle to effectively benefit from it due to the additional mental capacity requirements that accompany said strategy (Miller & Seier, 1994; Bjorklund & Coyle, 1995). From the amassed literature exhibiting variation in children's effective strategy use, a pivotal moment in the deliberate memory field emerged: Flavell's (1971) symposium at the Society for Research in Child Development conference entitled "What Is Memory Development the Development of?" This symposium sparked a new vein of research dedicated to analyzing the role of cognitive resources as they serve children's memory, particularly strategy use. Therefore, the following literature review provides information about what is currently known about children's deliberate memory skills during early childhood, mechanisms of stability and change over time in these skills, and how the current study aims to address identified gaps in this literature.

Types of Memory Strategies

Foundational studies that examined children's use of memory strategies were primarily conducted in laboratory settings where memory tasks were systematically stripped of contextual factors, allowing researchers to isolate the factors that most influence memory success (Schneider, 2015). The term "strategy" has been defined given the debate surrounding the conscious or unconscious nature of certain strategies:

> A strategy is comprised of cognitive operations over and above the processes that are natural consequences of carrying out the task, ranging from one such operation to a sequence of interdependent operations. Strategies achieve cognitive purposes (e.g., comprehending, memorizing) and are potentially conscious and controllable activities.
>
> (Pressley et al., 1985, p. 4)

With this rather broad definition, a considerable amount of work has simply focused on characterizing children's self-initiated, or spontaneous strategy use. Researchers would later examine the role of direct training on children's ability to learn effective memory strategies. Most studies in the 20th century were cross sectional in nature and highlighted differences between older children and younger children's strategy use to understand developmental differences in this skill. Indeed, findings from the work of Deloache, Cassidy, and Brown, (1985) suggest that children as young as 2 years old can use rudimentary memory strategies. Two strategies have been studied extensively (e.g., rehearsal and organization), and less work has focused on elaborations as a strategy used by children.

Rehearsal

Rehearsal is an encoding strategy (i.e., observed during the learning of new information) and refers to the repetition of items in memory. Children as young as four years old have been observed repeating items as though attempting rehearsal, but the effective use of the strategy does not emerge until later in childhood (e.g., Baker-Ward, Ornstein, & Holden, 1984). One of the first studies examining rehearsal is that of Flavell, Beach, and Chinsky, (1966) in which researchers observed 5-, 7-, and 10-year-olds in their spontaneous rehearsal strategies while working to remember a set of pictures. Very few 5-year-olds exhibited rehearsal strategies, about half of 7-year-olds did so, and almost all 10-year-olds rehearsed. Recall performance matched this trend: 10-year-olds exhibited the highest recall performance and 5-year-olds, the lowest. However, 7-year-olds who rehearsed recalled more pictures than the 7-year-olds who did not rehearse, suggesting rehearsal strategies play a role in memory performance. Later, Ornstein, Naus, and Liberty (1975) extended findings on spontaneous rehearsal. When studying to-be-remembered information, third graders used a passive style when rehearsing, repeating each word in isolation from other words. However, sixth graders used an active rehearsal style characterized by strings of words, adding new words as they were presented, and mixing the order to keep as many words alive in memory as possible. Unsurprisingly, the sixth graders remembered more words on average than the younger children and had a more pronounced primacy effect, suggesting that the quality of the rehearsal strategy at storage (i.e., during the study period) had a positive effect on retrieval. However, third graders who were given lists of words blocked according to taxonomic associations during the study period exhibited improved recall despite the fact that their rehearsal style was still passive. These findings shed light on the role that strategy use plays in *improving* recall performance, especially in young children who do not initially employ advanced strategies independently. When third graders were provided with items grouped by category, the salience of the associations among items may have served as cues during retrieval, utilizing children's existing knowledge base to form these associations (Ornstein

& Naus, 1978). The manipulation of these conditions also provided third graders with an opportunity for strategy use not present in the other condition (i.e., list items not pre-organized by category). These findings not only served as a foundation for additional work surrounding direct instruction of organizational strategies described below, but the implications also remain relevant today: children' *strategy use* is separate from *recall* and the support of early strategy use in young children – who may not spontaneously employ strategies by themselves – sets the stage for more complex remembering as they grow older.

Organization

It was this new understanding that a strong knowledge base may facilitate deliberate memory performance that ushered in the examination of organizational strategies. Organization, conceptually thought to aid the retrieval of information, involves arranging or categorizing to-be-remembered information into groups. Organization is more typically used spontaneously by older children, but young children can benefit from them if trained or prompted to do so (e.g., Bjorklund, Ornstein, & Haig, 1977; Bjorklund et al., 1994). To assess organization, researchers developed new sort-recall methodology, allowing for better assessment of how participants perceive and make use of semantically structured to-be-remembered stimuli (Bjorklund, Ornstein, & Haig, 1977) in addition to creating a new measurement approach to externalize the ways participants were creating an organizational plan to enhance recall (Naus & Ornstein, 1978). Measures that were developed included the ratio of repetition (i.e., ratio of category clustering; Bousfield & Bousfield, 1966), the adjusted ratio of clustering (Roenker, Thompson, & Brown, 1971), proximity analysis (Friendly, 1977), and multidimensional scaling analysis (Caramazza, Hersh, & Torgerson, 1976). These measures generally quantify the extent to which semantically related items are organized during the study period (i.e., sorting) and recalled adjacent to one another (i.e., clustering) (Lange, 1978).

In an early study, Liberty and Ornstein (1973) compared memory performance on a free-sorting task between fourth graders and adults. Results from this study highlighted that although age-related differences in recall and category clustering (i.e., recalling items by semantic cluster) were present, fourth graders exhibited sorting patterns during the study period that were idiosyncratic—some items were sorted together based on semantic association, but others were not. When later constrained to adults' sorting patterns (i.e., exhaustive grouping of semantically related items), clustering during recall and overall recall performance increased. Replicating and extending these findings, multiple studies have demonstrated the effectiveness of direct instruction and organizational training on the improvement of strategy use and recall performance in young children (Bjorklund et al., 1977; Corsale & Ornstein, 1980; Schneider & Pressley, 1989).

Elaborations

Elaboration, like rehearsal, is an encoding strategy employed during the learning of new information. It involves forming a connection between two or more items in memory (see Pressley, 1982, for a review). For example, to remember a list of individual items on a grocery list, you might think of a dish that utilizes all ingredients that you need to purchase to help you remember the entire list. Elaboration may be in the form of an image or verbalization and can increase recall for the target items. The work of Willoughby et al. (1999) demonstrated that the linkage between elaborations and recall does not emerge until early adolescence and the use of imagery seems to be the most effective. Although limited work has examined elaboration as a strategy utilized by young children, the role of memory elaborations may be more prominent in other domains of memory for this age group, such as autobiographical memory (Fivush, Haden, & Reese, 2006).

Sources of Stability and Change in Deliberate Remembering

Knowledge Base

With the understanding that one's *knowledge base* plays a role in one's ability to effectively benefit from strategy use, additional studies followed examining the role of prior knowledge under specific task conditions. In tasks where to-be-remembered stimuli are taxonomically related to one another, young children were more likely to spontaneously employ rehearsal (Ornstein et al., 1975) as well as organizational strategies, such as sorting and clustering (Best & Ornstein, 1986). Indeed, it has been suggested that one's knowledge base can influence memory performance in three ways: a) by making specific items more accessible, requiring fewer cognitive resources (i.e., attentional focus); b) by activating relations among items, as with categorically related items, in an automatic manner that frees up capacity to process less-familiar items; and c) by facilitating the use of deliberate strategies and metacognitive processes (Bjorklund, 1987).

Task Stimuli and The Role of Instruction

In addition to prior knowledge, sometimes the presentation of to-be-remembered stimuli may play a role in children's ability to remember. Under task conditions that include weaker semantic relations between stimuli, children have faced more difficulty creating an organizational structure that would facilitate remembering said stimuli (Ornstein & Corsale, 1979). In a study comparing third and seventh graders, seventh graders were able to sort stimuli into meaningful groups without instruction (Corsale & Ornstein, 1980). Although third graders were aware of the relations between the items and thought a related-item list would be easier to remember, on average they did not use this semantic knowledge unless specifically directed to do so. This study not only points to the role of task stimuli (i.e., level of semantic relations between items), but also the role of direct instruction.

It may seem obvious, but it is important to highlight that simply telling a child to "work to remember" task stimuli for subsequent recall has also been linked to higher levels of strategy use, as evidenced by the work of Corsale and Ornstein (1980). Children as young as 4 years old have been shown to behave differently when told to work to remember (Baker-Ward, Ornstein, & Holden, 1984). In the work of Baker-Ward et al. (1984) an experimenter told 4-year-olds either to "play with" or to "remember" target items. Children in the "remember" condition spent less time playing and more time engaging in deliberate behaviors such as naming and looking at the target stimuli. Although young children understand they should do "something" to help them remember (Wellman, 1988), the effectiveness of self-initiated strategies does not emerge until slightly later in development. However, when taught by an experimenter on how to use a specific strategy, young children have evidenced the successful use of strategic training in service of a memory goal. Indeed, multiple studies have demonstrated the effectiveness of direct instruction and organizational training for improving children's strategy use and recall performance (Bjorklund et al. 1977; Corsale & Ornstein, 1980; Schneider & Pressley, 1989). Importantly, causal links between strategy and recall have been established through experimental training in which children are coached to use strategic organizational techniques for remembering (Ornstein et al., 1985). Paired with evidence highlighting the role of task stimuli on deliberate remembering, this work demonstrates the importance of *context* in children's memory performance, a predictor of memory performance that would later become a prominent line of inquiry for researchers (Ornstein, Baker-Ward, & Naus, 1988).

Context-, Process-, and Individual-Level Predictors of Change

Although some research has suggested that the overall arc of memory development is gradual (Sodian & Schneider, 1999; Kron-Sperl, Schneider, & Hasselhorn, 2008), it has also been suggested that when measuring different facets of memory over short segments of time, the transition from nonstrategic to strategic use of mnemonic strategies occurs rather quickly over early elementary school years and that individual differences exist between children (Bjorklund et al., 2009; Schneider & Ornstein, 2019). Despite conflicting findings surrounding the shape of growth trajectories in the memory literature, it is well understood that external factors may contribute to these differences across studies. For this reason, additional predictors of home-, school-, and child-level factors have been explored by recent deliberate memory studies.

The Home Context and Parent–Child Processes

Given that children enter formal school exhibiting great variation in deliberate memory skills, this variability is thought to have originated from children's first learning environment: the home setting. In everyday interactions between children and their family members, predictors of deliberate memory and strategy use are thought to originate. For example, from a separate but parallel literature on children's autobiographical memory, parent–child conversations about shared past events (i.e., mother–child reminiscing) is recognized as an underlying mechanism that can explain developmental gains in autobiographical memory (Fivush, Haden, & Reese, 2006; Fivush, 2011). Indeed, differences in maternal reminiscing style, in particular the extent to which mothers pose Wh- questions (i.e., who, what, when, where), make associations with the event under discussion, validate comments made by their children, and evaluate their children's contributions to the conversation (e.g., Reese et al., 1993) has been consistently linked to the amount of detail that children recall about shared past events (Haden, Ornstein, Rudek, &

Cameron, 2009; Jack, MacDonald, Reese, & Hayne, 2009; McGuigan & Salmon, 2004, 2006; Reese et al., 1993). Since autobiographical memory and deliberate memory are thought to share the same underlying process of encoding, storage, retrieval, and reporting (Ornstein et al., 2006), some studies have supported the link between mother–child reminiscing and deliberate memory outcomes.

For example, the work of Langley et al. (2017) reported a positive association between mothers' elaborative conversational style during reminiscing conversations and children's strategy use on a deliberate memory task at age 3 and children's recall performance at ages 3, 5, and 6. However, this study assessed children's deliberate memory skills according to age (i.e., administering memory tasks at the approximate age of 3, 5, and 6, opposed to following an academic calendar) and mother–child reminiscing was re-assessed at each age, providing cross-sectional linkages between parents' conversation style and children's outcomes. Because of this, little is known about the role of mother–child reminiscing conversations as children transition to formal school. Specifically, how parents elaborative reminiscing style may be linked with children's deliberate memory skills at kindergarten entry, as well as how these skills may be retained as children progress through elementary school, has yet to be explored. Therefore, the current study aims to examine this hypothesized association in Research Question 1.

The Formal School Experience

School as Context

Preliminary studies examining the role of formal school experience and children's cognitive development have employed a school cut-off (SC) design in which differences between "older" pre-kindergarteners and "younger" kindergartners are compared to uncover the unique effect of general schooling experience on child outcomes. Indeed, deliberate memory skills (such as strategy use and recall) have been shown to be related to overall schooling experience (Morrison, Smith, & Down-Ehrensberger, 1995) and children's deliberate memory skills have also been shown to drastically change over the course of elementary school (Ornstein, Haden, & San Souci, 2008). The school cut-off literature can also be paired with cross-cultural findings highlighting differences in children's memory performance as a function of access to and participation in Western-style schooling, even after controlling for chronological age, in Morocco (Wagner, 1978) and Liberia (Scriber & Cole, 1978). Despite reviews of cross-cultural differences in children's deliberate memory skills (Rogoff, 1981), limited studies have uncovered what specific *aspects* of the schooling experience are relevant for the development of children's deliberate memory.

School as Process

Inspired by the work of Moely et al. (1992) in which teachers could be grouped by differences in their instructional language, a series of studies conducted by Coffman, Ornstein, and colleagues have since underscored the role that teachers play in creating a context for strategy discovery and use. Longitudinal findings from Coffman et al. (2008) demonstrated that at the end of the school year, first graders' use of memory strategies and recall differed as a function of the level of cognitive processing language (i.e., metacognitively rich language) used by teachers across a variety of deliberate memory tasks. After training teachers in the use of high levels of cognitive processing language, Grammer et al. (2013) supported a causal link between a metacognitively rich language environment and first graders' growth in deliberate memory skills. Follow-up studies have highlighted the first-grade effect on deliberate memory as it was maintained through the second grade, when the children were taught by different teachers

(Ornstein, Coffman, & Grammer, 2009) as well as how teachers' cognitive processing language has been related to children's increased use of study skills in fourth grade (Coffman et al., 2019).

Despite these findings, two gaps in the literature persist. First, teachers' mnemonic scaffolding practices have been primarily examined in first- and second-grade classrooms. Although one study has observed kindergarten teachers' cognitive processing language in mathematics lessons as it relates to children's math outcomes (Hudson et al., 2018), the proposed study aims to extend this literature by examining the role of teachers' cognitive processing language in kindergarten classrooms as it relates to children's deliberate memory skills. Second, there remains limited understanding of the sustained role of teacher–child processes in kindergarten, such as cognitive processing language, as children progress through elementary school. Although the work of Ornstein et al. (2010) and Coffman et al. (2019) evidenced differences in children's deliberate memory skills in 2nd and 4th grade respectively as a function of their teachers' levels of cognitive processing language in 1st grade, the differential role of the kindergarten experience over time has been unexplored by memory researchers. Therefore, the current study aims to address both of these identified gaps through Research Question 2.

Individual-Level Factors: Children's Self-Regulated Learning Skills

Driven by a theoretical understanding that children's preexisting skills may play a role in their ability to benefit from teacher–child interactions (Bronfenbrenner & Morris, 2006), as well as consistent findings in the deliberate memory literature underscoring individual-level contributors to successful strategy use (Bjorklund, 1987), a final question this proposal aims to address is the role of other cognitive skills on children's development of deliberate memory. Particularly, the proposed study will examine components of children's self-regulated learning skills – self-regulation and executive function – on children's developmental change over time in deliberate strategy use and recall performance.

Self-regulation (SR) is broadly defined as a person's ability to make choices and adapt to environmental stimuli in the service of a specific goal (McClelland et al., 2015). Although definitions of self-regulation vary (Morrison & Grammer, 2016), in general self-regulation is regarded as a top-down, cognitive process required for functional adaptation across the life span regarding a host of educational outcomes (Moffitt et al., 2011). Often used interchangeably with self-regulation, *executive function* (EF) refers to a set of higher-order cognitive processes that allow for individuals to plan and execute goal-directed behaviors. It is thought to encapsulate both conscious and unconscious processes that individuals use to regulate (e.g., control, modulate, inhibit, initiate) both their internal states (e.g., attention, emotion) and observable behaviors (McCoy, 2013; Nigg, 2017). Additionally, EF is thought to be comprised of three related, yet distinct subcomponents (Miyake et al., 2000): *working memory* to hold information in mind while processing other information (Gathercole et al., 2004), *inhibitory control* for overriding dominant responses (Dowsett & Livesey, 2000), and *cognitive flexibility* or *attention shifting* to maintain focus and adapt to challenging goals (Rueda et al., 2005). With the classroom setting in mind, EF serves as a mechanism for enabling or compromising goal-directed behavior (Hoffman et al., 2012) such as staying on task during an activity or assignment. Together, SR and EF can be considered components of children's broader *self-regulated learning skills*. In an attempt to consolidate varying definitions of SR and EF (Grammer & Torres, 2021) self-regulated learning can be considered a framework for understanding the intersection of *cognition* and *behavior* with regard to an array of actions, regulatory processes, and mental strategies used by children to specifically acquire knowledge or abilities (Zimmerman, 1990).

Two potential mechanisms underlie linkages between these components of self-regulated learning and children’s deliberate memory. First, SR and EF are related to children’s deliberate memory because these skills provide a foundation for the development of reasoning abilities and fluid mental capacities (Richland & Burchinal, 2013), which may serve children’s deliberate remembering in academic contexts. Indeed, a large body of research has supported that the ability to pay attention, remember complex rules, and persist on challenging tasks (i.e., self-regulation and executive function) has been associated with children’s academic success (Blair & Razza, 2007; Blair & Raver, 2015). Second, as children transition to formal school (kindergarten), they must adapt to new and more structured educational contexts that may require greater self-regulated learning skills to navigate, compared to less formal and structured educational environments experienced earlier (Schmitt et al., 2017). Recently, the work of Coffman et al. (2023) explored the differential role of teachers’ cognitive processing language on children’s deliberate memory as a function of their self-regulation skills. Results from this study suggested that children of lower self-regulation skills benefited more from exposure to CPL in first grade than their peer of higher self-regulation skills. Despite this one study, little is known about how the interplay of CPL and components of children’s self-regulated learning may support the development of deliberate memory skills in elementary school. Therefore, Research Question 3 asks: *are children with higher self-regulated learning skills better able to benefit from teachers’ instructional language than their peers who evidence lower self-regulated learning skills?*

The Current Study

Cross-sectional studies on children's deliberate memory in the 1960s and 1970s provided an understanding that young children gradually develop strategic competence as they develop more control over their behavior (Bjorklund, Dukes, & Brown, 2009). As described previously, an extant literature exists highlighting children's ability to effectively benefit from strategy use in tasks of deliberate remembering. However, this "snapshot in time" approach cannot fully reflect the complex nature of memory development or provide information about underlying mechanisms of change (Schneider, 2014).

Although recent studies have tracked children's memory skills over time, providing a basic understanding of developmental trajectories, (e.g., Kron-Sperl, Schneider, & Hasselhorn, 2008; Sodian & Schneider, 1999), they provide little information about the forces responsible for developmental changes in remembering (Schneider & Ornstein, 2015; 2019). Moreover, in studies that have included predictors of change in children's trajectories, a very different conclusion of children's growth patterns is reached: growth in deliberate memory skills were not as gradual and linear as once thought, but rather was characterized by clear shifts with consideration of individual or external factors (Bjorklund et al., 2009; Schneider & Ornstein, 2019). Although these studies provided information to some degree about external forces on memory development by comparing task conditions (e.g., different stimuli, different instructions), these preliminary findings about the contextualized nature of cognition served as the initial indication that in order truly understand human development, researchers needed to leave the laboratory setting (Dahl, 2017). If there is evidence of contextual differences in cognitive skills, how do these skills develop at the hands of "real world" contexts?

Drawing on Ornstein and Haden's (2001) discussion on *memory* development compared to the *development* of memory, the current study aims to follow recommendations that memory researchers have provided for future lines of inquiry. Mentioned previously, these recommendations include providing: "(a) a detailed characterization of children's skills at different ages, (b) an assessment of developmental change within individuals over time, and (c) an effort to identify mediators that can plausibly account for the observed changes in skill," (Ornstein & Coffman, 2020, p. 445). Accordingly, the proposed study fulfills all three requirements by utilizing four indicators of children's deliberate memory skills to create a detailed characterization of skillsets, tracking children's intraindividual change over time in these indictors over the course of two academic years, and examines three factors at the home-, school-, and child-level that may account for observed changes in these skills described by the hypotheses listed below. Additionally, these hypotheses were crafted in alignment with Urie Bronfenbrenner's bioecological model, in that (a) proximal processes (i.e., parent–child and teacher–child interactions) are considered primary predictors of developmental change and that (b) individual-level factors are thought to drive the *power*, *direction*, and *form* of these processes (see Bronfenbrenner & Morris, 2006). Accordingly, I aim to answer three research questions in a 6 wave, prospective longitudinal design:

Research Question 1

How do children's deliberate memory skills develop across the kindergarten and first-grade year as a function of their parents' elaborative reminiscing style?

Hypothesis 1a

Children with parents who evidence a higher elaborative reminiscing style will enter kindergarten with higher levels of deliberate memory skills than their peers with parents who have a lower elaborative style.

Hypothesis 1b

Children with parents who evidence a higher elaborative reminiscing style will develop more rapidly in their deliberate memory skills than their peers with parents who evidence a lower elaborative style.

Research Question 2

How do children's deliberate memory skills develop across the kindergarten and the first-grade year as a function of their kindergarten teachers' cognitive processing language (CPL)?

Hypothesis 2a

Children in kindergarten classrooms with teachers who are higher in CPL will have higher deliberate memory skills on average at the end of the first-grade school year than their peers with kindergarten teachers who are lower in CPL.

Hypothesis 2b

Children in kindergarten classrooms with teachers who are higher in CPL will develop deliberate memory skills more rapidly across the two years than their peers with teachers who are lower in CPL.

Research Question 3

How is the association between teachers' CPL and children's deliberate memory skills moderated by children's self-regulated learning skills (i.e., executive function and self-regulation)?

Hypothesis 3a

The association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade will be greater for children with higher levels of executive function than their peers with lower levels of executive function.

Hypothesis 3b

The association between teachers' CPL and increases in children's deliberate memory skills will be stronger for children with higher levels of executive function than their peers with lower levels of executive function.

Hypothesis 3c

The association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade will be greater for children with higher levels of self-regulation than their peers with lower levels of self-regulation.

Hypothesis 3d

The association between teachers' CPL and increases in children's deliberate memory skills will be stronger for children with higher levels of self-regulation than their peers with lower levels of self-regulation.

CHAPTER VI: METHOD

The Current Study

Parents, children, and teachers were recruited as participants in the Classroom Memory Study, a longitudinal study focusing on memory development in school settings. The overall study design involves two cohorts of students as they enter kindergarten – and are tracked across the kindergarten, first- and second-grade years. An initial sample of 79 kindergarten students were selected across 3 schools in a Southeastern school district. Within these schools, all kindergarten teachers were invited to join the study, resulting a sample of 10 classrooms. Families with children in participating classrooms received a letter of invitation to participate in the study, and all children who returned consent forms were enrolled in the Classroom Memory Study with no criteria for exclusion. In the fall of kindergarten (Time 1), children ranged in age from 4.93 to 6.43 years old (M = 5.72 years) and 54% of children were female. The diversity of the sample was representative of the school district from which the participants were drawn, with 53% of the children identifying as Caucasian, 10% African American, 10% Asian/Pacific Islander, 18% mixed racial identity, and 9% not reported. Primary caregivers taking part in the study completed background questionnaires. Of the primary caregivers taking part in the study, 83% identified themselves as mothers, 6% were fathers, 3% were grandparents, and 1% were nannies or other caretakers. Caregivers also provided information about their educational background, revealing that 6% have hold a high school degree or less, 6% have completed either some college or received an associate degree, 24% have received a bachelor's degree, 24% have received a master’s degree, and 28% have attained a professional degree (PhD, MD, or JD). 11% of children in the current study qualified for free or reduced lunch at Time 1.

Of the 10 teachers that agreed to join the study, 8 were Caucasian, 1 was African American, and 1 was Asian American. Teachers also provided background information surrounding years of total teaching experience (*M* = 13.44 years, SD = 10.57), years teaching kindergarten (*M* = 9.44, SD = 8.60), and educational attainment (50% held a master's degree).

Procedures

After being recruited, children participated in assessments after school to complete multiple cognitive tasks administered by a research assistant. Assessments were administered at the fall (Time 1), winter (Time 2), and spring (Time 3) of kindergarten, as well as the fall (Time 4), winter (Time 5), and spring (Time 6) of the first-grade academic year. To assess children's strategy use and recall performance in tasks of deliberate memory, two measures were selected from a battery of assessments: the Free Recall Task with Training (Moely et al., 1992) and the Object Memory Task (Baker-Ward et al., 1984). Additionally, The Head-Toes-Knees-Shoulders task (Ponitz et al., 2009) and the Dimensional Change Card Sort Task (Zelazo, 2006) were administered to assess children's self-regulation and executive function skills respectively. All assessments were video-recorded and later coded by research assistants.

Audio-recorders were sent home with children at the beginning of the kindergarten school year (Time 1) for primary caregivers and children to complete the mother-child reminiscing task (Reese et al., 1993). After returned to the research team, audio recordings were transcribed and then coded for analysis.

Teachers agreed to have themselves recorded while teaching mathematics and language arts instructional periods throughout the year, approximately mid-academic year (Time 2). Researchers positioned Go-Pro digital video cameras in classrooms to capture unobstructed views of the teachers. Teachers were instructed how to start and stop the cameras in their classrooms during times of instruction, with the goal of capturing 120 minutes of instruction, including 60 minutes each in language arts and mathematics. Go-pros were then returned to the research team for video coding and analysis.

Measures

Children's Deliberate Memory Skills

Free Recall Task with Organizational Training: FRT (Moely et al., 1992) (Time 1 – 6)

This task explores children's use of organizational strategies during study time (e.g., sorting) and their subsequent recall performance (Ornstein & Corsale, 1979). The aim of this task is to assess children's ability to learn organizational strategies for remembering as well as their ability to use these strategies with different materials at later timepoints. As described in Table 1, at Times 1 and 4 (fall of kindergarten and fall of first grade), children underwent three trials: baseline, training, and generalization. In the *baseline trial*, children are asked to "work to remember" 16 individual line drawings on notecards that fell into 4 (counterbalanced from multiple groups) conceptual categories (e.g., sports, seasons, food). During an open-ended study time, children's spontaneous strategy use was scored using as standardized index, the Adjusted Ratio of Clustering (ARC) measure (Roenker, Thompson, & Brown, 1971), which characterized the degree to which children's card sorting during study reflected organization according to the 4 semantic categories, while also taking chance sorting into account (Lange, 1978). Accordingly, sorting ARC scores can range from -1 (below chance) to 0 (chance) to 1 (perfect categorical sorting/grouping). Sorting ARC scores are calculated using a formula that considers the number of possible pairs a child could group together (i.e., card matched to a category), the number of pairs that were in fact grouped together, the total number of categories, the total number recalled, and the number of expected pairs (i.e., the sum of squares of the number of recalled items from each category / total number recalled). Therefore, observations of children's strategy use were double scored by research assistants and all disagreements were reconciled before calculating final sorting ARC scores used in the dataset.

When children were finished studying, a research assistant asked children to tell them the names of everything they could remember; children's recall performance was scored as how many total line drawings children are able to recall (range = 0 to 16). Immediately after, children then took part in a *training trial,* during which the research assistant orients children to an organizational sorting strategy aimed at training children to sort the 16 line drawings into 4 categories, demonstrating the potential to assist their memory (e.g., "See how these cards are all pictures of food?", "What should we call this category?"). Administered after a 15-minute delay, children then completed a *generalization trial* using a new set of 16 line drawings of 4 new categories. Similar to the baseline trial, children were not provided specific instructions on how to remember the drawings, but rather told to "work to remember" as long as they need to remember all the drawings. Children were once again scored across two indicators of deliberate memory skills: deliberate *strategy use* via the Adjusted Ratio of Clustering (ARC) measure (Roenker, Thompson, & Brown, 1971) and *recall performance* indicated by the number of drawings they could remember. While both of these skills can be considered as representative of children's deliberate memory skills, previous work has distinguished these two components from one another as they occur at different stages in children's skilled remembering (i.e., strategy use during encoding and recall during retrieval). Therefore, the examination of each of their unique trajectories over time is necessary to understand their differential relationships with predictor variables in the current study. Accordingly, *strategy use* and *recall* will be tested independently of one another in each model. As can also be seen in Table 1, during Times 1 and 4 (fall of kindergarten and fall of first grade), children' scores were collected during two trials: the baseline trial and generalization trial. However, during Times 2, 3, 5, and 6, (i.e., winter and spring of each year), they only took part in a single generalization trial, capturing children's retention of the strategy training trial across the academic year. Therefore, both indicators of children's deliberate memory assessed by the Free Recall Task with Organizational Training (FRT) span 8 repeated measures to include all trials and timepoints.

Table 1. Timeline of Assessments

Kindergarten			1st Grade		
Time 1 (Fall)	Time 2 (Winter)	Time 3 (Spring)	Time 4 (Fall)	Time 5 (Winter)	Time 6 (Spring)
Free Recall Task (FRT) *Baseline* *Training* *Generalization*	Free Recall Task (FRT) *Generalization*	Free Recall Task (FRT) *Generalization*	Free Recall Task (FRT) *Baseline* *Training* *Generalization*	Free Recall Task (FRT) *Generalization*	Free Recall Task (FRT) *Generalization*
Object Memory Task (OBJ)	Object Memory Task (OBJ)	Object Memory Task (OBJ)	Object Memory Task (OBJ)	Object Memory Task (OBJ)	Object Memory Task (OBJ)
Mother-Child Reminiscing Task (MRM)	Classroom Observations Head-Toes-Knees-Shoulders-Task (HTKS) Dimensional Change Card Sort Task (DCCS)				

Note: For the Free Recall Task with Organizational Training (FRT), Time 1 and Time 4 have two trials that were included in analyses: *Baseline* and *Generalization*. This results in 8 total repeated measures for this task.

The Object Memory Task: OBJ (Baker-Ward et al., 1984) (Time 1 – 6)

The Object Memory Task was used to assess children's spontaneous strategy use when asked to "work to remember" a set of 15 unrelated but familiar objects – including behavioral and linguistic strategies children display while attempting to remember a set of stimulus objects (Baker-Ward, Ornstein, & Holden, 1984) – as well as their subsequent recall of these objects. Each child was given 2 minutes to remember a set of 15 unrelated but familiar items (e.g., plastic toy animals or vehicles, or household items such as a mirror or brush). After 2 minutes passed, the objects were covered with a cloth and a research assistant asked children to recall everything they could remember. Administration of this task was video recorded for subsequent behavioral coding using the Noldus Observer XT v. 14 observational coding software.

Behavioral Coding (Time 1 – 3). Spontaneous strategies were coded using a coding scheme adapted from the work of Baker-Ward, Ornstein, and Holden (1984) that assessed children's verbal strategies (e.g., naming, associative talk, object talk) and behavioral strategies (e.g., categorizing, pointing, overt mnemonic activity, and covert mnemonic activity). Strategies were coded as either 'states' or 'events'. State codes captured the total duration of the occurrence of a given strategy in seconds. However, 'events' were not coded for duration, but rather captured the frequency of a code's occurrence. A composite score was created to indicate the overall strategy use of the child. This was done be summing the total duration of state codes and designating one second for each event code (ex. if a child exhibited five event codes, five seconds will be used to represent these events). Examples and descriptions of these codes are shown in Table 2. To establish reliability in the coding of these behaviors, two coders independently scored 25% of the records from each time point and were required to obtain at least 80% agreement on each file. At Time 1, the percentage of agreement scores ranged from

80% to 97%, with an average of 88%, at Time 2 the percentage of agreement scores ranged from 80% to 96%, with an average of 86.20%, and at Time 3 the percentage of agreement scores ranged from 80.23% to 100%, with an average of 85.57%. After reliability was established at each timepoint, the remaining files were evenly split between the two coders.

Table 2. Spontaneous Strategies with Corresponding Code Descriptions from the Object Memory Task Coding Scheme (Baker-Ward et al., 1984)

State Code Strategies	Overt Mnemonic Activity	Child displays an overt mnemonic activity (e.g., hides eyes while naming objects, self-tests, or rehearses aloud)
	Covert Mnemonic Activity	Child displays an overt mnemonic activity (e.g., closes eyes or looks at objects and looks aways *as if studying*, moves lips *as if rehearsing*, scans in an obvious repeated pattern).
Event Code Strategies	Naming	Child Labels an object without further description (e.g. "Flower", "this is a flower.")
	Associative Talk	Child verbalizes and association with or elaboration about an object (e.g. I have a car like this at home." "This isn't a real cat.")
	Object Talk	Child discusses the properties of the object (e.g. "These glasses are green.")
	Categorizing	Child groups two or more items verbally or physically. (e.g. child groups items by color).
	Pointing	Child points to a particular object without touching or moving it.

Children's Self-Regulated Learning Skills

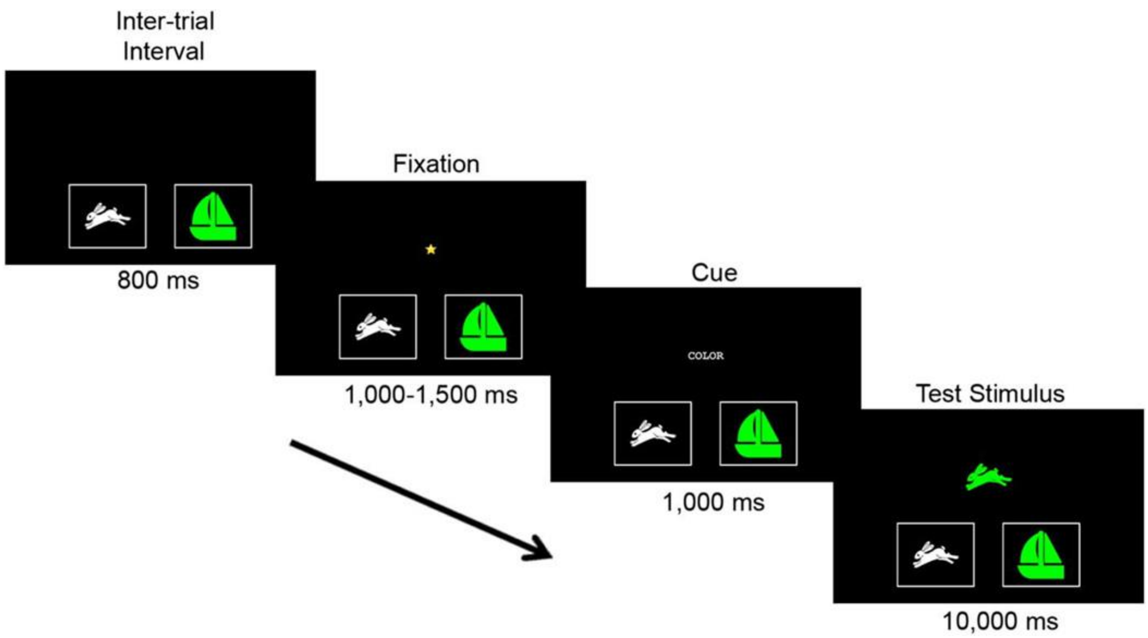
The NIH Toolbox Dimensional Change Card Sort Task (DCCS; Zelazo, 2006; Zelazo et al., 2014) (Time 2)

This task was selected from the NIH Toolbox Cognition Battery to assess children's executive function skills in the winter of the kindergarten school year (Time 2). In the standard version of the DCCS, children are shown two target cards (e.g., a blue rabbit and a red boat) and asked to sort a series of bivalent test cards (e.g., red rabbits and blue boats) first according to one dimension (e.g., color), and then according to the other (e.g., shape). In the current study, children were administered the task via iPad consisting of four blocks (practice, pre-switch, post-switch, and mixed). Instructions appeared visually on the monitor and were also read aloud by the research assistant to all children.

Practice Block. During the practice block, children took part in a series of practice trials on which they were instructed to sort a bivalent test stimulus (either a green rabbit or a white boat) by either shape or color. The test stimulus was presented on a central screen and participants sorted it by touching one of two laterally presented target stimuli (white rabbit and green boat). The structure for administering fixation points (e.g., a yellow star to direct attention to the center of the screen where the cue would appear), cues (e.g., the word "color" accompanied by a recording of someone saying the word "color"), and test stimuli (e.g., a green or white rabbit or boat), are shown in Figure 1. The initial dimension (shape or color) by which participants sorted was counterbalanced across participants through randomization. A response was recorded when participants touched either of the target stimuli (correctly or incorrectly sorted). In order to proceed to the next block, children were required to sort 3 out of 4 practice items correctly, and if they did not meet this criterion, they could receive up to two additional series of 4 practice trials (i.e., they were given as many as 3 chances to meet the criterion). Once the criterion was met for the first sorting dimension, participants were trained on the second dimension. If a participant failed to meet the criterion for either dimension, the task was stopped.

Pre-Switch Block. When the practice criterion was met for both dimensions, children were administered test trials that were the same structure of the practice trials (Figure 1) but were comprised of different colors (yellow/blue) and shapes (ball/truck) and no feedback was provided if children were correct or incorrect in their sorting responses. First, 5 pre-switch trials were administered in which participants needed to sort by the same dimension (e.g., color) that was used in the immediately preceding practice block.

Figure 1. Trial Sequence for the NIH Toolbox Dimensional Change Card Sort Task



Post-Switch Block. If participants sorted correctly on 4 of 5 pre-switch trials, they were told to switch to sorting by the other dimension (e.g., shape), and 5 post-switch trials were administered. If children failed to reach the criterion on either the pre- or post-switch block, the test was terminated.

Mixed Block. Children who met the criterion for post-switch trials were then informed that they would now be asked to switch back and forth between dimensions and were given 50 mixed trials, including 40 "dominant" (e.g., consistent with previous trial) and 10 "non-dominant" trials (e.g., inconsistent with previous trial) presented in a pseudorandom order (with 2–5 dominant trials preceding each non-dominant trial). The dominant dimension was always the sorting dimension used in the post-switch block (e.g., shape). The mixed block is characterized by instances in which children must overcome a dominant response (i.e., to sort consistent with previous block; e.g. shape) when presented with a non-dominant trial (e.g., a stimulus that must now be sorted by color).

Scoring. The NIH Toolbox scoring of the DCCS task considers both accuracy and reaction time. Performance was scored based on the total number of test trials completed, regardless of how many blocks or trials children completed (the practice block was not incorporated into this score). For all participants, accuracy was considered first, and scored on a scale from 0 to 5. Children were given 0.125 points (5 points divided by 40 total task trials: 5 pre-, 5 post-, and 30 mixed-block trials) for every correct response they made on trials they received. Therefore, the accuracy score is equal to 0.125 multiplied by the number of correct sorting responses. The reliability and validity of this measure as it is administered through the NIH Toolbox has been supported greatly by previous research. Specifically, analyses of psychometric properties of this measure have revealed excellent convergent validity when compared to other executive function measures, such as the WPPSI-III Block Design (r (74) = .69, p<.0001), excellent developmental sensitivity across childhood (R^2= .76), and strong test-retest reliability (ICC = .92) (Zelazo et al., 2013).

Head-Toes-Knees-Shoulders Task (HTKS;Ponitz et al., 2009; McClelland et al., 2014)(Time 2)

The Head-Toes-Knees-Shoulders Task (HTKS) was used to assess children's behavioral self-regulation skills. Previous research using the HTKS task has indicated high interrater agreement (κ > .90) and evidence supports convergent and predictive validity of this measure when assessing children's EF in culturally diverse samples and in different languages (McClelland et al., 2007, 2014; Wanless et al., 2011). In this task, children were asked to play a game in which they were instructed to do the opposite of what the experimenter said. For example, the research assistant instructed them to touch their head (or their toes), and instead of following the command, children were directed to do the opposite and touch their toes (head). There are two parallel forms of the HTKS: A and B, which were counterbalanced across children. Form A starts with head/toes and Form B starts with knees/shoulders.

Part 1 Training. First, children are administered a training block in which children are first instructed on the rules for the "game" and then are administered two trials in which they receive immediate feedback after each response (correctly or incorrectly touching body part).

Part 1 Practice. Then children are given four practice problems but are only provided with feedback for *incorrect* responses. Across both the training and practice portions, children are only allowed to be reminded of the rules following an incorrect response up to three times.

Part 1 Testing. In part 1, children are administered 10 trials with no feedback (i.e., touch your head, touch your toes) and are scored accordingly.

Part 2 Training. Then the research assistant introduces two new body parts that were not introduced in the previous training (e.g., knees and shoulders) and provides one practice question where children are asked to touch the opposite body part.

Part 2 Practice. Children are once again given 4 practice problems. Across both the part 2 training and practice portions, children are only allowed to be reminded of the rules following an incorrect response up to *two* times.

Part 2 Testing. The research assistant then administered 10 trials with no feedback that incorporate all four body parts (head, toes, knees, shoulders) and scored accordingly.

Scoring. There are a total of 20 test items (from Part 1 and Part 2 testing blocks) with scores of 0 (incorrect), 1(self-correct), or 2(correct) for each item. A self-correct is defined as any motion to the incorrect response, but self-correcting and ending with the correct action.

Possible scores range from 0 to 40 where higher scores indicate higher levels of behavioral self-regulation.

Parents' Elaborative Reminiscing Style

Mother–Child Reminiscing Task (Reese et al., 1993) (Time 1)

This task serves as a measure of parents' elaborative conversation style and was administered to participants at Time 1, in line with the understanding that maternal reminiscing style is stable across time (Reese et al., 1993; Reese, 2002). Parents were instructed to think of two specific past events to discuss with their children that a) were novel, b) were shared between the parent and child, and c) occurred over the past summer. Audio recorders were sent home with instructions for primary caregivers and children to reminisce at the time and place they desire, aiming to assess conversations in naturalistic settings. After discussing the two past events, that were selected by the parent, audio recorders were returned to the research team to be transcribed verbatim.

Conversation Coding. Transcriptions were then coded using a structural-functional coding scheme adapted from the work of Reese, Haden, and Fivush (1993) and Haden (1998). First, codes ascribed to utterances fell into two broad categories: maternal coding categories (MOT) and child (CHI). Although numerous individual codes within these categories can be provided, the primary codes of interest for parents included elaborations, associative talk, confirmations, and metamemory talk. See Table 3 for examples of each code. Transcriptions were coded by research assistants, each establishing inter-rater reliability of at least 80% with a master coder at the beginning of coding. Reliability scores ranged from 83% to 93%, with an average of 88%, After reliability was established, one of the coders completed the remainder of the files.

For each mother, mean frequencies of individual codes were calculated across the two events. Based on the work of Langley et al. (2017), a composite measure of *maternal elaborative style* was developed by including components of mothers' speech: 1) average elaborations; 2) average associative talk; 3) average confirmations; and 4) average metamemory talk. Due to the differing rates of occurrence, standard deviations, and ranges for each of these components demonstrated by the current sample and past research (Langley et al., 2017; Cook et al., 2021), it was necessary to compute standard scores for each of the four components using z-score conversions before combining them into a composite index. The z-scores from each of the four subcomponents (elaborations, associative talk, confirmations, and metamemory talk) were then summed in order to create a composite score of *mothers' elaborative style* when reminiscing. This approach, adapted from the work of Langley et al. (2017), allows each of the four subcomponents of mothers' elaborative style to contribute equal weight in the final composite measure. Unlike previous operationalizations of elaborative style that have utilized a median split method to dichotomize into "high" vs. "low" elaborative style (e.g., Reese et al., 2008; Langley et al., 2017), the current study utilized a continuous measure of parents' elaborative reminiscing style.

Table 3. Definitions and Examples of the Maternal Codes from the Mother–Child Reminiscing Task (Reese et al., 1993)

Code		Definition	Example
Elaborations	Open-Ended Question Elaborations	"Open-ended" questions asking the child to provide memory information about an event.	"What did we do at the zoo?" "Tell me what was your favorite thing to do there?"
	Yes-No Question Elaborations	Questions that ask the child to confirm or deny a piece of memory information provided by the mother.	"Did you have fun?" "Was it hot or cold outside?"

	Statement Elaborations	Any declarative comment made by the mother that provides information about the event.	"You dressed up so pretty when we went there." "Grandma and Grandpa came with too!"
Metamemory Talk		Mother remarks about the process of remembering or the child's memory performance.	"I forgot about that." "That's what I remember too!" "I don't remember that either." "Wow, you have a good memory."
Associative Talk		Statements or questions that are not about the particular event under discussion, but is related to the one under discussion.	"We saw fireworks a different night, didn't we?" "We should visit there again next summer." "Who is married to Aunt Mary?"
Confirmations		Comments that in some way confirm or deny information provided by the child.	"Yes." "You're right, that did happen." "Mhm."

Teachers' Cognitive Processing Language (CPL)

Taxonomy of Teacher Behaviors (Coffman et al., 2008) (Time 2)

To best capture teachers' instructional language, lessons of mathematics and language arts were video recorded using a camera set up in classrooms. Videos were subsequently coded in a laboratory setting by research assistants using the Taxonomy of Teacher Behaviors (Coffman et al., 2008) coding scheme. Teacher observations were made during a total of 240 intervals of 30 seconds, or 120 minutes of instruction, with 60 minutes each in language arts and mathematics. On average across teachers' mathematics and language arts lessons (120 minutes of instruction), observation videos ranged from 3 minutes to 17.5 minutes ($\bar{X}$ = 9.78 minutes) and were recorded over multiple lessons. To achieve the total 120 minutes, between 10 and 16 lessons per teacher were recorded ($\bar{X}$ = 12.8 lessons). On average, approximately half of these lessons were mathematics lessons (range = 5-9 lessons, $\bar{X}$ = 6.7) and half were language arts (range = 5-8, $\bar{X}$ = 6.1) for each teacher in the current sample. There were no significant differences in the average duration of lessons observed across mathematics ($\bar{X}$ = 9.85 minutes) and language arts ($\bar{X}$ = 10.14 minutes).

Video data were coding using the Noldus Observer XT v.14 coding software. Coding decisions were made every 30 seconds, using an established method used in previous studies utilizing this coding procedure (see Coffman et al., 2008; Grammer, Coffman, Sidney, & Ornstein, 2016; Hudson, Coffman, & Ornstein, 2018). This coding scheme characterizes teachers' language during whole group instruction using 26 unique codes (see Table 4). Teachers' language can be classified into one of four broad categories: a) *instructional activities*, b) *cognitive structuring activities*, c) *memory requests*, and d) *metacognitive information*. *Instructional activities* occur when the teacher provides information to the class (e.g., providing new, factual information or instructions for an upcoming activity). *Cognitive structuring activities* are instances in which the teacher promotes a deeper level of encoding or preparation for future retrieval. For example, cognitive structuring activities may occur when a teacher focuses students' attention or identifies relationships between two concepts (e.g., comparing and contrasting two shapes, using words like *more* or *less*). *Memory requests* consist of the teacher asking students to remember previously stored information or to prepare for the future retrieval of information (e.g., asking students to fill in the answer to a question on the smartboard or asking students to remember a specific procedure). *Metacognitive information* includes utterances that either request or provide metacognitive information (e.g., asking students why they are using a specific problem-solving method or providing a rationale for a more efficient method). Utterances within these four broad categories were then given more discrete, individual codes as can be seen in Table 4.

Table 4. Taxonomy of Teacher Behaviors Codes

Category	Abbr.	Definition
Non-Instruction/Non-Memory	NON	The teacher is not engaged in a memory or instructional activity
Instructional Activities		
Book Reading	BR	The teacher reads a book aloud to the group
General Information Giving	GIG	Presentation of factual information
Prospective Summary	PS	Description of upcoming events
Specific Task Instruction	STI	Instructions for performing a particular activity
Cognitive Structuring Activities		
Attention Regulation: Behavioral	ATB	Reprimand or guide behavior
Attention Regulation: Instructional	ATI	Redirect or focus attention
Massed Repetition	MREP	Performance of an activity in unison
Identifying Features	IDF	Generate features of a category
Categorizing	CAT	Verbally or physically putting material into categories
Personal Experience Connections: Home	PEH	Associate a prior outside-of-school experience to a current activity
Personal Experience Connections: School	PES	Associate a prior in-school experience to a current activity
Drawing Inferences	INF	Predict an outcome or assume the intentions or desires of another
Visual Imagery	IMG	Create visual mental images that relate to the material
Memory Requests		
Episodic	EPI	Retrieval of a specific past event in or out of the classroom
Semantic	SEM	Retrieval of an already learned fact, idea, or object
Procedural	PRC	Recollection of how to perform a series of activities to achieve a goal
Prospective	PRS	Non-instructional task to be completed in the future (behavioral goal)
Anticipated	ANT	Expectation for child to remember information (learning goal)
Metacognitive Information		
Metacognitive Rationale	MR	Provides rationale for strategy use or for planning, organizing, etc.
Metacognitive Questioning	MQ	Asks child to provide potential strategy or rationale for strategy choice
Suggestion	SUG	A recommended method for remembering information
Suppression	SUP	Refraining from using an unhelpful or inappropriate strategy
Replacement	REP	Recommendation of a more effective or alternative strategy

A set of videotaped lessons from a previous study was used to train coders in the use of the taxonomy system as well as to establish reliability before coding observations. After learning the coding scheme, both coders verified reliability on the taxonomy coding scheme using eight master files for a total of 60 minutes of instruction. The first two videos coded were used as practice files and each coder was required to reach 100% accuracy. For the remaining six files, coders were required to attain a level of agreement of at least 80% with the master file. Upon successful completion of the training process, each coder independently scored 25% of the intervals (a total of 150 minutes or 300 30-second intervals) to ensure interrater reliability. For the current analytic sample of classrooms, coders achieved above 80% interrater reliability scores for all files with an average of 86.55%.

In accordance with the work of Coffman et al. (2008), a composite index of teachers' cognitive processing language (CPL) was created based on five components related to deeper levels of processing and metacognitive understanding. Described in Table 5, the five component codes are a) strategy suggestions, b) metacognitive questioning, c) the co- occurrence of deliberate memory demands and instructional activities, d) the co-occurrence of deliberate memory demands and cognitive structuring activities, and e) the co-occurrence of deliberate memory demands and metacognitive information. Due to sometimes large variability between the frequency of certain codes (see Coffman et al., 2008), standard scores were used to create a composite measure via a standardization process derived from the work of Coffman et al. (2008) in which each code is standardized on the basis of its mean and standard deviation, resulting in T-scores for each of the five components. T-scores across measures were then averaged to yield a measure of CPL that was used to compare classrooms. Classrooms were split into high vs. low in the inclusion of CPL during instruction using a median split approach used to address the non-normal distribution of these data (Iacobucci et al., 2015).

Table 5. Component Codes from the Taxonomy of Teacher Behaviors Used to Index Cognitive Processing Language (Adapted from Coffman et al., 2008).

Code	Definition	Example
Strategy Suggestion	Recommending that a child adopts a mothed or procedure for remembering or processing information	"If that doesn't make sense, go back and reread or look at the picture."
Metacognitive Question	Requesting that a child provide a potential strategy, a utilized strategy, or rationale for a strategy they have used	"What are some strategies you could use to help you figure that out?"
Co-occurrence of Deliberate Memory and Instructional activities	Requesting information from a child's memory while also presenting instructional information	"Today, we are going to write a story about our field trip to the zoo. What was the first thing we did when we got there? Remember, a story has a beginning, middle, and end."
Co-occurrence of Deliberate Memory and Cognitive Structuring Activities	Requesting information from children's memory while simultaneously facilitating encoding and processing by focusing attention or organizing material	"Yesterday, we talked about states of matter. What are the three forms that water can take?"
Co-occurrence of Deliberate Memory and Metacognitive Information	Requesting information from children's memory while providing or soliciting metacognitive information	"How many seashells are there in all? How did you solve that problem? How did you know that you should add?"

CHAPTER V: RESULTS

In the following results chapter, first descriptive findings for all child-level variables – both deliberate memory and self-regulated learning skills – are presented. These initial results will be followed by the characterization of parents' elaborative reminiscing style and teachers' cognitive processing language, the two primary predictor variables in the current study. Then, in a Model Building Overview section, the four steps in the model building, testing, and evaluation process are outlined in line with the work of Raudenbush and Bryk (2002) and Curran et al. (2004; 2006). In Step 1, additional preliminary results are presented, such as raw patterns of growth over time of repeated measures along with information about the normality of data from the current sample. In Step 2, results from unconditional growth curves are presented to (a) formally establish a baseline amount of variance for each timepoint, (b) determine if the defined intercept was statistically significant from zero, and (c) assess if there was significant growth over time in children's deliberate memory skills. In Step 3, components of model fit – such as allowing for heteroscedastic Level 1 errors and probing for non-linear change over time through the quadratic function – are formally tested and discussed. Finally, in Step 4, predictor and moderator variables are entered into models – resulting in conditionalized models of children's growth – and corresponding results, figures, and tables are discussed in order of research question.

Descriptive Analyses

Child-Level Variables

The Free Recall Task with Training (FRT; Time 1 – 6)

Strategy Use on the FRT Task. As can be seen below in the first row of Table 6, children entered kindergarten with an average sorting ARC score of -.21 units on the Free Recall

Task with Organizational Training. This indicates that children's categorical sorting behaviors fell slightly below chance. Notably, no child in the current sample achieved perfect a perfect sorting ARC score (1.00) at kindergarten entry. As will be described further in Step 1 of the model building process, children's sorting ARC scores at T1 Baseline exhibited a non-normal distribution – as most children evidenced a score of -.23 at this timepoint – and can be therefore characterized by a relatively narrow standard deviation when compared to other timepoints (SD= .12), reported in the first row of Table 6. However, after undergoing organizational training, children's average sorting ARC scores increased to .01 units on average, as can be seen in the second row of Table 6. Scores then continued to gradually increase across all eight repeated measures, resulting in an average score of .73 units at the end of first grade. Further interpretation of these raw scores will be discussed at Step 1 in the modeling building process.

Table 6. Average Sorting ARC and Recall Scores on the Free Recall Task with Organizational Training

Variable	N	Minimum	Maximum	Mean	Std. Deviation
FRT Sorting ARC (8 repeated measures)					
T1 Baseline	76	-.23	.78	-.21	.12
T1 Generalization	72	-.23	1	.01	.46
T2 Generalization	73	-.23	1	.08	.52
T3 Generalization	73	-.23	1	.10	.52
T4 Baseline	68	-.23	1	.27	.59
T4 Generalization	68	-.23	1	.46	.60
T5 Generalization	67	-.23	1	.57	.57
T6 Generalization	67	-.23	1	.73	.49
FRT Recall (8 repeated measures)					
T1 Baseline	76	0	13	7.50	2.66
T1 Generalization	71	0	14	7.30	3.26
T2 Generalization	73	2	14	7.93	2.62
T3 Generalization	73	2	14	8.21	2.43
T4 Baseline	68	5	16	10.41	2.85
T4 Generalization	68	2	16	9.47	3.24
T5 Generalization	67	3	16	10.82	3.38
T6 Generalization	67	4	16	11.22	3.30

Recall on the FRT Task. As can be seen above in the 9th row of Table 6, children recalled 7.50 drawings at T1 Baseline, and after having received organizational training, children's recall slightly decreased to 7.30 drawings recalled reported in the 10th row of Table 6. As can be seen in the 9th – 12th rows of the 'Maximum' column, no child in the current study was able to recall all 16 drawings from the task across the kindergarten year. However, reported in the 13th – 16th rows of this same column revealed that once children entered first grade, some children were able to recall all 16 stimuli in the task. Accordingly, reported in the 13th row of Table 6, children entered first grade recalling 10.41 drawings on average. Similar to the beginning of kindergarten, after children underwent strategic organizational training at the beginning of the school year, their recall scores slightly decreased to 9.47 drawings as reported in the 14th row of Table 6. These slight dips in children's gradual growth over time in recall may reflect testing fatigue as children progress through a battery of tasks in the fall of each academic year. Children ended first grade recalling 11.22 drawings on average, as reported in the final row of Table 6. Further interpretation of these raw scores will be discussed at Step 1 in the modeling building process.

The Object Memory Task (Time 1 – 6)

Strategy Use on The Object Memory Task. Descriptive statistics for children's strategy use on the Object Memory Task were calculated by component codes of interest (see Table 2. for definitions of each code). As can be seen in Table 7, children varied greatly in their use of strategies within each timepoint. At Time 1, as can be seen in the first 1st, 4th, and 6th rows of Table 7, the most frequent strategies used by children were naming (*M* = 9.75), pointing (*M* = 1.86), and associations (*M* = 1.43). At Time 1, children did not engage in overt mnemonic activities, but exhibited .46 seconds of covert mnemonic activities and .08 instances of categorizing on average, reported in the 3^{rd} and 7^{th} rows of Table 7 respectively. Time 1 composite strategy (i.e, the sum of event codes and total duration of state codes) scores can be seen in the 8^{th} row of Table 7, detailing that children exhibited an average strategy score of 14.04 units in the fall of kindergarten. As can be seen in rows 9 – 15 of Table 7, Time 2 scores exhibited a similar pattern to that of Time 1 in that children engaged most frequently in naming (M = 9.27), pointing (M = 3.30), and associations (M = 1.53). Notable differences between Time 1 and Time 2 surround the increase in children's use of overt and covert mnemonic activities. At Time 2, children engaged in overt mnemonic activities for .69 seconds on average and engaged in covert mnemonic activities for 1.96 seconds on average, reported in the 10^{th} and 11^{th} rows of Table 7. The average occurrence of categorization also increased from .08 at Time 1 to .47 at Time 2.

When considering Time 3 individual component scores, a detailed picture of children's strategy use over the course of the kindergarten year can be seen. For example, although strategies of pointing, overt mnemonic, and covert mnemonic increased from Time 1 to Time 2, Time 3 scores revealed that children's average scores for each of these strategies returned to similar levels exhibited at Time 1. More specifically, children's average use of pointing strategies increased from 1.86 instances at Time 1 to 3.30 instances at Time 2, but then returned to 1.79 instances at Time 3 reported in the 17^{th} row of Table 7. Children's average use of overt mnemonic activity increased from 0 seconds at Time 1 to .69 seconds at Time 2, but then returned to 0 seconds at Time 3 reported in the 18^{th} row of Table 7. Lastly, children's average use of covert mnemonic activity increased from .46 seconds at Time 1 to 1.96 seconds at Time 2, but then returned to .74 seconds at Time 3 reported in the 19^{th} row of Table 7.

When considering Times 1, 2, and 3 together, children's average use of naming remained around an average of 9 instances for the entirety of the kindergarten year ($T1$ M = 9.75; $T2$ M = 9.27; $T3$ M = 9.68). Similarly, although children increased on average in their use of categorizing from Time 1 to Time 2, Time 3 scores remained similar to that of Time 2 ($T1$ M = 08; $T2$ M = .47; $T3$ M = .39). Finally, two individual codes appeared to gradually increase over the course of the kindergarten year: object talk ($T1$ M= .46; $T2$ M = .53; $T3$ M = .75) and associations ($T1$ M = 1.43; $T2$ M = 1.53; $T3$ M = 2.40). These findings support the notion that children's sophisticated strategies, such as categorizing, object talk, and associations increase or remain stable across the year as less sophisticated strategies decline over time. Discussed further at Step 1 in the model building process, children's overall composite strategy scores (listed in the first three rows of Table 8) slightly increased from 14.04 units at Time 1 to 17.74 units at Time 2, but then decreased slightly to 15.77 units at Time 3. As will be discussed further, this relative stability is consistent with previous research, but also may be due in part to the change over time in individual component codes as described above.

Table 7. Descriptive Statistics for Components of Children's Strategy Use on the Object Memory Task

Component	Min.	Max.	Mean	SD
Time 1				
Pointing	0	36	1.86	5.71
Overt Mnemonic (sec.)	0	0	0	0
Covert Mnemonic (sec.)	0	15	.46	2.39
Naming	0	64	9.75	13.03
Object Talk	0	6	.46	.99
Associations	0	15	1.43	2.72
Categorizing	0	6	.08	.69
T1 Strategy Use Composite	0	77	14.04	16.21
Time 2				
Pointing	0	112	3.30	13.92
Overt Mnemonic (sec.)	0	48	.69	5.74

Covert Mnemonic (sec.)	0	85	1.96	10.72
Naming	0	65	9.27	14.74
Object Talk	0	9	.53	1.28
Associations	0	13	1.53	2.62
Categorizing	0	16	.47	2.36
T2 Strategy Use Composite	0	112	17.74	24.11
Time 3				
Pointing	0	46	1.79	6.87
Overt Mnemonic (sec.)	0	0	0	0
Covert Mnemonic (sec.)	0	34	.74	4.59
Naming	0	50	9.68	13.99
Object Talk	0	4	.75	1.14
Associations	0	15	2.40	3.48
Categorizing	0	15	.39	2.38
T3 Strategy Use Composite	0	93	15.77	18.13

Note: Overt and covert mnemonic component codes are "state" codes capturing the total duration in seconds of a behavior. The remaining component codes are "event" codes and were measured by the frequency of their occurrence.

Recall on the Object Memory Task. As can be seen in the 4^{th} – 6^{th} rows of Table 8, children recalled 6.63 objects on average at the beginning of kindergarten, increased slightly to 6.95 objects in the winter, and then remained at a similar average score in the spring (6.92 objects on average). Between the spring of kindergarten and the fall of first grade, children increased the number of objects recalled on average from 6.92 to 8.15, reported in the 6^{th} and 7^{th} rows of Table 8. Across the first-grade year, children's recall scores remained slightly above 8 objects on average. Unlike the Free Recall Task with Organizational Training, no children in the current study were able to recall every stimulus in the Object Memory Task (highest possible score = 15) when considering all timepoints, as evidenced by the 'Maximum' column in Table 8. Further interpretation of change over time in these raw scores will be discussed at Step 1 in the modeling building process.

Table 8. Average Strategy Use and Recall Scores on the Object Memory Task

Variable	N	Minimum	Maximum	Mean	Std. Deviation
OBJ Strategy Use (3 repeated measures)					
T1	76	0	77	14.04	16.21
T2	70	0	112	17.74	24.11
T3	73	0	93	15.77	18.13
OBJ Recall (6 repeated measures)					
T1	76	1	12	6.63	2.23
T2	73	3	11	6.95	1.60
T3	73	3	11	6.92	1.76
T4	67	2	14	8.15	2.07
T5	68	5	14	8.15	2.17
T6	67	2	13	8.36	2.09

Children's Self-Regulated Learning Skills (Time 2)

Descriptive statistics for indicators of children's self-regulated learning skills can be seen in Table 9. Assessed in the winter of the kindergarten year (Time 2), children's average score on the Dimensional Change Card Sort Task (DCCS) was 66.75 units. Also reported below in Table 9, children's average score on the Head-Toes-Knees-Shoulders Task was 29.75 units in the winter of kindergarten.

Table 9. Average Self-Regulated Learning Skills in Kindergarten

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Executive Function (DCCS)	72	34	94	66.75	20.94
Self-Regulation (HTKS)	73	0	38	29.75	7.01

Parent- and Teacher-Level Variables

Parents' Elaborative Reminiscing Style (Time 1)

Descriptive statistics for individual components of parents' elaborative reminiscing style were also calculated prior to the creation of a composite measure in line with previous research. Based on the work of Langley et al. (2017), a composite measure of *parents' elaborative style* was developed by including components of parents' speech: 1) average elaborations; 2) average associative talk; 3) average confirmations; and 4) average metamemory talk. However, because these components differed substantially in frequency (see Table 10), it was necessary to compute standard scores using *z*-score conversions before combining them into a composite index. This approach, adapted from the work of Langley et al. (2017), allowed each of the four subcomponents of parents' elaborative style to contribute equal weight in the final composite measure. For example, shown in the second row of Table 10, *metamemory talk* had the lowest average frequency of the four components ($M = .67, SD = 1.05$), but even though instances of metamemory talk are rare they can nonetheless play an integral role in the development of children's memory skills. For this reason, a standardized composite approach to capturing maternal elaborative style prevented components from being "washed out" by more frequent conversational speech (such as elaborations and confirmations) (Langley et al., 2017). Descriptive statistics for parents' elaborative reminiscing style can be found in the final row of Table 10 and the 1st row of Table 14

Table 10. Descriptive Statistics for Components of Parents' Elaborative Style in the Mother–Child Reminiscing Task

Component	Min.	Max.	Mean	SD
Elaborations	7.5	119	39.58	22.59
Metamemory Talk	0	5.50	.67	1.05
Associative Talk	0	31.50	8.53	6.72
Confirmations	3	76	21.43	13.24
Elaborative Style	-4.17	9.70	0	3.06

N = 54

Teachers' Cognitive Processing Language (Time 2)

Descriptive statistics aiming to characterize kindergarten teachers' use of cognitive processing language (CPL) included illustrating the types and frequencies of each component code of CPL used by teachers. Described in the previous chapter, teacher-led whole-class mathematics and language arts lessons were first observed and coded using the *Taxonomy of Teacher Behaviors* to assess the frequency of different types of teacher instructional language. A total of 60 minutes of classroom instruction was captured for each teacher (600 minutes across the sample). Individual codes were only assigned once per 30-second interval. Therefore, descriptive findings shown in Table 11 represented the percentage of intervals for each teacher that contained a given code.

Table 11. Descriptive Statistics for All Codes in the Taxonomy of Teacher Behaviors

Individual Codes by Category	Overall Percent Occurrence	Range Across Teachers
Non-Instruction/Non-Memory	4.17%	1.67% - 9.58%
Instructional Activities	95.13%	92.08% - 98.75%
General Information Giving	82.46%	73.33% - 92.08%
Book Reading	9.33%	0.00% - 20.83%
Prospective Summary	7.29%	4.17% - 9.58%
Specific Task Information	47.04 %	29.17% - 67.08%
Cognitive Structuring	49.58%	37.08% - 60.42%
Attention Regulation: Behavioral Goal	19.88%	9.17% - 36.67%
Attention Regulation: Instructional Goal	19.75%	7.50% - 32.50%
Massed Repetition	13.33%	5.42% - 26.67%
Identifying Features	4.67%	0.00% - 16.67%
Categorization	2.00%	0.00% - 5.42%
Identifying Relationships	11.13%	2.50% - 20.00%
Personal Experience Connections: Home	1.38%	0.00% - 3.75%
Personal Experience Connections: School	10.67%	6.25% - 12.92%
Drawing Inferences	2.21%	0.00% - 2.50%
Visual Imagery	0.46%	0.00% - 2.50%
Memory Requests	58.33%	50.42% - 67.08%
Episodic	1.13%	0.00% - 3.33%
Semantic	53.54%	45.42% - 62.50%
Procedural	0.17%	0.00% - 1.25%
Prospective	1.17%	0.42% - 2.92%
Anticipated	5.25%	2.50% - 9.17%
Metacognitive Instruction	25.08%	12.92% - 34.17%

Metacognitive Rationale	5.08%	1.67% - 9.58%
Metacognitive Questioning	11.17%	5.00% - 21.67%
Suggestion	14.83%	2.50% - 27.50%
Suppression	0.92%	0.00% - 2.92%
Replacement	0.38%	0.00% - 1.67%

Note: Percentages represent the number of intervals for each code out of 120 (i.e., the total number of intervals observed per teacher.

As seen in Table 11, significant variability was observed in the frequencies for each type of language used by teachers in the current study. The majority of observed intervals contained some form of *instructional activity* (95.13%). Of this 95%, the most frequently observed codes were *general information giving* (82.46%) and *specific task information* (47.04%). Additionally, teachers used *cognitive structuring activities* in 49.58% of the observed intervals. Specifically, teachers were observed most frequently redirecting student *behavior* (19.88%) and focusing *attention* in service of an instructional goal (19.75%). On average, 11.13% of intervals included teachers *identifying a relationship* between two concepts, 10.67% involved connecting the current lesson to a *previous school experience*, and 13.33% involved engaging students' participation through *massed repetitions*. *Memory requests* were also frequently used by teachers (58.33%) and about half of these intervals included instances of the teacher asking students to recall *semantic* information (53.54%). However, other types of memory requests were less frequent, such as asking students to *anticipate* future memory demands (5.25%). Finally, *metacognitive instruction* was the least common of the four main categories of teacher language (25.08%).

In order to create an index of teachers' cognitive processing language (CPL), five component codes were calculated and are listed in Table 12. The mean percentage of intervals for each of the five components are listed in the first column. Due to the high level of variability across these components, standardized scores were generated for each code on the basis of means and standard deviations. Each of the resulting *T* scores was averaged to create a composite index of CPL. The mean *T* score was 50 (*SD* = 8.00) with a range of 40.39 to 61.15. Although CPL is a continuous measure, due to the small number of classrooms (*n* = 10) teachers were divided into high and low groups using a median split approach. Despite differences in teachers' use of cognitive processing language, the two groups were similar in other key areas. Teachers in each group were similar in age (Low CPL = 35.50 years; High CPL = 37.57 years), overall teaching experience (Low CPL = 13.40 years; High CPL= 11.60 years), and experience teaching kindergarten (Low CPL = 7.20 years; High CPL= 9.80 years). Differences across these demographic statistics were not statistically significant ts (8)≤.26, ps≥.33. However, teachers characterized by higher levels of CPL were more likely to hold a master's degree than teachers characterized by lower levels of CPL: 1 out of 5 teachers in the Low CPL group had a master's degree compared to 4 out of 5 in the High CPL group (t (8) = -2.12; p =.03). This finding is not consistent with previous work in which there have been no significant differences observed in teachers' use of CPL by their educational attainment (Coffman et al., 2008; 2019).

Table 12. Average Percentages of the Occurrence of Components of CPL

Components of CPL	Overall Sample	Low CPL	High CPL
Strategy Suggestion	14.83%	12.42%	17.25%
Metacognitive Questioning	11.17%	8.00%	14.33%
Co-occurrence of Memory Requests and Instructional Activities	55.46%	51.58%	59.33%
Co-occurrence of Memory Requests and Cognitive Structuring Activities	30.96%	25.42%	36.50%
Co-occurrence of Memory Requests and Metacognitive Information	15.00%	12.00%	18.00%

Research Questions 1 and 2 involve understanding the role of teachers' CPL on children's development of skills over time. In order to understand the potential confoundment between children's initial deliberate memory scores and their subsequent development as a function of CPL (i.e., if children's initial memory skills are primarily driving their development over time, not their environment), a series of t-tests were conducted to understand initial differences in children's deliberate memory scores at Time 1. These data were collected within the first few weeks of the kindergarten year and therefore is assumed that differences in children's deliberate memory scores may be attributed to teachers' CPL. As can be seen in Table 13, there were no significant differences in children's initial deliberate memory skills as a function of their placement in high- vs. low-CPL classrooms with one exception: In the third row of Table 13, significant differences were present for children's deliberate strategy use on the Object Memory Task as a function of CPL in the fall of kindergarten. However, these findings revealed that children in low-CPL classrooms evidenced higher initial strategy use on the Object Memory Task than their peers in high CPL classrooms (Low CPL M = 7.00; High CPL M = 12.00). Shown in the bottom two rows of Table 13, there were no significant differences in children's self-regulated learning skills (i.e., executive function and self-regulation) as a function of CPL.

Table 13. Mean Differences in Children's Early Outcomes Predicted by Teachers' CPL

Variable	t	df	One-sided p	Two-sided p	95% Confidence Interval Lower	Upper
T1 FRT Sorting ARC	-1.23	74	.11	.22	-.09	.02
T1 FRT Recall	-.04	74	.48	.97	-1.25	1.20
T1 OBJ Strategy Use	1.78	74	.04	.08	-.78	13.87
T1 OBJ Recall	-.32	74	.38	.75	-1.20	.87
T2 DCCS	-.42	70	.34	.68	-12.05	7.89
T2 HTKS	-.60	71	.28	.55	-4.29	2.31

Model Building Overview

In order to address the primary research questions and hypotheses, a series of hierarchical linear models (HLMs) were created to model growth curves, simultaneously examining the three-level structure of time nested within children, and children nested within classrooms. General model building, testing, and evaluation strategies described by Raudenbush and Bryk (2002) were followed alongside methods proposed by Curran et al. (2004; 2006) for testing and probing higher ordered interactions within the growth curve models. All analyses were conducted using the PROC MIXED procedure in SAS v. 14.1 (SAS Institute Inc., 2015) and missing data resulting from repeated measures were addressed using the restricted maximum likelihood (REML) estimation method, which produces estimates that are less biased than conventional missing data estimation approaches (Acock, 2005; Little & Rubin, 2002). Missing data at the predictor level resulted in listwise deletion, resulting in varying sample sizes across models. As can be seen in the first 4 rows of Table 14, Hypotheses 1a and 1b had a sample size of 54 children, Hypotheses 2a and 2b had a sample size of 76 children, Hypotheses 3a and 3b had a sample size of 72 children, and Hypotheses 3c and 3d had a sample size of 73 children.

Table 14. Varying Sample Sizes Across Hypotheses by Time-Invariant Covariate

Variable		N	Min.	Max.	Mean	Std. Deviation
Hypotheses	Time Invariant Covariates					
H. 1a and 1b	Parents' Elaborative Style	54	-4.17	9.70	0	3.06
H. 2a and 2b	Kindergarten Teachers' CPL	76	0	1	-	-
H. 3a and 3b	Executive Function (DCCS)	72	34	94	66.75	20.94
H. 3c and 3d	Self-regulation (HTKS)	73	0	38	29.75	7.01

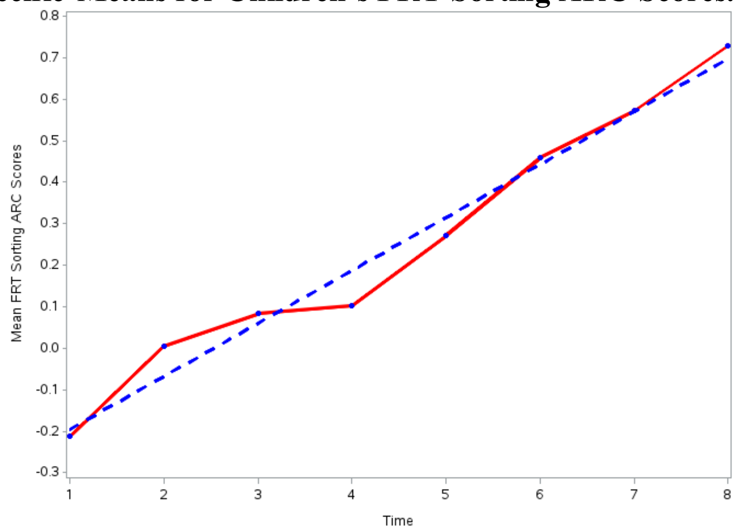
Note: Kindergarten Teachers' CPL is a dichotomous variable.

As is customary in the HLM framework (Singer & Willett, 2003), first, described under the Step 1 heading below, time-specific means for children's deliberate memory development over time were examined and plotted. Second, noted below the Step 2 heading, a series of unconditional models were estimated to capture individual growth trajectories (intercepts and slopes) of children's deliberate memory skills across the kindergarten and first-grade years. The purpose of these models was to establish a baseline amount of variance explained by children's deliberate memory skills, to determine if the defined intercept is statistically significant from 0, and to assess if there is statistically significant average growth in these skills over time. Fixed and random effects will be interpreted at this step. In accordance with model building practices, if a repeated measures outcome does not exhibit change over time, it will be dropped from all further analyses. The third step of model building focuses on improving model fit prior to entering in predictor variables. This will be done in two ways: probing improved model fit through (a) allowing for heteroscedastic error terms at Level 1 and (b) allowing for a quadradic model of development. In order to test the first assumption of Level 1 homoscedasticity in multilevel modeling (i.e., that the residual variance is the same for children's deliberate memory skills across all timepoints), model fit will be assessed before and after allowing for a heteroscedastic error variance structure and tested through a likelihood ratio test (LRT; as defined by the REPEATED statement). Given the number of repeated measures in the current study, probing for a quadratic random effect is necessary to best represent the data. Similar to testing the assumption of homoscedasticity at Level 1, an LRT test will be conducted for each unconditional model to highlight the potential improvements in model fit if allowing for a non-linear pattern of growth. If improvements to model fit for a given outcome are found for either parameters of (a) heteroscedastic error terms or (b) quadratic slopes, these modifications will be included in all conditional models to follow. The fourth and final step involves entering predictors, resulting in conditional growth curve models. For Research Questions 1 & 2, fixed effect outputs of conditional models will be interpreted. For models resulting in significant conditional results, random effects will also be interpreted. For Research Question 3, given the complexity of a three-way interaction, first a series of cross-sectional models will be conducted to understand the main and interaction effects at one timepoint. If results support significant fixed main and interaction effects, these models will then be expanded to include Time as a predictor and once again model conditional growth over time in children's deliberate memory skills. The results of these models will be subsequently interpreted.

Step 1: Exploring Time-Specific Means

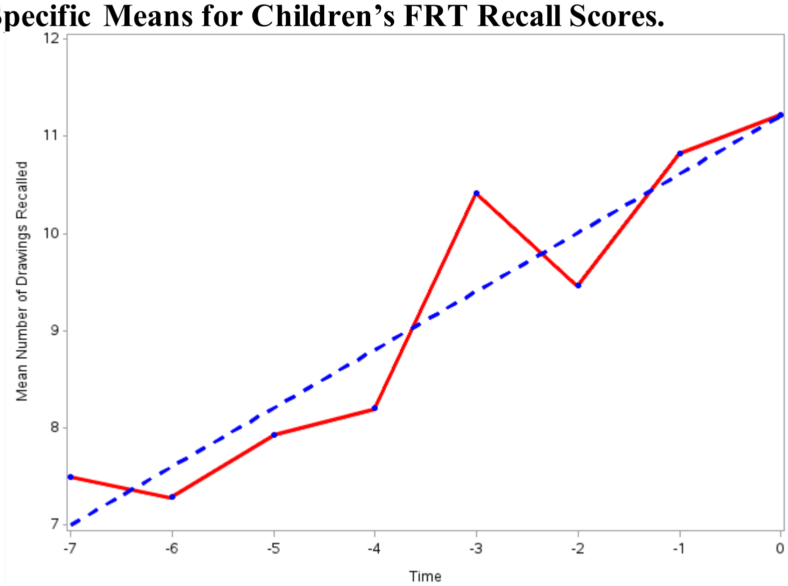
Descriptive statistics, including means, standard deviations, and minimum and maximum values, were reported previously in Tables 6, 8, 9 and 10. The normality of data was first assessed, and outliers regarding predictor and repeated measures outcomes were assessed. No outliers were identified, and the data were normally distributed with the exception of one variable: Children's sorting ARC scores on the Free Recall with Organizational Training Task. In line with previous research using sorting ARC as an index of children's strategy use (Coffman et al., 2008; 2019; Langley et al., 2017) a unique but consistent phenomenon has been observed: the majority of children evidence uniformly low levels of strategy use at baseline. Once children undergo organizational training, variability is represented by the data. Therefore, this is one limitation of this task and may have implications for the interpretation of results. Prior to formally testing unconditional growth, descriptive statistics of the repeated measures data structure were first explored. Time-specific means for each dependent variable were calculated and plotted using the PROC GPLOT function to examine initial patterns of growth over time. As can be seen below in Figures 2, 3, and 4, children's FRT sorting ARC, FRT recall, and OBJ recall scores exhibited a linear pattern over time. Children's average FRT sorting ARC scores increased from -.21 at kindergarten entry to .73 at the end of first grade, FRT recall scores increased from 7.50 at kindergarten entry to 11.22 at the end of first grade, and OBJ recall scores increased from 6.63 to 8.36 from kindergarten entry (T1) to the end of first grade (T6). However, children's OBJ strategy use scores (Figure 5) did not appear to fit a linear pattern of growth over the course of the kindergarten year (T1 – T3).

Figure 2. Time-Specific Means for Children's FRT Sorting ARC Scores.



Note: The Free Recall with Organizational Training Task (FRT) has 8 repeated measures across 6 timepoints to include baseline and generalization trials at times 1 and 4.

Figure 3. Time-Specific Means for Children's FRT Recall Scores.



Note: The Free Recall with Organizational Training Task (FRT) has 8 repeated measures across 6 timepoints to include baseline and generalization trials at times 1 and 4.

Figure 4. Time-Specific Means for Children's OBJ Recall Scores.

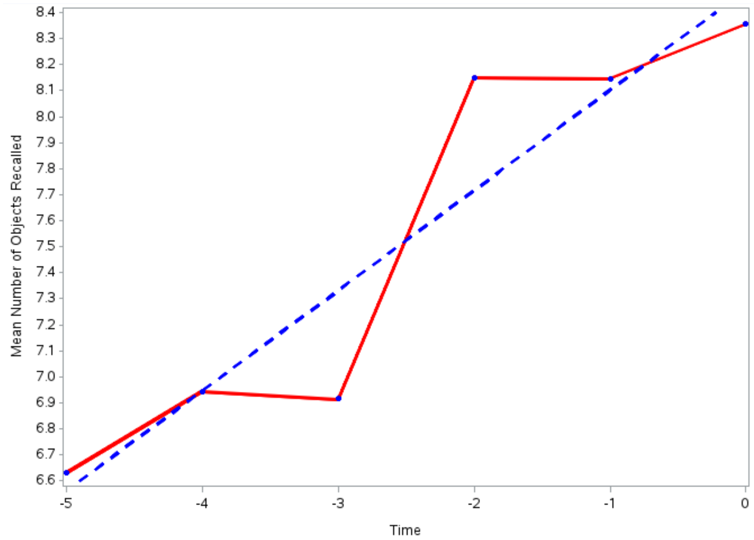
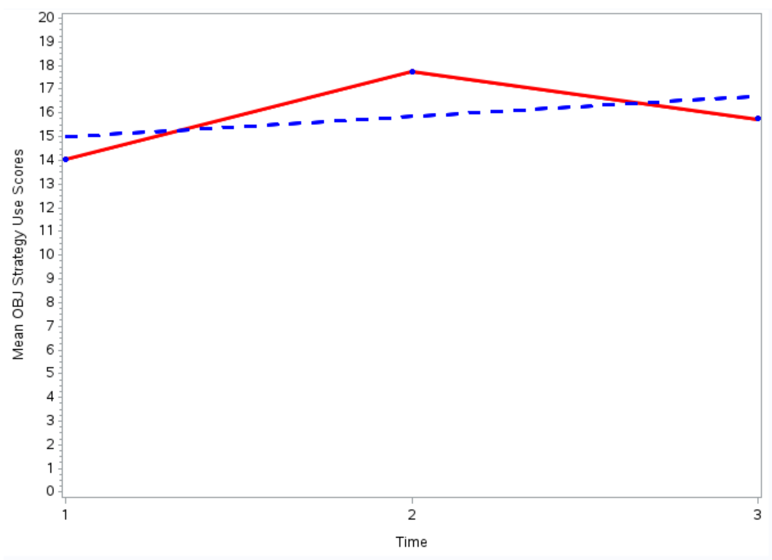


Figure 5. Time-Specific Means for Children's OBJ Strategy Use Scores.



Step 2: Unconditional Growth Curve Models

A series of unconditional growth curve models (random intercept and random slope models) were tested to (a) formally establish a baseline amount of variance for each timepoint, (b) determine if the defined intercept was statistically significant from zero, and (c) if there was significant growth over time in children's deliberate memory skills. Fixed effect outputs for each dependent variable are displayed in Table 15. reporting average estimates for all children in the sample, across all classrooms. Specific effects will be discussed in more detail below. Not only was it necessary to test for significant variability between children at T1 (kindergarten entry) to answer RQ1, but it was also necessary to examine differences between children at T6 (end of first grade) to answer RQ2 and RQ3. Therefore, intercept estimates for both T1 and T6 are reported below in Table 15.

Table 15. Fixed Effects Results for Unconditional Growth Curve Models of Children's Deliberate Memory Outcomes

Estimated Fixed Effects	Coefficient	SE	t	df	p	95% Confidence Interval	
						Lower	Upper
FRT Sorting ARC							
Intercept at T1	-.20	.04	-5.66	78	<.0001	-.28	-.13
Intercept at T6	.70	.06	11.76	78	<.0001	.58	.82
Slope	.13	.01	14.26	484	<.0001	.11	.15
FRT Recall							
Intercept at T1	7.00	.26	27.25	78	<.0001	6.48	7.50
Intercept at T6	11.18	.31	35.63	78	<.0001	10.55	11.80
Slope	.60	.06	10.61	483	<.0001	.49	.71
OBJ Strategy Use							
Intercept at T1	14.94	1.80	8.32	74	<.0001	11.36	18.52
Intercept at T3	16.89	2.53	6.68	74	<.0001	11.85	21.93
Slope	.98	1.37	.71	143	.48	-1.74	3.69
OBJ Recall							
Intercept at T1	6.53	.19	34.45	78	<.0001	6.16	6.91
Intercept at T6	8.48	.22	39.32	78	<.0001	8.05	8.91
Slope	.39	.05	7.17	344	<.0001	.28	.50

Free Recall Task with Organizational Training

In the first three rows of Table 15, fixed effects for children's FRT sorting ARC scores can be seen. The model implied average at T1 was -.20 ($p < .001$) and .70 at T6 ($p < .001$), indicating that children transitioned from slightly below chance to above chance with regard to their strategic sorting efforts over the course of the kindergarten and first-grade years. Shown in the third row of Table 15, the estimate for the linear expected increase was .13 units per timepoint ($p < .001$). For both the intercept and slope parameters, significant fixed effects were found, revealing differences from zero. Estimated random effects can be seen in below in Table

16. Reported in the fifth row of Table 16, when specifying the intercept to T1, there was significant variance among children's individual slopes ($\hat{\tau}_{11}$= .00, p = .04) and there remained significant variability at Level 1 after accounting for the effect of time ($\hat{\sigma}^2$=.16, p <.001) as can be seen in the sixth row. However, shown in the first row of Table 16, there was no significant variance between individual children's intercepts at T1 ($\hat{\tau}_{00}$= .02, p = .17) and no significant covariance between these intercepts and individual slopes ($\hat{\tau}_{10}$= .00, p = .36). However, when specifying the intercept to T6, as shown in the 3rd and 4th rows of Table 16, parameter estimates of children's intercepts significantly differed from 0, demonstrating significant variability among children's individual intercepts ($\hat{\tau}_{00}$= .18, p <.001) and a significant covariance between the intercepts and slopes ($\hat{\tau}_{10}$= .02, p = .00). Significant slope parameters and Level 1 variability remained the same regardless of intercept specification.

Table 16. Random Effects Results for Unconditional Growth Curve Models of Children's Deliberate Memory Outcomes

		Covariance Parameter Estimates			
		Estimate	SE	Z Value	p
FRT Sorting ARC					
Intercept at T1	$\hat{\tau}_{00}$	.02	.02	.95	.17
	$\hat{\tau}_{10}$	.00	.00	.91	.36
Intercept at T6	$\hat{\tau}_{00}$	.18	.02	4.17	<.0001
	$\hat{\tau}_{10}$	.02	.01	2.82	0.00
Slope	$\hat{\tau}_{11}$	.00	.00	1.71	.04
	$\hat{\sigma}^2$	.16	.01	14.46	<.0001
FRT Recall					
Intercept at T1	$\hat{\tau}_{00}$	2.52	1.10	2.29	.01
	$\hat{\tau}_{10}$	-.17	.18	-.91	.36
Intercept at T6	$\hat{\tau}_{00}$	4.21	1.19	3.53	.00
	$\hat{\tau}_{10}$	.38	.19	1.98	.04
Slope	$\hat{\tau}_{11}$	.07	.04	1.72	.04
	$\hat{\sigma}^2$	6.32	.44	14.43	<.0001
OBJ Recall					
Intercept at T1	$\hat{\tau}_{00}$	1.33	.46	2.88	.00
	$\hat{\tau}_{10}$	-.08	.11	-.76	.45
Intercept at T6	$\hat{\tau}_{00}$	1.86	.57	3.27	.00

	$\hat{\tau}_{10}$	.19	.13	1.50	.13
Slope	$\hat{\tau}_{11}$	.05	.04	1.44	.07
	$\hat{\sigma}^2$	2.62	.22	11.80	<.0001

Regarding children's recall scores in FRT, fixed effect analyses shown in the fourth and fifth row of Table 15 revealed the model implied average at T1 was 7 drawings recalled ($p < .001$) and 11.18 drawings recalled at T6 ($p < .001$). The estimate for the linear expected increase, reported in the 6th row, was .60 drawings per timepoint ($p < .001$). For both the intercept and slope parameters, significant fixed effects were found, revealing differences from zero. Exhibited by random effects outputs in the 7th and 11th rows in Table 16, when specifying the intercept to T1, there was significant variance between individual children's intercepts at T1 ($\hat{\tau}_{00}$= 2.52, p = .01) and there was significant variance among children's individual slopes ($\hat{\tau}_{11}$= .07, p = .04). Reported in the 12th row of Table 16, there remained significant variability at Level 1 after accounting for the effect of time ($\hat{\sigma}^2$= 6.32, p <.001). However, as reported in the 8th row of Table 16, there was no significant covariance between intercepts at T1 and individual slopes ($\hat{\tau}_{10}$= -.17, p = .36). When specifying the intercept to T6, parameter estimates of children's intercepts still significantly differed from 0, demonstrating significant variability among children's individual intercepts ($\hat{\tau}_{00}$= 4.21, p = .00) and a significant covariance between the intercepts and slopes was observed ($\hat{\tau}_{10}$= .38, p = .04), reported in the 9th and 10th rows of Table 16 respectively. Significant slope parameters and Level 1 variability remained the same regardless of intercept specification.

The Object Memory Task

In the fixed effects analyses of children's strategy use in the Object Memory Task (OBJ), the model implied average at T1 and T3, reported in the 7th and 8th rows of Table 15, were 14.94 ($p < .001$) and 16.89 ($p < .001$) respectively, indicating that children slightly increased in their strategic efforts in OBJ over the course of the kindergarten year. The estimate for the linear expected increase was .98 units per timepoint, as shown in the 9th row of Table 15, but this change over time was not statistically significant ($p = .48$). It is important to note that children's strategy use in OBJ was only assessed over the kindergarten year (3 timepoints) due to availability of data. Additionally, since a baseline amount of change over time could not be established in the estimated fixed effects, children's strategy use in OBJ were dropped from all further analyses.

Regarding children's recall scores in OBJ, fixed effect analyses revealed the model implied average at T1 was 6.53 objects recalled ($p < .001$) and 8.48 objects recalled at T6 ($p < .001$), reported in the 10th and 11th row of Table 15 respectively. The estimate for the linear expected increase was .39 objects per timepoint ($p < .001$), shown in the 12th row of Table 15. For both the intercept and slope parameters, significant fixed effects were found, revealing differences from zero. Exhibited by random effects outputs in Table 16, when specifying the intercept to T1 reported in the 13th and 17th rows of Table 16, there was significant variance between individual children's intercepts at T1 ($\hat{\tau}_{00}$= 1.33, p = .00), there was marginal variance among children's individual slopes ($\hat{\tau}_{11}$= .05, p = .07). Shown in the 18th row of Table 16, there remained significant variability at Level 1 after accounting for the effect of time ($\hat{\sigma}^2$= 2.62, p <.001). However, as reported in the 14th row of Table 16, there was no significant covariance between intercepts at T1 and individual slopes ($\hat{\tau}_{10}$= -.08, p = .45). When specifying the intercept to T6, parameter estimates of children's intercepts still significantly differed from 0, demonstrating significant variability among children's individual intercepts ($\hat{\tau}_{00}$= 1.86, p = .00) as reported in the 15th row of Table 16, but a non-significant covariance between the intercepts and slopes was observed ($\hat{\tau}_{10}$= .19, p = .13), listed in the 16th row. Significant slope parameters and Level 1 variability remained the same regardless of intercept specification.

Step 3: Probing Model Fit

After establishing significant intercepts and slopes across unconditional models predicting children's FRT sorting ARC scores, FRT recall, and OBJ recall, it was important to test for improvements to model fit through allowing for heteroscedastic error structures at level 1 (time) and probing for non-linear change over time through the quadratic function. One assumption of hierarchical linear modeling is that the Level 1 error variances are homoscedastic. Within the current set of questions, this meant that there was an assumption that the variance surrounding children's deliberate memory skills remained the same for each timepoint. This restriction may not hold given the characteristics of these data. One way to improve model fit would be to allow the residual variances to differ from one another as a function of time, enabling a heteroscedastic error structure of Level 1 residual variances. Therefore, a series of Likelihood Ratio Tests (LRT) were conducted to determine if the homoscedasticity assumption is valid and could subsequently improve model fit.

Table 17. LRT Results for Testing Heteroscedastic Errors.

	Convergence Criterion 1	Convergence Criterion 2	LRT	df	p
FRT Sorting ARC	689.9	568.0	121	7	.00
FRT Recall	2705.7	2691.2	14.5	7	.04
OBJ Recall	1701.0	1691.9	9.1	5	.11

Note: Intercept specification is irrelevant for these tests.

As can be seen above in Table 17, the REML convergence criterion for the more restricted model (e.g., homoscedastic errors) was compared to that of the less restricted model (i.e., heteroscedastic errors). The LRT results for OBJ recall shown in the third row of Table 17 resulted in a non-significant p-value (LRT= 9.1, *p* =.11), indicating that model fit was not significantly improved when allowing for a heteroscedastic error structure at Level 1. When allowing for heteroscedastic errors in unconditional models of FRT sorting ARC and FRT recall scores, LRT results suggested that model fit significantly improved (LRT = 121, p = .00; LRT = 14.5, p = .04), shown in the first and second rows of Table 17. Therefore, for all subsequent conditional growth curve models of FRT sorting ARC and recall, the allowance of heteroscedastic error terms will be retained to best fit the data.

Due to the number of timepoints in the current growth curve models, it was necessary to examine if a quadratic model of change over time better represented the data. As can be seen below in Table 18, fixed and random effects for the quadratic component (time*time) are reported. When predicting children's FRT recall scores over time, the fixed quadratic effect was non-significant (p = .23), shown in the 7th row of Table 18, and the random effect was estimated at 0, shown in the 8th row of Table 18, indicating that there was 0 observed variance among children's individual slopes when allowing for non-linear change over time.

Table 18. Fixed and Random Effects of Quadratic Unconditional Growth Models.

Estimated Effects	Coefficient	SE	t(fixed)/Z(random)	df	p
			FRT Sorting ARC		
Fixed Effects					
Intercept at T6	.73	.06	11.85	78	<.0001
Linear Slope	.16	.03	4.73	483	<.0001
Quadratic Slope	.01	.00	1.05	483	.29
Random Effect					
$\hat{\tau}_{22}$	.00	.00	1.92	.	.03
			FRT Recall		
Fixed Effects					
Intercept at T6	11.39	.38	29.85	78	<.0001
Linear Slope	.80	.18	4.43	482	<.0001
Quadratic Slope	.03	.02	1.21	482	.23
Random Effect					
$\hat{\tau}_{22}$	0	.	.	.	.
			OBJ Recall		
Fixed Effects					
Intercept at T6	8.49	.26	33.03	78	<.0001
Linear Slope	.40	.18	2.22	343	.03
Quadratic Slope	.00	.03	.06	343	.96
Random Effect					
$\hat{\tau}_{22}$	.01	.02	.93	.	.18

Note: Intercept specification is irrelevant for these tests.

Similarly, when predicting children's OBJ recall scores, both the fixed quadratic effect in row 11 (p = .96) and the random quadratic effect in row 12 were non-significant ($\hat{\tau}_{22}$ = .01, p = .18). For both FRT recall and OBJ recall development, there is evidence that allowing for a quadratic model of change over time is unnecessary and that a linear trajectory best fit the data. However, when predicting children's FRT sorting ARC scores over time, the fixed quadratic effect was non-significant (p = .29) as listed in the third row of Table 18, but the variance of the quadratic random effect was significant ($\hat{\tau}_{22}$ = .00, p = .03) shown in the fourth row of the same table. This provides ambiguous evidence that a quadratic effect is needed. Accordingly, an LRT test was conducted to formally test the improvement in model fit with the inclusion of the quadratic term, comparing the more restricted model (i.e., linear) to the less restricted model (i.e., quadratic). Although the results of this test were statistically significant (LRT = 78.9, p<.0001), the quadratic trend in this case is so small that it was omitted from further analyses – in favor of the linear model of change – to simplify model specification when analyzing a small sample.

Step 4: Conditional Growth Curve Models

Research Question 1

How do children's deliberate memory skills develop across the kindergarten and first-grade years as a function of their parents' elaborative reminiscing style?

To address research question 1, a 2-level growth curve model was created to examine the between-child effect of parents' elaborative reminiscing style on children's deliberate memory skills. Described by the algebraic notation in Figure 6 below, Time is entered into the model as a predictor at Level 1 and parents' elaborative style was entered into the model at Level 2. Hypothesis 1a posited that children with parents who evidenced higher elaborative reminiscing style would enter kindergarten with higher levels of deliberate memory skills than their peers with parents evidencing lower elaborative style. Contrary to hypothesis 1a, the main effect of parents' elaborative style in models predicting FRT sorting ARC scores ($\hat{\gamma}_{01}$ = .02), FRT recall scores ($\hat{\gamma}_{01}$ = .11), and OBJ recall scores ($\hat{\gamma}_{01}$ = .13) are all non-significant, as can be seen on the next page in the 3rd, 6th, and 9th rows of Table 19. Results indicated that the model-implied intercepts for children's FRT sorting ARC, FRT recall, and OBJ recall scores respectively were .02, .11, and .13 units higher for every one unit increase in parents' elaborative style at kindergarten entry, but these are not statistically significantly different from zero.

Figure 6. Algebraic Notation for Hypotheses 1a and 1b

Level-1 conditional model

$$Deliberate\ Memory_{ij} = \beta_{0j} + \beta_{1j}Time_{ij} + r_{ij}$$

Level-2 conditional model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}ElaborativeStyle_j + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}ElaborativeStyle_j + u_{1j}$$

$Deliberate\ memory_{ij}$ = students' average deliberate memory skills
β_{0j} = students' deliberate memory skills at fall of kindergarten
β_{1j} = students' growth rate of deliberate memory skills
γ_{01} = average deliberate memory skills by parents' elaborative style at fall of kindergarten
γ_{11} = growth rate of deliberate memory skills by parents' elaborative style

Table 19. Conditional Fixed Effects Predicting Children's Deliberate Memory Outcomes from Parents' Elaborative Style at Kindergarten Entry

Estimated Fixed Effects	Coefficient	SE	t	df	p	95% Confidence Interval Lower	Upper
FRT Sorting ARC							
Intercept	-.22	.04	-5.33	52	<.0001	-.30	-.14
Slope	.14	.01	14.04	336	<.0001	.12	.16
ElabStyle	.02	.01	1.41	52	.16	-.01	.05
ElabStyle*Slope	.00	.00	.91	336	.36	-.00	.01
FRT Recall							
Intercept	7.11	.31	22.75	52	<.0001	6.49	7.74
Slope	.66	.07	9.65	336	<.0001	.52	.79
ElabStyle	.11	.10	1.04	52	.30	-.10	.31
ElabStyle*Slope	-.00	.02	-.19	336	.85	-.05	.04

OBJ Recall							
Intercept	6.61	.23	28.72	52	<.0001	6.15	7.06
Slope	.44	.06	7.04	238	<.0001	.32	.55
ElabStyle	.13	.07	1.80	52	.07	-.01	.28
ElabStyle*Slope	-.04	.02	-2.17	238	.03	-.08	-.00

Note: Intercept specified to T1

Hypothesis 1b posited that children with parents who evidenced higher elaborative reminiscing style will develop more rapidly in their deliberate memory skills than their peers with parents who evidenced lower elaborative style. There was mixed evidence supporting this hypothesis, in that the ElaborativeStyle*Time interaction was only significant when predicting change over time in children's OBJ recall ($\hat{\gamma}_{11}$ = -.04), shown in the final row of Table 19, but not for FRT sorting ARC ($\hat{\gamma}_{11}$ = .00) or recall scores ($\hat{\gamma}_{11}$ = -.00), reported in the 4th and 8th rows of Table 19 respectively. This reflected that the model-implied linear slopes for children's recall in OBJ differed as a function of parents' elaborative style; for every one unit increase in parents' elaborative style, children's OBJ recall scores were estimated to decrease by .04 units on average at each timepoint. To further probe this interaction, model-implied simple intercepts and simple slopes for the trajectory of OBJ recall scores were calculated one standard deviation above the mean (i.e., high), at the mean (i.e., medium), and below the mean (i.e., low) in terms of parent's elaborative style.

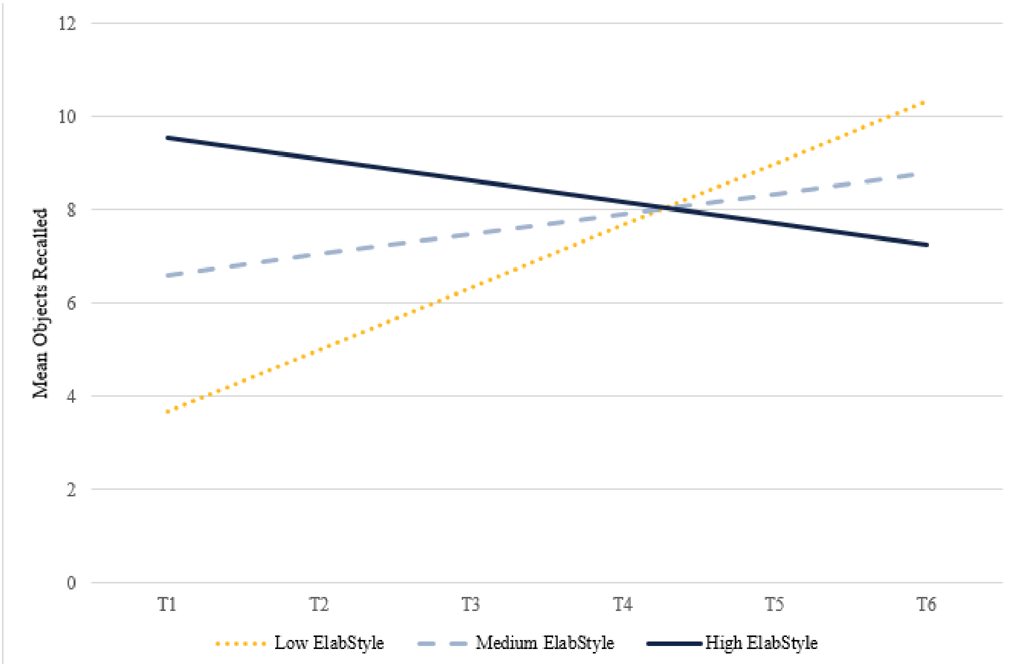
Table 20. Model-Implied Intercepts and Slopes of Children's OBJ Recall Scores.

Level of Elaborative Style	Estimate	Coefficient	SE	df	t	p
Low	Intercept	3.67	1.68	52	2.18	.03
	Slope	1.33	.45	238	2.99	.00
Medium	Intercept	6.61	.23	52	28.72	<.0001
	Slope	.44	.06	238	7.04	<.0001
High	Intercept	9.54	1.68	52	5.68	<.0001
	Slope	-.46	.45	238	-1.03	.30

Note: Intercept specified to T1

As can be seen above in the 2nd and 4th rows of Table 20, the slope trajectory was significant and positive at low and medium levels of elaborative style, but the slope was not significantly different at high levels of elaborative style (*p* = .30), listed in the final row. Further illustrated below in Figure 7, these results indicate that children with parents who evidenced low and medium levels of elaborative style at kindergarten entry developed more rapidly over the course of the kindergarten and first-grade years compared to their peers with high levels of parental elaborative style.

Figure 7. Simple Intercepts and Slopes for Children's OBJ Recall Scores Predicted by Parents' Elaborative Style.



Research Question 2

How do children's deliberate memory skills develop across the kindergarten and first-grade years as a function of their kindergarten teachers' cognitive processing language?

To answer this question, a 2-level growth curve model was constructed to examine the between-classroom effect of kindergarten teachers' CPL on children's deliberate memory skills. Initially, a 3-level model was considered (time nested within children, nested within classrooms). However, in line with model building practices suggested by Curran et al. (2004; 2006), initial random effects ANOVA model outputs revealed interclass correlation estimates close to 0 for all assessments of children's deliberate memory scores (FRT sorting ARC ICC = .01; FRT Recall ICC= .00; OBJ Recall ICC = .00), indicating little variability in these scores end of first grade that could be attributed to between-classroom differences. Therefore, teachers' CPL was entered into all conditional growth curve models at Level-2 (the child level) and was conceptualized in this model as representing *children's individual experiences of CPL* to analyze between-child effects, as reflected in the algebraic notation in Figure 8.

Figure 8. Algebraic Notation for Hypotheses 2a and 2b.

Level-1 conditional model

$$Deliberate\ Memory_{ij} = \beta_{0j} + \beta_{1j}Time_{ij} + r_{ij}$$

Level-2 conditional model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}CPL_j + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}CPL_j + u_{1j}$$

$Deliberate\ memory_{ij}$ = students' average deliberate memory skills
β_{0j} = students' deliberate memory skills at spring of first grade
β_{1j} = students' growth rate of deliberate memory skills
γ_{01} = average deliberate memory skills by children's exposure to CPL at spring of first grade
γ_{11} = growth rate of deliberate memory skills by children's exposure to CPL

Hypothesis 2a posited that children of high CPL kindergarten teachers would have higher deliberate memory skills on average at the end of the first-grade school year than their peers of low CPL teachers. As can be seen below in the 6th and 9th rows of Table 21, the main effect of children's exposure to teachers' CPL in models predicting FRT recall scores ($\hat{\gamma}_{01}$ = .72) and OBJ recall scores ($\hat{\gamma}_{01}$ = -.11) were non-significant. However, this same main effect was significant when predicting children's FRT sorting ARC scores ($\hat{\gamma}_{01}$ = .34), shown in the 3rd row of Table 21, reflecting that the model-implied intercept for children's sorting ARC scores was .34 units higher at the end of first grade for children exposed to high CPL teachers when compared to children exposed to low CPL teachers.

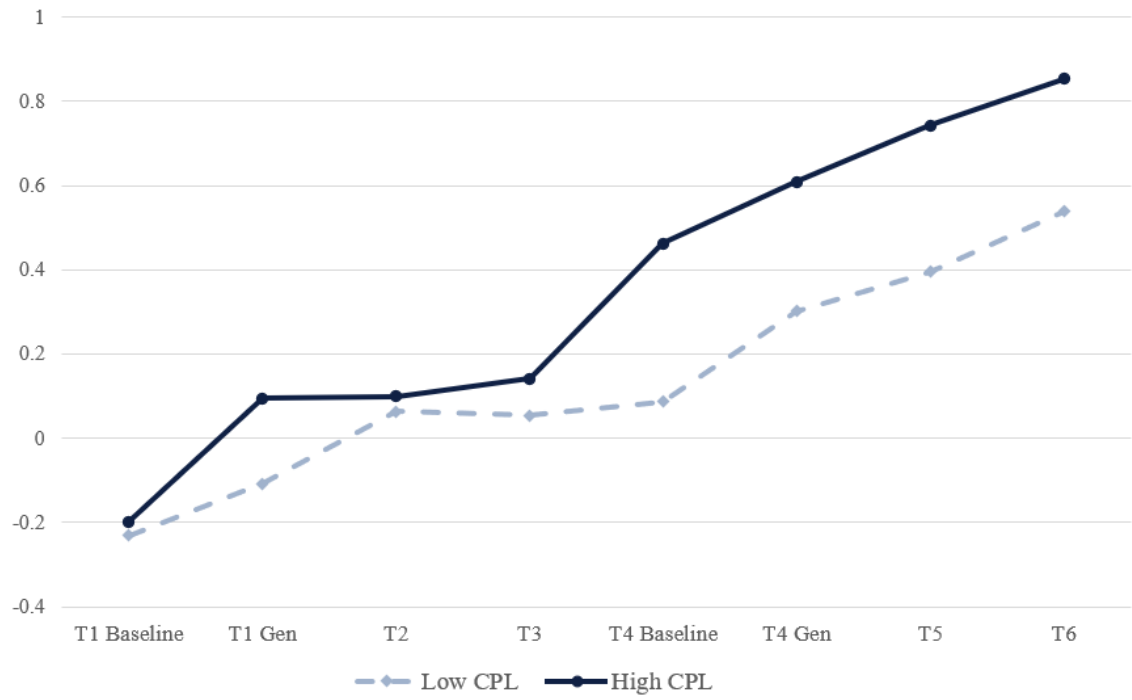
Table 21. Conditional Fixed Effects Predicting Children's Deliberate Memory Outcomes from Teachers' CPL at the End of the First-Grade Year.

Estimated Fixed Effects	Coefficient	SE	t	df	p	95% Confidence Interval	
						Lower	Upper
FRT Sorting ARC							
Intercept	.53	.09	6.04	74	<.0001	.36	.70
Slope	.11	.01	8.56	474	<.0001	.08	.13
CPL	.34	.12	2.83	74	.01	.10	.57
CPL*Slope	.04	.02	2.49	474	.01	.02	.08
FRT Recall							
Intercept	10.60	.48	22.02	74	<.0001	9.64	11.56
Slope	.53	.08	6.28	473	<.0001	.37	.70
CPL	.72	.65	1.11	74	.27	-.57	2.01
CPL*Slope	.06	.11	.51	473	.61	-.16	.28
OBJ Recall							
Intercept	8.57	.34	25.37	74	<.0001	7.90	9.24
Slope	.41	.08	4.98	337	<.0001	.25	.58
CPL	-.11	.45	.45	74	.81	-1.01	.79
CPL*Slope	-.04	.11	-.35	337	.73	-.26	.18

Note: Intercept specified to T6

Hypothesis 2b posited that children in kindergarten classrooms with teachers who were higher in CPL would develop deliberate memory skills more rapidly on average across the two years than their peers with teachers lower in CPL. As can be seen above in the 8th and 12th rows of Table 21, the interaction effect between children's exposure to teachers' CPL and time (CPL*Slope) in models predicting FRT recall scores ($\hat{\gamma}_{01}$ = .06) and OBJ recall scores ($\hat{\gamma}_{01}$ = -.04) were non-significant. However, as can be seen in the fourth row of Table 21, this interaction effect was significant when predicting children's FRT sorting ARC scores ($\hat{\gamma}_{01}$ = .04), reflecting that the model-implied linear slopes between children differed as a function of their exposure to high vs. low levels of CPL; for children that were exposed to high levels of CPL in kindergarten, their FRT sorting ARC scores were estimated to increase by .04 units on average at each timepoint. To further probe this interaction, raw mean scores for children's FRT sorting ARC scores were first plotted by their kindergarten teachers' level of CPL, as can be seen in Figure 9.

Figure 9. Children's Raw Average Sorting ARC Scores by Teachers' CPL.



Then, simple intercepts and simple slopes were calculated using the ESTIMATE command, were reported in Table 22, and plotted in Figure 10. Reported on the next page in Table 23, random effects pertaining to both research questions 2a and 2b revealed a significant amount of variability remained in the random intercept ($\hat{\tau}_{00}$ = 4.22, p = .00) and the random slope ($\hat{\tau}_{11}$ = .08, p = .03) after accounting for children's exposure to CPL. There also remained significant variability at Level 1 after accounting for the effect of time.

Table 22. Model-Implied Intercepts and Slopes of Children's FRT Sorting ARC Scores.

Level of CPL	Estimate	Coefficient	SE	df	t	p
Low	Intercept	.52	.09	74	5.99	<.0001
	Slope	.11	.01	474	7.96	<.0001
High	Intercept	.86	.08	74	10.99	<.0001
	Slope	.15	.01	474	12.14	<.0001

Note: Intercept specified to T6

Figure 10. Simple Intercepts and Slopes for Children's FRT Sorting ARC Scores Predicted by Teachers' CPL.

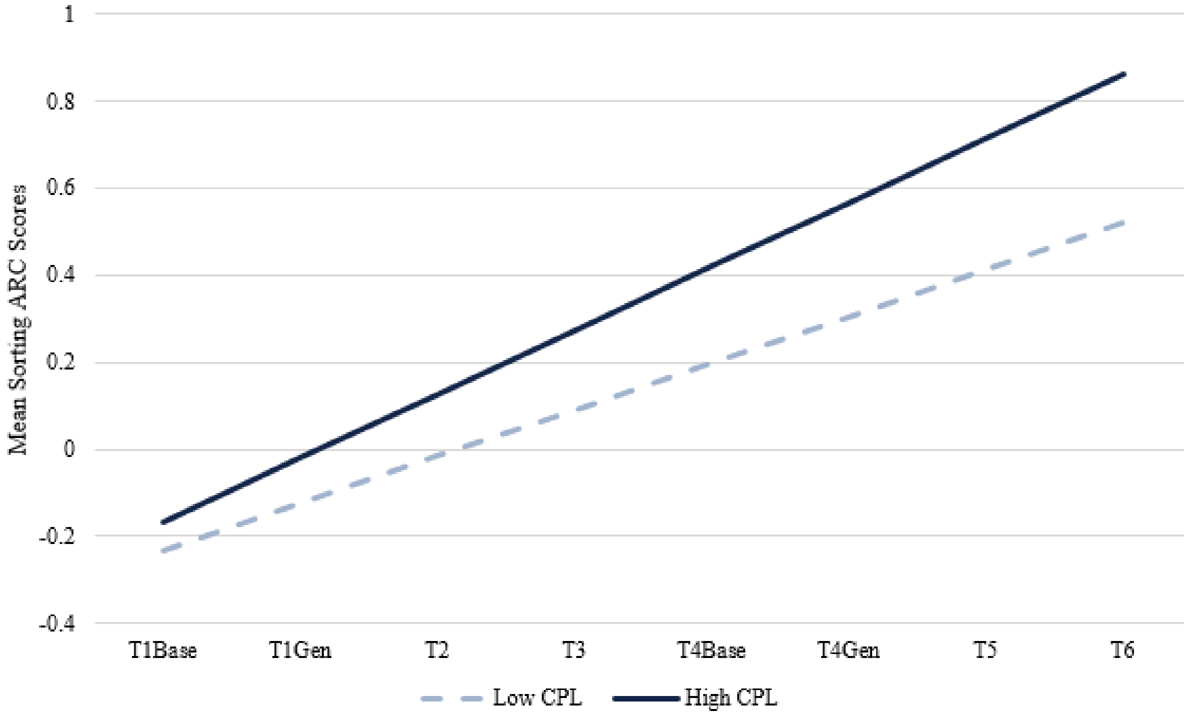


Table 23. Conditional Random Effects Predicting Children's FRT Sorting ARC Scores from Teachers' CPL at the End of the First-Grade Year.

Covariance Parameter Estimates

		Estimate	SE	Z Value	p
Intercept	$\hat{\tau}_{00}$	4.22	1.33	3.18	.00
	$\hat{\tau}_{10}$	.39	.21	1.82	.07
Slope	$\hat{\tau}_{11}$	.08	.04	1.82	.03
	$\hat{\sigma}^2$	.	.	.	.

Note: Intercept specified to T6; $\hat{\sigma}^2$ estimates were calculated for each timepoint when allowing for a Level-1 heteroscedastic error structure and have been omitted from the final row of this table.

Research Question 3

How is the association between teachers' CPL and children's deliberate memory skills moderated by children's self-regulated learning skills?

Given the complexity of this question, first a series of cross-sectional analyses were performed in line with model building practices suggested by Curran et al. (2004; 2006), starting with a random intercept model, then a random intercepts and slopes model, and finishing with a binary predictor of these intercepts and slopes. Accordingly, the algebraic notation is listed for final random intercept and slope models in Figures 11 and 12, entering child-level predictors at Level 1 and teacher-level predictors at Level 2.

Figure 11. Algebraic Notation for Hypothesis 3a.

Level-1 conditional model

$Deliberate\ Memory_{ij} = \beta_{0j} + \beta_{1j}EF_{ij} + r_{ij}$

Level-2 conditional model

$\beta_{0j} = \gamma_{00} + \gamma_{01}CPL_j + u_{0j}$

$\beta_{1j} = \gamma_{10} + \gamma_{11}CPL_j + u_{1j}$

$Deliberate\ memory_{ij}$ = students' average deliberate memory skills

β_{0j} = students' deliberate memory skills at spring of first grade

β_{1j} = students' growth rate of deliberate memory skills

γ_{01} = avg. deliberate memory skills by children's exposure to CPL at spring of first grade

γ_{10} = avg. deliberate memory skills by children's EF at spring of first grade

γ_{11} = magnitude of the regression between children's exposure to CPL and children's EF on children's deliberate memory skills at the end of first grade.

Note: EF = Executive Function

Figure 12. Algebraic Notation for Hypothesis 3c.

Level-1 conditional model

$Deliberate\ Memory_{ij} = \beta_{0j} + \beta_{1j}SR_{ij} + r_{ij}$

Level-2 conditional model

$\beta_{0j} = \gamma_{00} + \gamma_{01}CPL_j + u_{0j}$

$\beta_{1j} = \gamma_{10} + \gamma_{11}CPL_j + u_{1j}$

$Deliberate\ memory_{ij}$ = students' average deliberate memory skills

β_{0j} = students' deliberate memory skills at spring of first grade

β_{1j} = students' growth rate of deliberate memory skills

γ_{01} = avg. deliberate memory skills by children's exposure to CPL at spring of first grade

γ_{10} = avg. deliberate memory skills by children's SR at spring of first grade

γ_{11} = magnitude of the regression between children's exposure to CPL and children's SR on children's deliberate memory skills at the end of first grade.

Note: SR = Self-Regulation

Hypothesis 3a posited that the association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade would be greater for children with higher levels of executive function than their peers with lower levels of executive function. As can be seen on the next page in the 7th row of Table 24, there was a significant fixed main effect of children's executive function in predicting their FRT recall ($\hat{\gamma}_{10}$= .06, p=.04), indicating that for every one unit increase in children's executive function .06 unit increase in children's FRT recall scores was observed at the end of the first-grade year. However, fixed main effects shown in the 3rd and 9th rows of Table 24 for children's executive function predicting FRT sorting ARC scores ($\hat{\gamma}_{10}$= -.00, p=.78) and OBJ recall scores ($\hat{\gamma}_{10}$= .02, p=.41) were non-significant. Additionally, all interaction effects between teachers' CPL and children's executive function skills were non-significant across all deliberate memory outcomes, providing a lack of support for this hypothesis. Accordingly, model building practices would not support the expansion of this model to then consider children's *rate of change over time* (slope) predicted by teachers' CPL and children's executive functioning. Therefore, Hypothesis 3b – positing that the association between teachers' CPL and increases in children's deliberate memory skills would be stronger for children with higher levels of executive function than their peers with lower levels of executive function – was not supported.

Table 24. Conditional Fixed Effects Predicting Children's Deliberate Memory Outcomes from Teachers' CPL and Children's Self-Regulated Learning Skills at the End of the First-Grade Year.

Estimated Fixed Effects	Coefficient	SE	t	df	p	95% Confidence Interval	
						Lower	Upper
			Executive Function				
FRT Sorting ARC							
Intercept	.52	.09	5.54	59	<.0001	.33	.71
CPL	.33	.12	2.64	59	.01	.08	.58
DCCS	-.00	.00	-.28	59	.78	-.01	.01
CPL*DCCS	.00	.01	.67	59	.50	-.01	.02
FRT Recall							
Intercept	10.75	.62	17.40	59	<.0001	9.52	11.99
CPL	.51	.82	.62	59	.54	-1.13	2.14
DCCS	.06	.03	2.06	59	.04	.00	.12
CPL*DCCS	-.02	.04	-.55	59	.59	-.10	.06

OBJ Recall							
Intercept	8.39	.41	20.56	59	<.0001	7.58	9.21
CPL	-.16	.54	-.29	59	.77	-1.24	.93
DCCS	.02	.02	.82	59	.41	-.02	.05
CPL*DCCS	.02	.03	.74	59	.46	-.03	.07
Self-Regulation							
FRT Sorting ARC							
Intercept	.54	.09	6.26	60	<.0001	.37	.71
CPL	.31	.12	2.70	60	.01	.08	.54
HTKS	.04	.01	2.78	60	.01	.01	.07
CPL*HTKS	-.05	.02	-2.67	60	.01	-.08	-.01
FRT Recall							
Intercept	10.80	.60	17.94	60	<.0001	9.60	12.01
CPL	.53	.80	.66	60	.51	-1.07	2.14
HTKS	.23	.10	2.36	60	.02	.04	.43
CPL*HTKS	-.14	.12	-1.18	60	.24	-.38	.10
OBJ Recall							
Intercept	8.83	.39	21.44	60	<.0001	7.65	9.22
CPL	-.12	.52	-.24	60	.81	-1.17	.92
HTKS	.06	.06	.93	60	.36	-.07	.19
CPL*HTKS	.05	.08	.62	60	.54	-.11	.21

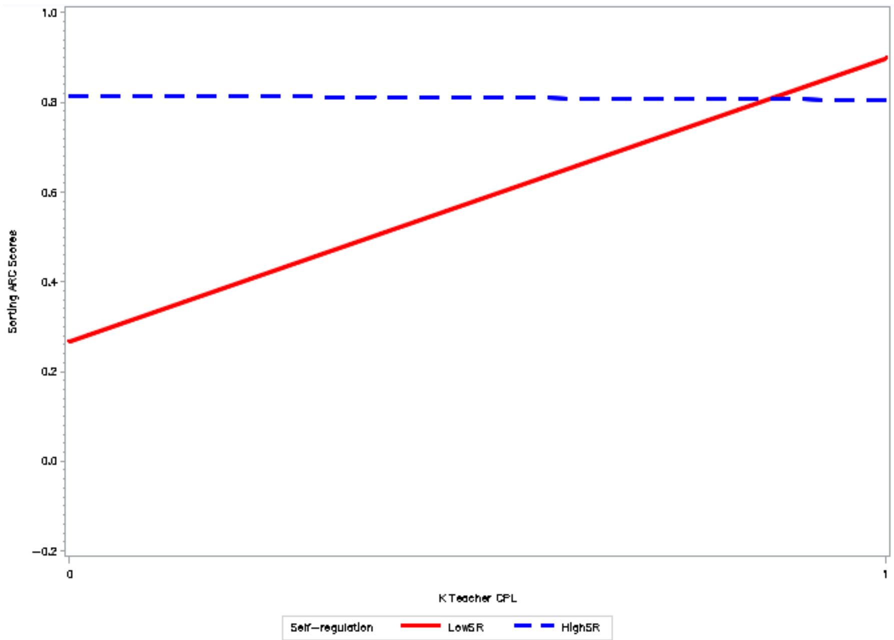
Note: Random intercept and random slope model results are shown above; Intercept specified to T6; All indicators of children's self-regulated learning were grand mean-centered before being entered into each model.

Hypothesis 3c posited that the association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade would be greater for children with higher levels of self-regulation than their peers with lower levels of self-regulation. Algebraic notation for this cross-sectional model can be seen previously in Figure 12. Similar to results from Hypothesis 3a, a significant fixed main effect of children's self-regulation skills was found when predicting FRT recall scores ($\hat{\gamma}_{10}$= .23, p=.02) but not when predicting OBJ recall scores ($\hat{\gamma}_{10}$= .06, p=.36), shown in the 19th and 23rd row of Table 24. As can be seen in 14th and 15th row of Table 24, when predicting children's FRT sorting ARC scores at the end of first grade, there were significant main effects of kindergarten teachers' CPL ($\hat{\gamma}_{01}$= .31, p=.01) and children's self-regulation ($\hat{\gamma}_{10}$= .04, p=.01). Additionally, there was a significant interaction effect between children's self-regulation skills and teachers' CPL ($\hat{\gamma}_{11}$= -.05, p=.01), shown in the 16th row of Table 24, suggesting that the magnitude of the regression between self-regulation and sorting

ARC scores was .05 units less for children who were exposed to high levels of CPL than their low CPL counterparts. Further described by simple slopes and intercepts plotted in Figure 13 on the next page, the model-implied estimates of children's sorting ARC scores for children of higher self-regulation skills were relatively consistent when exposed to differing levels of CPL. Conversely, for children with lower self-regulation skills, the differential exposure to high vs. low levels of CPL in kindergarten resulted in differing sorting ARC scores at the end of first grade.

Although these significant results were not in direct support of Hypothesis 3c, the expansion of this cross-sectional model predicting children's FRT sorting ARC scores to consider children's *rate of change over time* as predicted by teachers' CPL and children's self-regulated learning skills was warranted to test Hypotheses 3d. Since there were no significant cross-sectional interaction effects of children's exposure to CPL and their self-regulation skills for FRT recall and OBJ recall scores, these models were not explored further. Similar to the analyses reported for research questions 2a and 2b, a 3-level growth curve model was initially considered to address Hypothesis 3d. However, due to a lack of classroom-to-classroom variability in children's deliberate memory outcomes, a 2-level model was selected once again to best fit the data and the corresponding algebraic notation is displayed in Figure 14.

Figure 13. Simple Intercepts and Slopes for Children's FRT Sorting ARC Scores at T6 Predicted by Teachers' CPL and Children's Self-Regulated Learning.



<u>Figure 14. Algebraic Notation for Hypotheses 3c and 3d.</u>

Level-1 conditional model
$Deliberate\ Memory_{ij} = \beta_{0j} + \beta_{1j}Time_{ij} + r_{ij}$

Level-2 conditional model
$\beta_{0j} = \gamma_{00} + \gamma_{01}CPL_j + \gamma_{02}SR_j + \gamma_{03}CPL * SR_j + u_{0j}$
$\beta_{1j} = \gamma_{10} + \gamma_{11}CPL_j + \gamma_{12}SR_j + \gamma_{13}CPL * SR_j + u_{1j}$

$Deliberate\ memory_{ij}$ = students' average deliberate memory skills
β_{0j} = students' deliberate memory skills at spring of first grade
β_{1j} = students' growth rate of deliberate memory skills
γ_{01} = avg. deliberate memory skills by children's exposure to CPL at spring of first grade
γ_{02} = avg. deliberate memory skills by children's SR at spring of first grade
γ_{03} = avg. deliberate memory skills by children's exposure to CPL and SR at spring of first grade
γ_{11} = growth rate of deliberate memory skills by children's exposure to CPL
γ_{12} = growth rate of deliberate memory skills by children's SR
γ_{13} = growth rate of deliberate memory skills by children's CPL and SR

Hypothesis 3d posited that the association between teachers' CPL and increases in children's deliberate memory skills would be stronger for children with higher levels of self-regulation than for their peers with lower levels of self-regulation. As can be seen in the fixed effects output on the next page in Table 25, similar to the cross-sectional findings described above, a significant main effect of teachers' CPL remained when predicting children's FRT sorting ARC scores at the end of the first-grade year ($\hat{\gamma}_{01}$ = .32, p=.01. However, the main effect of children's self-regulation skills became marginally significant ($\hat{\gamma}_{02}$ = .03, p=.05), shown in the 4th row of Table 25, when including main and interaction effects of time in the model. Significant Slope*CPL and Slope*HTKS interaction effects were found, as can be seen in the 5th and 6th rows of Table X ($\hat{\gamma}_{11}$ = .04, p=.02; $\hat{\gamma}_{12}$ = .00, p=.04), indicating that the magnitude of the linear slope of children's FRT sorting ARC scores over time increased by approximately .04 units for children exposed to high levels of CPL and that this magnitude also increased by .00 units for every one unit increase in children's self-regulation skills. However, as can be seen in the 7th and 8th rows of Table 25, there was no significant interaction effect between CPL and HTKS on children's FRT sorting ARC scores at the end of first grade ($\hat{\gamma}_{03}$ = -.02, p=.16), nor was there a significant three-way interaction to describe the interaction of CPL and HTKS on differences in children's rate of change over time ($\hat{\gamma}_{13}$ = -.00, p=.10). Results from this three-way interaction model provide lacking support for Hypothesis 3d. The possible reasons for these null findings are described further in the discussion section.

Table 25. Conditional Fixed Effects Predicting Children's FRT Sorting ARC Scores from Teachers' CPL and Children's Self-Regulation Skills at the End of the First-Grade Year.

Estimated Fixed Effects	Coefficient	SE	t	df	p	95% Confidence Interval	
						Lower	Upper
Intercept	.54	.09	6.28	69	<.0001	.37	.71
Slope	.11	.01	8.85	469	<.0001	.09	.14
CPL	.32	.12	2.77	69	.01	.09	.56
HTKS	.03	.01	1.94	69	.05	-.00	.05
Slope*CPL	.04	.02	2.43	469	.02	.01	.07
Slope*HTKS	.00	.00	1.99	469	.04	.00	.01
CPL*HTKS	-.02	.02	-1.43	69	.16	-.06	.01
Slope*CPL*HTKS	-.00	.00	-1.63	469	.10	-.01	.00

CHAPTER VI: DISCUSSION

Only recently have developmental scientists begun to examine children's memory development – or intra-individual change over time in children's skills, as opposed to cross-sectional differences – as a function of contextual factors (Ornstein & Coffman, 2020). Children enter formal school with a variety of skills; therefore, understanding the way in which these individual-level factors play a role in children's experiences in the classroom is of interest to both scholars and educators. Accordingly, the current study aimed to address persisting gaps in the literature by examining children's development of deliberate memory skills (strategy use and recall) as a function of parent– and teacher–child interactions. In the following chapter, first a summary and in-depth discussion of findings will be presented for each research question – as designed to parallel components of Bronfenbrenner's bioecological model of human development. For each research question, interpretation of results will also be paired with consistent or conflicting findings from previous research, potential reasons for differences in findings, and general implications. This chapter ends with a thorough overview of strengths and limitations of the current study, recommended future directions for researchers, and implications for educators.

Effects of Parental Elaborative Style on Children's Deliberate Memory (RQ1)

Despite neither hypothesis 1a nor 1b in Research Question 1 being supported – that **at kindergarten entry,** children with parents of higher elaborative reminiscing style display higher deliberate memory skills and develop these skills **more rapidly over time** than their peers with parents of lower elaborative style – overall findings provide a unique description of children's developmental trajectories of deliberate recall performance beginning at kindergarten entry. Findings pertaining to hypothesis 1a resulted in *marginally* significant results, indicating that parents' elaborative reminiscing style – or the degree to which parents posed Wh- questions (i.e., who, what, when, where), made associations with the event under discussion, validated comments made by their children, and evaluated their children's contributions to the conversation (e.g., Reese et al., 1993) – was associated with children's deliberate recall **at kindergarten entry** on The Object Memory Task. Although not statistically significant, children with parents who used a higher elaborative style entered kindergarten with higher recall scores than their peers of lower elaborative parents. However, this pattern was not present for children's strategy use and recall skills on The Free Recall Task with Organizational Training. This is consistent with previous research (Langley et al., 2017) in that parents' elaborative reminiscing style has been associated with children's spontaneous recall on the Object Memory Task, but *not* their performance on the Free Recall Task with Organizational Training.

This difference across tasks may be due in part to key differences between these two tasks. First, the task Free Recall Task with Organizational Training includes stimuli that orient individuals to the use of a specific strategy (i.e., sorting cards into their respective categories) and therefore may not lend itself well to the use of multiple strategies for remembering like the Object Memory Task (e.g., rehearsing the names of objects while visually scanning, describing the properties of the objects, associating the objects with events outside the task). Therefore, it is possible that parents' elaborative style is associated with children's approaches to encoding new information more broadly – and therefore their subsequent recall – than the use of a specific strategy (i.e., sorting by semantic category). Second, the Object Memory Task is a timed task in which children are encouraged to utilize the entire 2-minute study period to do everything they can to "work to remember" a set of unrelated, but familiar objects (e.g., child: *"Okay, I remember them all."*, Researcher: *"You still have a little more time left, keep working to* *remember all the toys."*). However, the length of study period during the Free Recall Task with Organizational Training is entirely up to the child and in some cases can last less than 30 seconds if the child indicates they are finished working to remember. In the Object Memory Task, when children are told to keep on task after indicating they are "finished remembering", they are then faced with maintaining their attention on the task stimuli for the remainder of the study period. Because of this, the way in which children exhibit *task persistence* – an indicator of motivation and self-regulated learning in young children – during the study period may also play a role in their strategy use and subsequent recall skills (Marulis & Nelson, 2021). It is therefore possible that parents' elaborative reminiscing style is associated with other strategies that were not assessed in the current study, such as children's task persistence. Indeed, parents' elaborative style has been associated with children's information-seeking behaviors – another indicator of early self-regulated learning skills (Revelle et al., 1985; Flavell et al., 1981) – in reminiscing conversations (i.e., child-initiated, open-ended questions; Cook et al., 2023). Children exhibited a variety of strategies on the Object Memory Task at the beginning of kindergarten and the change over time in these strategies varied greatly – in that some were used consistently across the kindergarten year and others increased or decreased. Therefore, future research would benefit from examining the role of parents' elaborative reminiscing style with regard to the development of *specific* strategies used in the Object Memory Task – as it is possible that some strategies are more effective than others on this task, just as there is an optimal strategy for the Free Recall Task with Organizational Training (i.e., categorizing).

The second hypothesis posed in Research Question 1 focused on the effect of parents' elaborative reminiscing style on children's development of deliberate memory skills **over time** – specifically it was hypothesized that children with parents who exhibited higher levels of elaborative style would develop more rapidly over the course of kindergarten and first grade than their peers with parents who used lower levels of elaborative conversation. This hypothesis was driven by Bronfenbrenner's bioecological model – placing emphasis on proximal processes between parents and children as drivers of development– and previous research using the Free Recall Task with Organizational Training in which children with high elaborative parents were better at (a) *picking up and successfully applying* strategic organizational training from a research assistant at the beginning of kindergarten and (b) *retaining* this strategic training over the course of the academic year than their peers of parents with lower elaborative style (Cook, Coffman, & Ornstein, 2023). However, results from the current study revealed that it was children who entered kindergarten who had parents who evidenced *lower* levels of elaborative style that developed more rapidly over time in their recall skills on the Object Memory Task. Although contradictory to the direction of effects hypothesized in the current study, these results were similar to findings in studies that have examined the differential role of parenting practices over time for children with lower initial cognitive abilities (e.g., Taylor et al., 2008). For example, the work of Leerkes et al. (2011) demonstrated that the positive effect of maternal emotional support on children's gains in pre-academic skills from age 3 to 4 was especially apparent for children whose pre-academic skills were low at age three. Similarly, recent findings using the same sample as the current study have demonstrated that although children of parents with positive mathematics attitudes and appropriate mathematics expectations (e.g., parents' level of confidence engaging in mathematics) entered kindergarten with higher math problem-solving skills, it was children with parents who reported more negative attitudes and inappropriate expectations towards mathematics who developed more rapidly in these skills over the course of the first two years of elementary school (Coffman et al., 2023).

The results of Research Question 1 have important implications for understanding the interplay of home- and school-level influences on children's development of early deliberate memory skills. Specifically, something about the early school experience may be particularly important for children with lower elaborative parents. Indeed, these results align with Bronfenbrenner's bioecological model, in that human development is driven by proximal processes – such as parent-child reminiscing conversations – that become *increasingly more complex* over time (Bronfenbrenner & Morris, 1998). Given that it has been established in the literature that maternal elaborative style has shown to remain stable as children age (Reese et al., 1993; Reese, 2002), and accordingly measured at one timepoint in the current study, understanding the increasing complexity of other proximal processes – such as teacher–child processes – becomes the next step for understanding children's development of deliberate memory skills.

Effects of Kindergarten Teachers' CPL on Children's Deliberate Memory (RQ2)

Results from the current study posed in Research Question 2 replicated and extended previous research examining children's deliberate memory development. Specifically, hypotheses 2a and 2b were both supported: Children who were exposed to higher levels of cognitive processing language (CPL) in kindergarten **developed more rapidly** over time in their sorting ARC scores in the Free Recall Test with Organizational Training (FRT), and by the **end of the first-grade year**, their scores were significantly higher than children who were exposed to lower levels of CPL. Interestingly, prior work (Coffman et al., 2008) demonstrated linkages between first-grade teachers' CPL and differences in change over time in first-graders' strategy use on the Object Memory Task, differences at the end of the year in children's recall and strategy use on the Object Memory Task, and also children's strategic clustering (i.e., recalling items by semantic category) in the Free Recall Task with Organizational Training. Although the current study did not evidence linkages between teachers' CPL and children's recall skills, this could be due to a variety reasons. First, the current study examined children's development over two academic years – kindergarten and first grade – to examine the potential lasting effect of exposure to CPL in kindergarten. Therefore, model-implied estimates of children's trajectories in the current study utilized more repeated measures and covered a greater time period, resulting in a different depiction of development. Previous studies that have utilized a growth curve model approach to understanding the role of teachers CPL on children's deliberate memory have included three (Coffman et al., 2008), four (Coffman et al., 2008), and seven (Coffman et al., 2023) repeated measures: the current study includes *eight* when modeling children's change over time in children's sorting ARC scores.

Although the differing results across these models may be in part to differences between samples, in other areas of developmental science, quantitative researchers have been discussing how the placement (i.e., *when* in a child's development) and the number of repeated measures may yield different findings even when using the same variables. For example, recent work examining the co-development of children's executive function and mathematics skills have resulted in similarly conflicted findings: Although both studies utilized the same measures of children's executive function and mathematics achievement, one study included 4 repeated measures in their model (fall preschool, spring preschool, fall kindergarten, spring kindergarten; Schmitt et al., 2017) and the other – aiming to replicate this model – included 3 repeated measures (preschool, kindergarten, first grade; Ellis et al., 2021). This seemingly small difference between the studies has been acknowledged as a potential reason for differences in results, despite covering a similar developmental period (see Ellis et al., 2021 for a discussion).

Nevertheless, the current study's results are important for understanding the lasting role of early exposure to teachers' metacognitively-rich language. Indeed, the current study's findings are similar to those of Coffman et al. (2019), in which children in high-CPL first grade classrooms not only ended first grade with higher sorting ARC scores than their low-CPL peers, but these differences were present at the end of second and fourth grade as well – even after children had been exposed to different teachers during three intervening years.

Second, this study is the first to link *kindergarten* teachers' cognitive processing language to children's developmental gains in deliberate memory skills. Much of the existing literature on children's deliberate memory development has focused on understanding the lasting impact of "the first-grade experience" (see Ornstein & Coffman, 2020 for a review). However, more recent studies have identified kindergarten as a context in which children are being taught strategies for a variety of problem-solving scenarios. It has been well established that although young children can be taught how to use memory strategies (Deloache et al., 1985) and children of this age know they need to "something" to help them remember information (Wellman, 1988), the association between children's strategy use and recall is not strong until after kindergarten. Therefore, it is possible that the proximal processes that drive children's developmental gains in recall performance prior to first grade exist outside the classroom – perhaps at home, as suggested by the findings from Research Question 1.

One final important consideration regarding these findings surrounds the nature of the Free Recall with Organizational Training Task. The conceptualization of deliberate memory as a cognitive skill is nuanced, in that it can refer to both (a) children's recall performance and (b) the use of memory strategies, typically assessed by behaviors children exhibit during encoding or retrieval stages of remembering. Simultaneously, a question has persisted in the deliberate memory literature: Is strategy use an *outcome* or a *predictor* of deliberate memory? With school-readiness in mind, researchers at the intersection of developmental and educational sciences would consider strategy use a desired outcome for young children in formal school contexts. Specific approaches to learning taught in public schools in the United States, such as those implemented through the Common Core State Standards Initiative (2010), are intended to serve as the foundation for children's advanced learning in middle childhood and adolescence. For example, addition and subtraction strategies that were observed being taught by kindergarten teachers in the current study have included number decomposition, "counting on" (i.e., 5, 6, 7, 8), and how to select the most efficient strategy out of all the strategies one has learned for a given problem. These early strategies in the context of mathematics are thought to serve as a foundation for children's abstract mathematical systems, such as algebra (Baroody & Ginsburg, 1983; Carpenter et al., 2003; Knuth et al., 2006). Therefore, children's ability to *initially learn* and then *successfully apply* strategies through explicit, adult-to-child instruction is a skill that is thought to be supportive of children's academic success in most formal schooling environments in the United States today.

This is the first study to my knowledge that models children's intraindividual change over time in the FRT task covering *two* training trials (one at the beginning of kindergarten and one at the beginning of first grade). Therefore, developmental trajectories examined in the current study describe not only children's spontaneous strategy use at kindergarten entry, but also their ability to (a) take up and apply strategic organizational training at the beginning of kindergarten and (b) once again take up and apply the same strategic organizational training at the beginning of first grade. It is important to note that the current study did not formally examine children's raw change over time as a function of their exposure to CPL. The following hypotheses are intended for future directions surrounding specific points in children's development characterized by sharp or gradual increases in strategy use—as this comparison has been a continued area of inquiry in the deliberate memory literature (Schneider et al, 2004; Schlagmüller & Schneider, 2002). As can be seen descriptively in the raw data that are displayed in Figure 9, differences in children's sorting ARC scores as a function of their kindergarten teachers' level of CPL are evident in two places: (a) developmental change between T1 Baseline and T1 Generalization, describing differences in children's initial uptake of strategic organizational training as a function of their exposure to CPL and (b) change between T3 and T4 Baseline, describing differences in children's sustained use of strategic organizational training from the end of kindergarten to the beginning of first grade as a function of exposure to CPL. In both instances, it appears that children who were exposed to high levels of CPL in kindergarten may have been better able to initially take up and apply strategic organizational training at the beginning of kindergarten and may also be better able to *retain* this training between kindergarten and first grade, resulting in higher sorting ARC scores than their peers exposed to low levels of CPL. Additionally, the change between T4 Baseline and T4 Generalization in Figure 9 described differences in children's uptake of strategic organizational training in *first grade* as a function of kindergarten CPL. Although children who were exposed to low levels of CPL evidenced greater increases in sorting ARC scores between T4 Baseline and T4 Generalization, this training does not seem to suggest the same degree of strategic sorting skills as their peers who had been exposed to high level of CPL in kindergarten. Although these are descriptive findings that were not formally tested for statistically significant differences, they may provide some guidance regarding the need to examine the role of teachers' cognitive processing language in children's memory skills as they transition to a new learning context: first grade. A clear next step for researchers would be to formally test for between-group differences not only at the end of first grade, but also at the beginning of the year to understand how children's experiences in kindergarten may set them up to benefit from instruction in first grade.

Effects of Teachers' CPL and Children's Self-Regulated Learning Skills on Children's Deliberate Memory (RQ3)

Understanding the effects of a predictor on an outcome "for whom and under what circumstances" has remained a core line of inquiry for developmental scientists over the past 50 years (Ragosa, 1980). The Institute of Education Sciences (IES) has stated explicitly their interest in exploring: "(a) … malleable factors that are associated with education outcomes for students (student outcomes) and (b) factors and conditions that may mediate or moderate the relations between malleable factors and student outcomes." (IES, 2019, p. 1). In the context of the current study, we have first examined a malleable factor that is associated with student outcomes (teachers' CPL). Research Question 3 then aimed to address this second objective: *How do children's self-regulated learning skills moderate the association between teachers' CPL and children's deliberate memory outcomes?*

Hypothesis 3a posited that the association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade would be greater for children with higher levels of *executive function* than their peers with lower levels of executive function – as measured by the Dimensional Change Card Sort Task (Zelazo, 2006). Similarly, Hypothesis 3c posited that the association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade would be greater for children with higher levels of *self-regulation* than their peers with lower levels of self-regulation – as measured by the Head-Toes-Knees-Shoulders Task (Ponitz et al., 2009). The rationale behind testing the moderating role of executive function and self-regulation originates from a large body of research asserting that the ability to pay attention, remember complex rules, and persist on challenging tasks helps children perform better academically (Blair & Razza, 2007; Blair & Raver, 2015). Therefore, children with higher self-regulated learning skills would be better able to benefit from teachers' cognitive processing language. Studies that examine the co-development of executive function, self-regulation, and academic skills (e.g., mathematics) during the transition from preschool to kindergarten have supported a unidirectional relation between EF and academic skills once children enter formal school (Schmitt et al., 2017). Specifically, these findings have led to the hypothesis that instructional differences between preschool and elementary school (i.e., kindergarten and onwards) may lead children to call upon different skills in order to benefit from the relatively unique context of whole-group, teacher-driven instruction. Deliberate memory researchers have generally agreed with this hypothesis and have placed emphasis on the importance of early self-regulated learning skills as they relate to future academic success (Grammer & Torres, 2021). The consideration of executive function and self-regulation separately was also intentional in an effort to both replicate recent findings that consider the interplay of CPL and self-regulation (see Coffman et al., 2023) as well as extend these findings to test the role of other higher-order cognitive processes, such as EF, with regard to the effect of teachers' CPL on children's memory outcomes.

Initial cross-sectional results from the current study did not support hypothesis 3a, that the association between teachers' CPL and differences in children's deliberate memory skills at the **end of first grade will be greater for children with higher levels of executive function** than their peers with lower levels of executive function. But findings were in in partial support of hypothesis 3c: the association between teachers' CPL and differences in children's deliberate memory skills at the end of first grade were greater for children with higher levels of self-regulation than their peers with lower levels of self-regulation. Given the results of Research Question 2, the examination of a moderation effect of children's self-regulated learning skills on the positive association between teachers' CPL and children's deliberate memory outcomes was only possible for models including children's FRT sorting ARC score trajectories. While main and interaction effects involving children's executive function were non-significant, there was a statistically significant interaction of children's self-regulation and teachers' CPL on children's sorting ARC scores at the end of first grade. However, after further probing the nature of this interaction effect, the hypothesized direction of moderating effects was not supported and therefore contradictory to propositions of human development posited by Urie Bronfenbrenner's bioecological model. Although Bronfenbrenner's PPCT model emphasizes *proximal processes* as drivers of human development, results from this model revealed that for children with lower self-regulation skills, the differential exposure to high vs. low levels of CPL in kindergarten resulted in differing sorting ARC scores at the end of first grade. Specifically, although proximal processes (i.e., teacher–child interactions in the form of CPL) were thought to be the primary predictor of differences in children's developmental outcomes, rather, it was in classrooms where children were exposed to lower levels of CPL, early *self-regulation skills* were the key predictors of differences in sorting ARC scores at the end of first grade. Another way of understanding this moderation effect is that for children exposed to higher levels of CPL in kindergarten, their initial self-regulation skills could not account for differences in sorting ARC scores at the end of first grade. So once again, children's resource characteristics (i.e., self-regulation) did not seem to have an effect on the direction or strength of proximal processes. Although inconsistent with theory, these findings are consistent with previous research in that exposure to higher levels of

CPL may be especially important for children with lower levels of self-regulation (Coffman et al., 2023). However, when expanding these models into analyses of repeated measures, the main effect of children's self-regulation became marginally significant, and although interaction effects of CPL*Time and HTKS*Time were significant, the two-way interaction of CPL*HTKS became non-significant and the three-way interaction between CPL*HTKS*Time was marginally significant ($p < .10$). Accordingly, neither hypothesis 3b nor 3d – hypotheses testing moderation effects of children's self-regulated learning skills on the positive association between teachers' CPL and children's *change over time* in sorting ARC scores – were supported.

Nevertheless, findings from the current study provide information about the role of children's early self-regulated learning skills on aspects of their deliberate memory skills later in development. Indeed, children's executive function and self-regulation in kindergarten were predictive of their deliberate recall skills on the Free Recall Task with Organizational Training (FRT) at the end of first grade. Specifically, children's self-regulation, exposure to CPL in kindergarten, and the interaction between these two effects were predictive of differences in children's deliberate strategy use at the end of first grade. These findings are notable, given that that teachers' use of cognitive processing language seems to be especially important for children who are entering kindergarten with lower regulatory skills. This highlights a potential pathway through which educators can support children with varying levels of regulatory skills in the classroom. Given that this relation was not supported when considering the interaction between EF and teachers' CPL, these findings suggest that although executive function may be linked to later deliberate memory performance, children's EF skills were not related to their ability to benefit from teachers' instructional language or development of strategy use.

Strengths, Limitations, and Future Directions

Strengths of the current study lie at the intersection of theorical perspectives of human development and the methodology employed in this study. Specifically, the parameters outlined in the present study were modeled after components of Urie Bronfenbrenner's bioecological model of human development, applied methodological recommendations provided by memory researchers (Ornstein & Haden, 2001; Haden, 2021), and addressed previously identified gaps in the deliberate memory literature. In doing so, the current study allowed for a detailed description of children's intra-individual change over time in deliberate memory skills – with growth curve models of repeated measures spanning two academic years. The timing of these repeated measures aligned with the beginning, middle, and end of the academic calendar. Therefore, unlike previous research linking mother–child reminiscing conversations to components of children's deliberate memory skills (Langley et al., 2017), the current study's findings have immediate implications for understanding the role of parents' memory-scaffolding practices as they serve children's skillsets as they enter formal school. Unlike previous research that has utilized a median split approach, (Reese et al., 2008; Langley et al., 2017; van Bergen & Salmon, 2010) this study benefited from maintaining a continuous index of parents' elaborative style, describing the nuanced continuum of this parent–child process as it relates to other continuous variables.

Moreover, this is one of a handful of studies to examine both home- and school-level effects on children's deliberate memory skills. Besides this being identified as a next step for developmental scientists, the observation of both home and school contexts is one final way this study parallels Urie Bronfenbrenner's bioecological model – as the mesosystem refers to the interaction between two microsystems. Both home- and school-level processes were measured using direct observational techniques, measures that contribute to the ecological validity (Wang & Repetti, 2014) and objectivity (Repetti et al., 2013) of findings from this study. Indeed, observing everyday settings of a developing individual can provide situation-level, contextualized information that other methodological approaches fail to capture (Wang, 2018).

Despite these strengths, contextual assessments used in the current study also faced limitations. With regard to applying Bronfenbrenner's theory, it is important to highlight that the current study did not formally examine children's development at the hands of mesosystem components – such as the interaction between home- and school-level processes – as these predictors were not simultaneously entered into the same statistical model and were examined separately. Indeed, the challenges that might arise when including all components of PPCT into one statistical model – such as limitations of statistical power – were not considered during the inception of Urie Bronfenbrenner's theory (Navarro et al., 2022). Future studies would benefit from applying the work of Navarro et al. (2022) and Xia et al. (2020) to properly operationalize Bronfenbrenner's model of human development.

Parent–child reminiscing conversations were recorded in a naturalistic, but somewhat constrained environment for ease of measurement; parents were sent audio recorders with directions about discussing two shared past events with their child. Although there was no time limit, time of day, or location specified for parent-child dyads, it was clear that these conversations occurred in quiet, private contexts for audio clarity. Therefore, these conversations were not assessed throughout daily routines in the everyday lives of children, during which reminiscing conversations may occur with multiple partners in various contexts (e.g., in the car, at the store, or during a shared activity besides conversation). Commonly used approaches to observing parent–child reminiscing continue to pose threats to construct validity (i.e., The

Hawthorne Effect; McCambridge et al., 2014) and would benefit from more discrete observational tools such as the Language Environment Analysis System (LENA) to lessen participants' reactivity to data collection methods. The observational methods used by the current study to measure teachers' cognitive processing language also faced limitations in that teachers were only observed for 120 minutes' worth of instruction during two areas of content: mathematics and language arts. Additionally, teachers' use of CPL was only measured during whole-group instruction. Future research would benefit from expanding the measurement of teachers' CPL to include small-group lessons and individualized learning situations in elementary school classrooms. Specifically with regard to theory, in order to more appropriately apply Bronfenbrenner's bioecological model, future research would benefit from assessing teachers' cognitive processing language *over time,* resulting in multiple timepoints of CPL data, as the measurement of proximal processes over time is a key recommendation for researchers looking to operationalize this theory (Navarro et al., 2022). Finally, the exploration of exposure to high vs. low levels of CPL across multiple grades (i.e., CPL assessed in both kindergarten and first grade classrooms) is a clear next step for this line of research.

Besides strengths and limitations of measurement, one of the primary limitations of this study surrounds statistical power for adequate effect sizes within a multi-level modeling framework. The number of children nested within classrooms (range: 6 – 11) and total classrooms (10) may have contributed to the likelihood of a Type II error, or failing to reject the null hypothesis in favor of the alternative. This is especially evident given the marginally significant effects produced by growth curve models that included the three-way interaction effect of CPL*Self-Regulation*Time on children's deliberate strategy use. Data collection efforts utilized in the longitudinal study – The Classroom Memory Study – from which the current study's data originated was compromised due to the presence of Hurricane Florence in the Southeastern region of the United States and the COVID-19 global pandemic. The Classroom Memory Study was originally structured to utilize a cohort design in which an initial cohort of approximately 100 children would be recruited from three schools (the current sample), followed by the recruitment of a second cohort of equal size. Cohort 1 (the current sample) resulted in approximately 80 child participants, began initial assessment in 2017, and were followed successfully across two academic years. In the fall of 2018, in which the initial recruitment of Cohort 2 was set to occur, two serious hurricanes hit central North Carolina, resulting in a small sample of kindergarteners from two schools. Because of its size, Cohort 2 was then added to Cohort 1 and the recruitment of a third cohort – to take the place of Cohort 2 – began in 2019. While the recruitment of the third cohort went similarly to that of Cohort 1, in the beginning of 2020 (Time 2 +), The COVID-19 pandemic brought all data collection to a halt – resulting in incomplete assessments of repeated measures for participants enrolled after the initial school year, a move to online assessments for existing participants, and missing teacher-level data (i.e., classroom observations).

A second limitation of the current study surrounds the conceptualization of child-level constructs, such as self-regulated learning and deliberate memory skills. Both constructs are thought to have multiple indicators and/or subcomponents. For example, self-regulated learning as a construct has been thought to include indicators of metacognition, executive function (EF), and motivational processes (e.g., Dignath et al. 2008). However, motivational processes have been acknowledged as not having been thoroughly explored in early childhood, therefore, their existence within a skillset of self-regulated learning for this age group – kindergarteners – is not well understood and requires further investigation (Marulis & Nelson, 2020). However, future studies looking to examine the role of self-regulated learning skills on children's academic development should aim to include measurements of children's metacognitive skills.

"Conceptual clutter and measurement mayhem" have been highlighted as primary limitations of the executive function and self-regulation literature (Morrison & Grammer, 2016). The current study does not use the tripartite model of executive function (i.e., working memory, inhibitory control, and cognitive flexibility), rather, the current use of the Dimensional Change Card Sort Task (Zelazo, 2006) is meant to represent executive function broadly just as the Head-Toes-Knees-Shoulders Task (Ponitz et al., 2009; McClelland et al., 2014) is meant to represent self-regulation broadly. Future research would benefit from incorporating a latent variable approach when incorporating EF into statistical models, such as studies that have been drawn upon by the current study (e.g., Schmitt et al., 2017; Ellis et al., 2021) or conduct a principal components analysis (PCA) to subsequently create a composite score, an approach that has been argued as being less biased if modeling intra-individual change over time in EF (see Camarota et al., 2020).

Implications

The implication of findings from the current study are primarily applicable to teachers' efforts to support children's deliberate memory and information processing skills during the transition to formal school, skills that are believed to serve their long-term academic success. Consistent with previous research (Hudson et al., 2018), findings from the current study support the understanding that both parents and teachers play a role in supporting children's cognitive development: parent–child interactions seem to predict differences in deliberate memory outcomes at school entry, but once children progress through elementary school, the role of teachers becomes increasingly apparent. These findings also extend previous research by highlighting the differential role of CPL on children's skills, particularly those with lower initial self-regulation skills. Indeed, findings from a qualitative analysis of interviews with teachers in the current sample, all 10 teachers in the current study self-reported intentionally employing various instructional strategies to meet the needs of a classroom characterized by diversity in children's existing skills (Bonanno et al., 2022). Therefore, providing information to current educators about the efficacy of CPL on children's development may provide them with additional information about ways to support children with lower initial self-regulated learning skills.

The original conceptualization of teachers' cognitive processing language was built upon observations of *actual* classrooms (Coffman et al., 2008). Teachers using higher compared to lower levels of metacognitive language taught the same curriculum, but the differences were evident in the type of language used as opposed to the content of the lesson. Subsequently, the "teachability" of aspects of cognitive processing language – specifically the provision of metacognitive information and questioning – has been supported by experimental studies (e.g., Grammer et al., 2013). Paired with results from the current study that suggest that teachers' cognitive processing language continues to play a role in children's development, even after they have transitioned to first grade – particularly for children with initially low self-regulation skills – the cumulative evidence indicates a clear next step in the research process: applying these findings towards teacher preparation programs and professional development opportunities.

Professional development for in-service teachers, for example, has traditionally focused on "workshops" attended at scheduled times – often after school, on the weekend, or during the summer. However, the implications of CPL may be best shared with *instructional coaches* working in school districts, of which the staffing rate has doubled from 2000 to 2015 as a function of educational policies like No Child Left Behind (Galey, 2016). Unlike traditional professional development opportunities, instructional coaches observe teachers in their classroom, provide feedback, and engage in meaningful discussions with teachers about their lessons. Associations between support of instructional coaches and improved instructional practices have been strong (see Kraft et al., 2018); providing information about cognitive processing language to coaches may be an effective way to implement these language processes in elementary school classrooms. Indeed, even teachers in the current study that were classified as “Low CPL” were found exhibiting some degree of metacognitively rich instructional language. Therefore, the potential efficacy of CPL-focused training for educators appears to be achievable, focused on strengthening components of teachers’ existing instructional practices, and can be paired with any curricula.

Conclusion

The current study provides a holistic understanding of children’s deliberate memory development during the transition to formal school by (a) bridging two parallel literatures on children’s memory development, (b) adhering to current recommendations of deliberate memory scientists, and (c) applying propositions of human development posited by Bronfenbrenner’s bioecological model of human development. Results revealed first, that although children of parents with higher levels of elaborative reminiscing style entered kindergarten with higher levels of deliberate memory skills, it was children with parents who used lower levels of elaborative style that developed more rapidly over the course of the kindergarten and first grade years. Second, children who were exposed to teachers with high levels of cognitive processing language (CPL) in kindergarten developed *more rapidly* in their deliberate strategy use and ended first grade with higher levels of deliberate strategy use than their peers who were exposed to lower levels of cognitive processing language in kindergarten. Finally, contrary to prediction, for children with lower self-regulation skills, those exposed to higher levels of CPL in kindergarten evidenced higher levels of deliberate strategy use at the end of first grade than their peers exposed to lower levels of CPL. There were many strengths of the current study, including the consideration of home-, school-, and individual-level factors on children's development over the first two years of elementary school and the use of observational measures supporting the ecological validity of these results. Findings from this study provide an opportunity for future research to explore children's development as they are exposed to CPL in both kindergarten and first grade classrooms, as the current study only explored exposure to CPL in kindergarten. Importantly, findings from this study have implications for teaching practices aiming to support children's early deliberate memory skills as they serve children's long -term academic success.

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