CONCEPTUALIZING AND ASSESSING METACOGNITIVE DEVELOPMENT IN YOUNG CHILDREN

by

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DEDICATION

I dedicate this dissertation to two very special people who have made my heart sing, my soul exult, and my mind imagine.

To my high-school sweetheart, eternal soul-mate, partner-in-everything, and husband, Christopher Sego.

To my beautiful aunt and godmother, Patricia Marulis Kelly, the person who first inspired me to pursue a career in early education learning with young children to make the greatest positive difference in the world. She was truly an inspiration to all who were fortunate enough to meet her.

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LIST OF ABBREVIATIONS

ChAT   Children Articulating Thinking

DA   Dynamic Assessment

EF   Executive Function

EVT   Expressive Vocabulary Test

HTKS   Head Toes Knees Shoulders (task)

GPM   Graduated Prompt Method

GSRP   Great Start Readiness Program

Mc   Metacognition

McK   Metacognitive Knowledge

McKI   Metacognitive Knowledge Interview

MLE   Mediated Learning Experience

MSK   Metastrategic Knowledge

SRL   Self-regulated Learning

ToM   Theory of Mind

CHAPTER I

Introduction

Toward a Conceptualization of Metacognition: Background and Relevant Literature

In a special issue of *Educational Psychology Review* focused on Metacognition (Mc),

Self-regulation (SR) and Self-Regulated Learning (SRL), Dinsmore, Alexander, & Loughlin

(2008) reviewed how these related constructs have been conceptualized and measured in the

literature. It will likely not surprise researchers in these areas that these constructs were explicitly

defined by researchers in only 49% of the studies reviewed; this was particularly true for Mc

(32%; 39/123 studies). In addition, when these constructs were defined, they were often

interchangeably conceptualized (i.e., the same or similar definition given for Mc in one paper

was given for SR in another) (Dinsmore, et al., 2008). Furthermore, variants of seven keywords

(monitor, control, regulate, cognition, motivation, behavior, and knowledge) were reiterated in

explicit definitions of these constructs to varying degrees across the different constructs (see

Table 1.1). This analysis indicated differential emphases among the constructs, specifically

between Mc and SR/SRL indicating that SR/SRL had a broader emphasis compared to Mc. This

was evidenced by the higher proportions of the keywords "cognition," "motivation," and

"behavior" in definitions of SR/SRL (when they were explicitly defined which was 57% of the

time for SR and 69% of the time for SRL) compared to the targeted way that Mc was defined

with minimal keywords related to "motivation" or "behavior." Additionally, the keyword,

"knowledge" was used far more frequently in reference to Mc than SR or SRL. Interestingly, the keywords "monitor" and "control" were only slightly more frequently used as keywords for Mc over SR, and SRL though these term have been used in seminal definitions of Mc from its inception (i.e., Flavell 1979) to Nelson and Narens' (1990) prominent model of metamemory processes.

Table 1.1.

Percentage of SRL Studies with Keywords Appearing in Explicit Definitions

	Metacognition (Mc)	**Self-regulation (SR)**	**Self-regulated Learning (SRL)**
Monitor	51	35	39
Control	49	39	33
Regulate	44	*	*
Cognition	*	48	43
Motivation	03	42	50
Behavior	05	42	39
Knowledge	59	06	15

Notes: Adapted from Dinsmore, Alexander, & Loughlin, 2008, p. 400
　　　* Authors did not code the nested term cognition for Mc nor regulation for SR or SRL

It may be that, as Dinsmore et al. (2008) speculated, a key difference between Mc and SR/SRL related to monitoring and control processes is the focus on *what* is being monitored or controlled, which is often not emphasized by researchers in operationalizations or keywords; it may be that behavior, emotions, motivation, and/or cognition are being monitored and controlled for SR/SRL whereas cognition specifically is being monitored and controlled for Mc. This is an important distinction for researchers to make.

The review described above suggests a substantial amount of conceptual overlap in this terrain. This overlap extends to the tools and the manner in which researchers measure these constructs (e.g., Veenman 2007; Marulis, Baker, Basilio, & Whitebread, in preparation). When

Dinsmore et al. (2008) analyzed the alignment between authors' construct definitions and the types of measures they used, they found that more than 92% of the SRL studies had full alignment whereas this dropped to 71% for Mc and 63% for SR studies. The authors concluded with a plea for researchers and educators to be 'vigilant' in the way they conceptualize and measure these interrelated (though distinct) constructs. This is what my dissertation studies were designed to address: The conceptualization and measurement of early metacognitive processes.

Origins and Models of Metacognition

Metacognition, coined by John Flavell (1976), is how one monitors or thinks about one's own cognition. At its essence, it is "thinking about one's own thinking." In his seminal paper, Flavell (1976) focused broadly on several "metas" that he believed were of utmost importance to learning (and particularly to problem-solving). The first "meta" he mentioned (that children gradually acquire through information storage and retrieval) was being aware of situations in which intentional, conscious storage of particular information may be beneficial to future learning (e.g., a math fact or effective reading comprehension strategy). The second was keeping this information current and at the ready (e.g., monitor this information and change it with any new information or when it becomes clear that it is not accurate or effective and be ready to retrieve it when needed). The third, was when the information was not deliberately stored for subsequent usage (i.e., when this need was unable to be anticipated), making purposeful and systematic searches for any and all stored information with the potential to facilitate solving a problem. Flavell notes his deliberate avoidance of using the term 'memory' when describing these metaskills because he says that these processes could be internal or external (e.g., the use of notes previously taken or a concept map previously created). Prior to the 1976 paper, however, Flavell wrote about "metamemory" and conducted research on this construct (e.g.,

Flavell, 1971; Kreutzer, Leonard, & Flavell, 1975), so the distinction is not clear cut. Even Flavell himself indicated that memory can be viewed as "in good part just applied cognition" (1971, p. 273). I share this view that memory is just one (albeit key) type of cognition, though prefer the term metacognition to metamemory as it subsumes all other "metas" related to cognitive processing and has a closer connection to authentic learning contexts that rarely recruit only one cognitive process. Such a distinction would be important when, for example, investigating associations between metamemory and memory skills compared to associations between attention and attention skills. However, as that type of examination is not my focus, I will use the term metacognition (Mc) throughout this multiple-manuscript dissertation.

Flavell's original conception of Mc—framed within the information processing theory of cognitive development—was that of Piagetian stage theory wherein, with development and experience, we learn to better monitor our thinking by understanding what we need to monitor and regulating our thinking by setting goals and initiating strategies to achieve these goals and assess progress. Flavell, in creating a model of cognitive monitoring (1979), parsed Mc into four main components as follows: metacognitive knowledge (McK[1]) including knowledge of one's self and others' thinking, tasks, and strategies; metacognitive experiences (McE) which include conscious experiences related to thinking (cognitive or affective); cognitive goals or tasks, which are the objectives of thinking; and cognitive actions or strategies, which are the cognitions and/or behaviors that are enacted to achieve the cognitive goals. Flavell emphasized that the successful and efficient interaction of these four processes could lead to greater levels of learning and

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[1] Included **declarative** (knowledge about one's own capabilities/abilities and factors that may influence processing and performance), **procedural** (knowledge related to how to execute procedures and strategies) and **conditional** (knowledge about when and why to apply particular actions and strategies).

performance (through developing and applying metacognitive skills). See Figure 1.1 (Flavell, 1979).
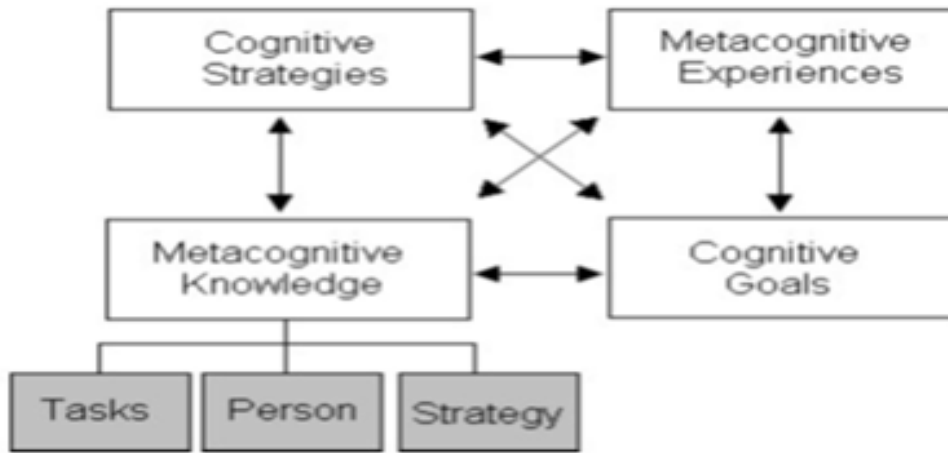
Figure 1.1. Flavell's model of cognitive monitoring (1979).

Interestingly, though some of Flavell and colleagues' early work would be categorized within a deficit model approach, he was explicit that this was not his overarching emphasis: "...it will naturally be very important to try to discover the early competencies that serve as building blocks for subsequent acquisitions rather than merely cataloging the young child's metacognitive lacks and inadequacies" (1979, p. 909).

Though these seminal papers (Flavell, 1976; 1979) mark the official unveiling of the term "metacognition" in psychological and educational research, there was a long previous history of reference to similar concepts such as reflection or introspection, traces of which can be seen as far back as the musings of Plato, Aristotle and Simonides (403 B.C.). John Locke, in 1690, introduced greater specification by distinguishing "reflection" as a more important and privileged form of thinking than other forms or "sensations" that do not tend to produce "long-lasting ideas" or deep levels of understanding (Locke, 1690 as cited in Brown, 1987, p. 70). Furthermore, early educators such as John Dewey had similar ideas. In his Pedagogic Creed

(1897), Dewey stated his belief that the learning process would be disorganized and unsystematic (and thus not "educative") when left unexamined and that by looking within one's psychological processes would lead to educative leverage (Dewey, 1897). It is likely that the influence of behaviorism in the field of psychology in the early 20th century is related to the hiatus in research and theorizing about Mc (and the resurgence just after the shift from behaviorism to cognition with the "cognitive revolution" of the 1950s).

Around the same time that Flavell was exploring this new conceptualization, Ann Brown, wrote a paper entitled, "Knowing when, where, and how to remember: A problem of metacognition" (Brown, 1978). She focused on the importance of Mc as a distinct entity in studying developmental cognition and learning rather than an add-on or product of cognition. Brown framed Mc within efficient thinking, which she purported to be made up of several basic characteristics: "predicting, checking, monitoring, reality testing, and coordination and control of deliberate attempts to learn or solve problems" (1978, p. 78). However, she emphasized the significance of the addition of this new conceptualization (Mc) of what may have been viewed as simply good study skills or good thinking. Her justification was based on the "change of emphasis" inherent in this term—rather than its being simply an epiphenomenon—from "cognitions themselves" to "knowledge about one's own cognitions" (Brown, 1978, p. 79). Later studies have provided empirical evidence supporting this claim indicating that the "meta" does provide distinct information (e.g., modest correlations, $r=.42$, between metamemory and memory across a wide range of learning contexts; Schneider & Bjorklund, 1988). We see an additional viability to the distinction of Mc from earlier similar concepts such as study skills (e.g., Brown & Smiley, 1977; Robinson, 1941) as it forms a deeper theory of change rather than separate piecemeal study skills that may be less likely to be taught in relation to cognition and how the

mind and brain work, which can help children make larger connections and stronger associations (e.g., see Carol Dweck's intervention work using Brainology ®; e.g., Dweck, 2008). Others have supported Brown's (1978) notion of the critical nature of having a unified theory of learning and mechanisms of development and change, such as that of Mc, to cognitive and developmental psychology (including social cognition theories) as well as educational practice (Larkin, 2010).

Later, in 1987, Brown created an extended model of Mc that distinguished between knowledge about cognition, and regulation of cognition. She re-emphasized that Mc is "at the very roots of the learning process" (p. 66) and, though a multifaceted complex construct (and often a confusing and 'fuzzy' concept for researchers and educators), is key to targeting mechanisms of change and development. She clarified that cognitive strategies such as elaboration should not be lumped into the Mc construct and made it clear that only when one reflects or regulates the strategy of elaboration or knows when or how to recruit this strategy, for example, should it be considered a metacognitive process. Brown (1987) suggested that regulation of cognition (metacognitive regulation; McR) is more context-than-age-dependent; one may regulate their cognitive processes in one situation but not another, and a child may show regulatory behaviors where an adult does not (see Figure 1.2).
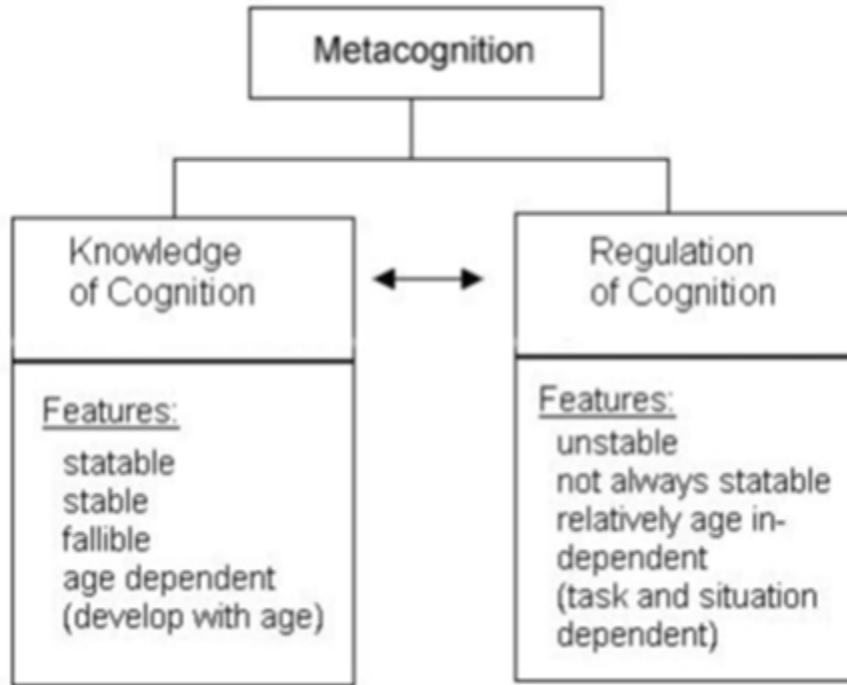
Figure 1.2. Brown's model of metacognition (1987)

Furthermore, the regulatory aspects of MC are not necessarily stable or statable; knowing how to regulate may not be conscious or easily reported to others (Brown, 1987). Brown (1987) discussed several researchers interested in Mc at that time (e.g., Henry Wellman and Lila Gleitman) who proposed that, to reduce the 'mystery' of the Mc construct, it be limited to its original conception (i.e., Flavell, 1976): "knowledge about cognition." This would reduce the confusion with related concepts such as SR and SRL and other (related) processes such as "planning-ahead" or "resource allocation" could be used independently rather than subsumed under the unwieldy umbrella term Mc. Nearly 15 years later, SRL researchers concurred proposing that Mc be reserved for McK and processes related to control and regulation excluded from this construct (e.g., Pintrich, Wolters, & Baxter, 2000). Though, even a cursory review of the literature would illustrate that this was not by any means universally adopted (see Table 1.1

for one indication), influential researchers have reaffirmed this proposal since Brown's 1987

paper. The authors and editors of a recent empirically-based book *Trends and Prospects in*

Metacognition Research (Efklides & Misailidi, 2010) have adopted this perspective. In the

introduction, the editors make an explicit statement to this effect: "All contributors to this book

share the definition of metacognition as cognition of cognition", (Ibid. p. 2). However, this

"cognition of cognition" is often reflected in (and operationalized as) self-regulatory actions such

as creating and enacting a plan for approaching a learning task. Thus, Mc remains a complex and

somewhat "mysterious" construct, not to mention issues such as when it emerges and how it can

be measured. Thus, the focus of the current dissertation studies is on the conceptualization and

assessment of metacognitive processes in young children to target these pressing issues.

Importance of Metacognition to Learning

There is considerable empirical evidence indicating a strong association between Mc and

greater levels (and depth) of general learning and academic achievement across grade levels and

even when controlling for other cognitive and SRL[2] factors (e.g., August, Flavell & Clift, 1984;

Borkowski, Carr, & Pressley, 1987; Bransford, Brown & Cocking, 2000; Carr, Kurtz, Schneider,

Turner & Borkowski, 1989; Garner, 1990). Moreover, Mc is related to intelligence (Borkowski,

et al., 1987; Sternberg, 1984, 1985) and has additionally been shown to predict academic

achievement and learning beyond measures of intelligence (e.g., Demetriou, Gustafsson,

Efklides, & Platsidou, 1992; Elshout, 1987; Sternberg, 1985; Veenman, & Spaans, 2005).

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[2] The positive influence of Mc is not limited to academic learning. Mc has also been shown to have important associations to other positive life outcomes (e.g., relieving depression and other disorders such as Obsessive Compulsive Disorder, anxiety, and generally to making better life choices and decisions) (e.g., Fisher, 2009; 2011; Wells, 2008) but the focus of this chapter is the relation between Mc and cognitive development/academic learning.

Further, the predictive strength of Mc is consistent across domains (e.g., analogical reasoning: Brown & Kane, 1988; problem-solving: Davidson & Sternberg, 1998; Whitebread, 1999; inductive reasoning: Prins, Veenman, & Elshout, 2006; mathematics: Desoete, Roeyers, & Huylebroeck, 2006; science: Georghiades, 2004, White & Frederiksen, 1998; writing: Bereiter & Scardamalia, 1987, Harris, Graham, Brindle, & Sandmel, 2009; and reading comprehension: Palincsar & Brown, 1984; Pressley, 2002). These findings have also indicated that Mc was especially important for learning tasks within learners' zones of proximal development (ZPD; Vygotsky, 1978); when tasks were at the boundaries of their knowledge and abilities (Prins et al., 2006). As will be reviewed shortly in more detail, Mc has more recently been shown to influence even preschool-aged children's cognitive ability and academic achievement (Shamir, Mevarech, & Gida, 2009; Whitebread, Bingham, Grau, Pasternak, & Sangster, 2007; Whitebread et al., 2009). Moreover, there is recent preliminary evidence that, at the neurological level, Mc is associated with enhanced indicators of learning in the brain (i.e., error detection and correction responses related to progress monitoring) in primary school children (Rueda et al., 2011) and preschool-aged children (Marulis, Kim, Grammer, Carrasco, Morrison, & Gehring, 2013).

The most robust evidence indicating the importance of Mc to learning and academic achievement comes from two meta-reviews. The first is a content analysis conducted by Wang, Haertel, & Walberg (1990). Wang and colleagues examined the most influential factors in learning and achievement across six general categories from distal (e.g., state and district variables such as demographics of the district) to proximal (e.g., classroom variables such as climate or instruction). These categories spanned across levels of analysis from district/school/classroom variables to individual variables such as cognitive, social, behavioral or SRL variables. The authors reviewed hundreds of studies and focused on 179 "authoritative"

articles with relevant data. In all, they coded 30 variables within the 179 studies to examine their relationships to learning and achievement in school. Wang and her colleagues (1990) next ranked these relationships from 1 (weak or inconsistent) to 3 (strong) and then averaged the rankings across studies that included each variable. They found that, of the 30 variables, Mc had the strongest relation to learning across all articles and was the only individual student variable with a coded average of 2.0 or above (Wang et al., 1990).

More recently, Dignath, Buettner, & Langfeldt (2008) conducted a meta-analysis that examined the efficacy of interventions targeted broadly to enhance SRL in elementary-aged school children. They found that the most effective interventions were ones that combined metacognitive aspects of training with other SRL or cognitive strategies (*d*=1.23-1.44). Importantly, interventions relying exclusively on cognitive strategies produced low effects (*d*=.23-.37).

Many researchers advocate for the early acquisition of metacognitive skills through instruction, scaffolding and facilitative environments for best chances of enhancing learning and achievement. Further, developing and implementing these interventions or facilitative instructions and environments in the before school years is both more cost effective (e.g., Heckman & Masterov, 2007) and sustaining (e.g., Li, Farkas, Duncan, & Burchinal, 2013). Most studies on metacognition and learning focus on children in elementary school and beyond and thus there remains limited information on: what different ways of measuring developing Mc can reveal about children prior to entering formal schooling when academic functioning becomes particularly important.

In view of the conceptual and methodological confusion that surrounds metacognition—coupled with its importance for learning and academic functioning—the primary research goals of the current series of programmatically-linked studies in this this multiple manuscript dissertation were to develop and examine a direct measurement tool for conceptualizing and assessing metacognitive knowledge in 3-5 year olds and examine how metacognitive processes are facilitated in young children.

Development of Metacognition

Researchers have argued that Mc does not emerge until at least age 7-8 (e.g., Flavell, 1979; Kreutzer, Leonard, & Flavell, 1975; Veenman, Van Hout-Wolters, & Afflerbach, 2006) though some of these researchers have speculated that their findings were likely related —at least partially—to limited experiences, training or instruction and that intervening on these skills was both "feasible as well as desirable" for children (Flavell, 1979, p. 910). However, conclusions drawn from these studies have continued to be in line with a deficit perspective, postulating that young children are unable to be metacognitive, or thoughtful about their own thinking and learning. What is often not taken into full consideration is that these assessment approaches and tools were often decontextualized (i.e., the children were asked abstract questions about hypothetical situations). Other contemporaneous studies found, for example, that, in a familiar context (i.e., listening to storybooks read by their mothers), 2.5-3 year olds displayed robust evidence of comprehension monitoring and even explicit communication of how to resolve comprehension discrepancies (Karabenick, 1981). Flavell himself, in 1992, suggested that children as young as 6 years of age would be able to reflect on their own thinking *within a domain in which they have previous knowledge* (Flavell, 1992). In 2010, Lyons & Ghetti concluded that "young children may be much more adept at monitoring their mental activity than

is often assumed", p. 265, pointing to the developing use of mental state verbs—e.g., *know, think,* and *I don't know*—by the end of children's 2nd year as indicators of preliminary Mc. In addition, Lyons & Ghetti, 2010 reviewed evidence of rudimentary forms of Mc in 30 months old infants who were able to successfully assess whether or not they knew something (e.g., Marazita & Merriman, 2004; Moore, Furrow, Chiasson, & Patriquin, 1994). Recent work has speculated that origins of metacognitive awareness and skills is present in 2-4 month old infants at which time they begin to be able to participate in joint monitoring and control interactions with adults (Brinck & Liljenfors 2013).

Questions posed to children in earlier (and some recent) studies tended not to be developmentally appropriate or sensitive to development enough to detect Mc or McK in preschool-aged children. Use of differing methodologies was found to be associated with early (and some recent) studies' limited evidence of Mc in children under age 7-8 (Efklides & Misailidi, 2010). In general, the belief that Mc would not emerge until later in childhood likely originates from the way it was first conceptualized within an information-processing, Piagetian stage theory framework. Within this framework is the idea that higher order levels of thought operate on lower order levels, which is categorized within the formal operations stage of development that is specified to emerge well into adolescence. Related to this, Tunmer and Herriman (1984) argued that, to be capable of Mc, children would need to transition from automatic to controlled processing, which, according to the Piaget, does not occur until around age 7-8 (during the transition to concrete operations). Furthermore, recent researching finding that metacognitive processes develop far younger than originally thought (e.g., Shamir et al., 2009; Whitebread et al., 2007; 2009; 2010 to be reviewed shortly) rings similar to findings several decades after Piaget's original research (e.g., Gelman & Baillargeon, 1983) indicating

that many conclusions of later-developing skills (i.e., at 7-8 years) were related to measurement issues (e.g., the measurement was not developmentally appropriate leading to young children 'failing' the task). In fact, the underestimation of early cognitive and learning-related/SRL skills is particularly pervasive in the area of Mc (e.g., Veenman, et al., 2006).

Beyond the way Mc has been measured (e.g., type of questions asked), some of these differences are likely due to the developmental appropriateness of the category of measurement applied (e.g., verbal reports vs. think alouds vs. observational studies) as well as the environment in which Mc was measured (e.g., a lab setting vs. a naturalistic setting such a preschool). Indeed, as mentioned previously, more recently there have been several studies employing naturalistic observational measures—whose authors advocate against the primary reliance on self-reports or assessments that require verbalizations in children under these traditional threshold ages—with promising evidence of the application McK, strategies and regulation in 3-5 year old nursery-school children (Shamir et al., 2009; Whitebread et al., 2007; 2009; 2010). This robust evidence of Mc in preschool-aged children spanned across individual and group learning tasks and was predictive of cognitive ability and learning. Due to space constraints, I will review the first two of these seminal studies.

Recent Evidence of Earlier Emergence of Metacognition: Toward a More Comprehensive Assessment of Metacognition

The principal research group providing seminal evidence for an earlier emergence of Mc is headed by Dr. David Whitebread of the University of Cambridge. Whitebread and his colleagues (2007) observed 1,440 3-5 year old preschoolers in their classrooms over a two-year period and coded their naturally occurring behaviors (verbal and non-verbal). They found extensive evidence of Mc across these 3-5 year olds. Specifically, in their large sample of

preschool-aged children, they coded at least one—and for the majority of the children several—instances of metacognitive behaviors (examples of behaviors that Whitebread et al., 2007 coded as being metacognitive are included in Appendix 1.A). The instances in which Mc was most frequently seen were during learning situations that were initiated by the children themselves, when the children were working in small groups or pairs (as opposed to as individuals or with a teacher), and during learning activities that "involved extensive collaboration and talk" between children (Whitebread et al., 2007, p . 440). This study was the first to empirically illustrate the existence of Mc in even the youngest students indicating a much earlier emergence than previously believed. The authors argued that this detection was largely due to the naturalistic contextualized setting of the study paired with the limited reliance on verbalizations from the children. The researchers cautioned that this evidence should not be taken as a reason to limit individual learning situations nor that the individual children were not experiencing rich and high level of Mc during their individual learning. It may be, they suggested, that these experiences are taken place internally or less likely to be explicitly exhibited or verbalized (Whitebread et al., 2007).

Another study with evidence of earlier emergence of Mc—in support of Whitebread et al., 2007—Shamir and her colleagues (2009) examined indications of 64 4-5 year old children's verbal and non-verbal McK related to a memory recall task. Children were asked to recall nine picture cards in both individual learning and peer-assisted learning contexts in their preschool classrooms. Their procedural metacognitive behavior was assessed using primarily observational assessments with one self-report interview question ("Please tell me what you did in order to recall the cards"; for the peer-assisted learning context: "You remembered the cards very nicely. Please tell your friend what to do in order to recall the cards; please help him/her".). Similar to

Whitebread and colleagues (2007), Shamir et al. (2009) found robust evidence of McK in these young preschool-aged children (examples of behaviors and responses that Shamir et al., 2009 coded as being metacognitive are can be seen in Appendix 1.B). They found that the children displayed significantly greater procedural than declarative McK (in both contexts) and greater procedural McK in the peer-assisted learning context (controlling for language ability and Theory of Mind). The best predictor of cognitive performance was procedural McK in the peer-assisted learning context whereas declarative McK did not explain any further variance. These results provide an additional (cross-cultural) indication that not only are children (younger than previously thought) able to demonstrate McK but, also, that aspects of this ability predict their performance on a cognitive task. Furthermore, this ability appears to increase when children work with similarly-able peers.

Taken together, the findings from Shamir and colleagues (2009) and Whitebread and colleagues (2007) provide ample empirical support for the proposal that previous results indicating later emerging Mc were—at least partially—a function of measurement. The issue of measurement of Mc is multidimensional in that it is crucial to consider not only the measurement instrument (e.g., employing observational assessments in place of or in addition to self-reports or think alouds), but also the context in which the measurement takes place (e.g., naturalistic settings such as classrooms compared to less authentic settings such as experimental laboratories) and the methods (e.g., making the assessment more concrete and contextualized to a developmentally appropriate learning and facilitating conducive environments for Mc).

However, these studies focused on verbal and non-verbal metacognitive behaviors where Mc was typically inferred rather than directly assessed. While these observational methods are a more sensitive way to capture Mc in young children, their exclusive use may not result in a

comprehensive depiction of early Mc competency. Furthermore, articulation (i.e., think-aloud) has successfully been used as cognitive intervention (e.g., Montague, 1993) indicating its effect on learning; Mc may be similarly mediated by its articulation. Therefore, it is crucial that the way we measure early Mc is carefully and comprehensively studied to examine the transiency, depth and breadth of this important skill.

Analogous to the aims of these researchers who have recently developed comprehensive observational tools (including a singular declarative interview question in Shamir et al., 2009) that are sensitive to capturing Mc capabilities of young children, a key goal for my dissertation research was to develop such a measurement tool for directly assessing articulated declarative metacognitive knowledge in preschool-aged children. To that end, in Study 1, I developed the Metacognitive Knowledge Interview (McKI)—to be discussed in depth in Chapter II—which was designed to comprehensively capture the declarative McK of young children sensitively and developmentally appropriately. To comprehensively assess metacognitive processes, the convergent validity between the measurement tool I created (the McKI) and an established measure of metacognitive behavior (Children Articulating Thinking [ChAT] Bryce & Whitebread 2012; Whitebread, Pino Pasternak, Marulis, Okkinga, & Vuillier, in preparation) was assessed in Study 2, which will be discussed in Chapter III.

Moreover, because these studies (Shamir et al., 2009; Whitebread et al., 2007) relied on correlational analyses, the precise relations between Mc and instructional factors have not been established. Seminal researchers have called for greater attention to examining these associations (e.g., Whitebread et al., 2009), thus another key aim of my programmatic dissertation studies was to examine these associations through experimental manipulation. Therefore, in Study 3, I

conducted a Dynamic Assessment intervention to examine how metacognitive processes were facilitated in preschoolers, which will be discussed in Chapter IV.

There are at least three additional (and interrelated) likely reasons that the evidence of the earlier emergence of Mc has only been recent and limited to a few research groups. First, being a predominantly internal process, Mc is challenging to measure and even more challenging with young children who have limited and less sophisticated expressive vocabularies. Second, there are stronger and clearer links between Mc and academic achievement in older children though this may be a function of the first reason. And third, there are established and validated measures for older children and adults such as the *Motivated Strategies for Learning Questionnaire;* (MSLQ Pintrich, Smith, Garcia & McKeachie, 1991), the *Metacognitive Awareness Inventory* (MAI; Schraw & Dennison, 1994), and the *Learning and Study Strategy Inventory* (LASSI; Weinstein, Palmer, & Shulte, 1987). However, the focus of my dissertation research is on young children prior to formal instruction (i.e., preschool-aged children; 3-5 year olds). This is due primarily to the evidence indicating that this is the most effective and efficient time to intervene (e.g., Heckman & Masterov, 2007; Li et al., 2011) and because it is a sensitive period for later school success (Rimm-Kaufman & Pianta, 2000). My resolve to target preschool-aged children has been strengthened by this more recent evidence (e.g., Shamir et al., 2009; Whitebread et al., 2007; 2009; 2010) indicating that it is during this period when Mc and its relations to learning and academic achievement may be emerging. In addition to the important policy and practice implications for educators, educational psychologists, and interventionists, studying preschool-aged children's Mc has the potential to make valuable contributions to the theories and developmental trajectories of developmental and cognitive psychology.

Additional Measurement Issues

In addition to being associated with differences in identifying the age of emergence of

Mc, there are larger challenges surrounding measurement for Mc researchers. The issue of

measurement is particularly important when studying concepts such as Mc that tend not to be

defined or operationalized in a consistent way. In addition to this, researchers have been vocally

skeptical about the value of studying what they deemed to be a "broad and elusive" construct

(Schraw 2000, p. 304). To address these concerns, and also push Mc researchers to be more

precise and comprehensive, Schraw (2000) bestowed four cautions derived from work of

measurement experts (see Figure 1.3). In my own research—including these dissertation

studies—I have incorporated these suggestions as much as possible.

Four cautions: (from measurement experts) when studying metacognition:

1. **Field needs a plan for comprehensive assessment of the construct**
   a. **Reliability and validity norms**
   b. **Plan for translating theory into instruments that can be appropriately evaluated**
2. **Generate and test models**
   a. **Translate metacognitive theory into testable models**
3. **Construct and evaluate instruments that assess specific components of the model**
   a. **Use multiple measures/using multiple methodologies (convergent validity)**
4. **Use diverse assessment models**
   a. **Use multitrait, multimethod (MTMM) approach. See Campbell & Fiske, 1959 and Cook & Campbell, 1979.**
   b. **Incorporate diverse approaches including neurophysiological.**

Figure 1.3. Cautions from the work of measurement experts for effectively examining Mc.

Adapted from Schraw, 2000, p. 304-308

Similarly, regarding the examining of Mc, Baker and Cerro (2000) have emphasized the

importance of converging evidence from different methods with different sources of error. They

proposed that if these divergent methods produce similar results, this evidence can be considered valid, reliable, and robust: "we can be more confident that we have measured what we set out to measure", Baker & Cerro, 2000, p. 129.

Facilitating Metacognition

Mechanisms of Change

According to Schraw & Moshman (1995), the three factors that are most likely to bring about metacognitive change are: *cultural learning*, *individual construction,* and *peer interactions*.

Cultural learning. Schraw & Moshman (1995) described cultural learning as informal and formal socialization, the prototypical example being explicit instruction. They focused on metacognitive interventions that have shown significant gains in Mc and cognition/achievement such as the Informed Strategies for Learning (ISL; Cross & Paris, 1988), Reciprocal Teaching (RT; Palincsar & Brown, 1984) and a metamemory strategy training program (Kurtz & Borkowski, 1987). Another, similar intervention program within the domain of science that Schraw & Moshman did not discuss is the ThinkerTools Inquiry project (White & Frederiksen, 1994; 2000). This program focused on enhancing children's McK related to inquiry-based science and helping them apply it to a physics curriculum. All of these interventions involved children being directly and indirectly (e.g., through modeling) taught to effectively use cognitive and learning strategies (and understand when and how to use them) with ample feedback and scaffolding. Each of these programs was rigorously examined using comparable control groups and found strong evidence of efficacy of this type of explicit instruction. The results indicated an enhancement of not only metacognitive processes but also of domain-specific learning. When

designing my Dynamic Assessment (DA) intervention for Study 3—which will be described in Chapter IV—I used these types of metacognitive interventions as models within a sociocultural framework (Vygotsky, 1978) wherein mediated instruction is posited to enhance children's learning.

Individual construction. Schraw & Moshman (1995) described individual construction as individuals independently constructing their own knowledge and understanding, typically outside of formal or informal instruction. They described this process as involving diverse strategies including phenomenological bootstrapping (e.g., Flavell, Miller, & Miller, 1993) where individuals use their own cognitive experiences to reflect on the nature of cognition. Individual construction focuses chiefly on reflection and analysis of one's own thinking and develops with age and experience. I found this section limiting in its mechanistic explanation of change as key factors to facilitate this self-reflection and analysis to take place and develop such as motivation or Executive Function (EF)/SR were not discussed. However, it seems important to include both social and individual aspects of learning as important mechanisms of change. While my DA intervention is designed to take place within instructional settings, it involves individual construction as much of the support is focused on children constructing their own knowledge and understanding and reflecting on their own thinking. Thus, the design principles of my DA intervention are based on two of the three mechanisms of change for facilitating Mc described by Schraw & Moshman (1995). While I agree that peer interactions are also a powerful way to facilitate metacognitive processes, they were beyond the scope of this dissertation research. However, they will be discussed in Chapter V on future directions.

Peer interactions. The last factor Schraw & Moshman (1995) discussed related to the facilitation of Mc was peer interactions. They described these as social interactions among peers

of "roughly the same cognitive level in relevant aspects so that none can be considered an expert with cultural knowledge to be passed on to the others" (Schraw & Moshman, 1995, p. 364). This conceptualization is similar to that of Shamir et al. (2009) in their peer-assisted learning condition which provides empirical support for this position as they found that the peer-assisted learning condition was the most facilitative of Mc in 3-5 year old children. Peer interactions were described as a type of collective or socially shared reasoning whose key function was the resolution of divergence. The strongest evidence implicating this factor as a mechanism of change was a study conducted by Geil & Moshman (1994) which included both an individual and group problem-solving condition. They found that 75% of the students working in groups of 5-6 reached the correct solution, only 9% did when working as individuals did so. Interestingly, Geil & Moshman (1994) asked half of the groups to work on the same problem prior to the group collaborative problem-solving and found that 95% of the individuals comprising the groups were unable to successfully find the solution even though they came to the correct solution in their groups (only 2 students in this condition arrived at the correct solution on their own, prior to the group work). Schraw & Moshman (1995) suggested that these results support their notion that peer interactions facilitate enhanced metacognitive knowledge and processing leading to increased levels of problem-solving capabilities. Though they discussed the influence of cultural processes, Schraw & Moshman differentiated peer interactions from the other two factors.

Schraw & Moshman (1995) viewed these factors as distinct but interacting in bringing about change in metacognitive processes. Similar to my discussion of the importance of integrating SRL variables rather than viewing or examining any one as a sole predictor of learning, Schraw & Moshman described these factors as being integrated non-mutually exclusive conduits to enhanced Mc.

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By interactive, we mean that improvements made via any of the three factors described above reciprocally affect the remaining factors. For example, the communication of specific information about cognition via direct instruction may enhance a student's ability to construct an informal or formal theory of his or her own cognition. Similarly, peer discussion and collective theorizing about cognition may enhance the effectiveness of direct instruction. (Schraw & Moshman, 1995, p. 365).

Good Information Processing. All of the evidence I have reviewed here broadly supports a similar model of the central characteristics of learners who are "Good Information Processors" (see Figure 1.4) developed a few years after Schraw & Moshman's 1995 paper (Borkowski, Chan, & Muthukrishna, 2000). Borkowski and colleagues (2000) described good information processing as the highest ideal for learning—including the successful integration of knowledge with higher-order skills and beliefs—and indicative of students who will be most successful in school and with long-term academic outcomes.

1. Knows a large number of useful learning *strategies.*
2. Understands *when, where* and *why* these strategies are important.
3. Selects and monitors strategies wisely, and is extremely reflective and planful.
4. Adheres to an incremental view regarding the growth of mind.
5. Believes in carefully deployed effort.
6. Is intrinsically motivated, task-oriented, and has mastery goals.
7. Doesn't fear failure-in fact, realizes that failure is essential for success—hence, is not anxious about tests—rather sees them as learning opportunities.
8. Has concrete, multiple images of "possible-selves," both hoped-for and feared selves in the near and distant future.
9. Knows a great deal about many topics and has rapid access to that knowledge.
10. Has a history of being supported in all of the above by parents, schools, and society at large.

Figure 1.4. Ten major characteristics that define a "Good Information Processor".

From Borkowski, Chan, & Muthukrishna, 2000, p. 4.

Borkowski et al. (2000) focused on Mc that they portrayed as the essential underlying factor and describe these metacognitive learners ("good information processors") as being able to

effectively integrate their knowledge with higher-order skills (such as EF) and beliefs (such as academic goal orientations or other motivational beliefs) in order to successfully perform academic tasks. The authors are not specific in terms of a developmental trajectory, but based on the literature I have reviewed and my experience as a preK teacher, it follows that even in preschool-aged children, the successful integration of appropriate Mc with effective EF skills and motivational factors (behaviors, emotions and beliefs) is strongly related to their academic achievement in core domain areas. This view seems to be aligned with researchers who stress the importance of individuals viewings themselves as agents of their own thinking (e.g., Kaplan, 2008; Kluwe, 1982) and supports interventions such as Carol Dweck's Brainology® program, which teaches children about how their brains work to help them to feel in control of their learning and achievement with the goal of helping them develop an "growth mindset" (i.e., an incremental theory of intelligence and ability). When children are taught, or come to understand, that their own learning and thinking is—in large part—malleable and under their own control, they will likely adopt the types of self-efficacy and motivational beliefs and actions associated with greater levels of learning (Dweck, 2006; Dweck & Leggett, 1988). Dweck and her colleagues have found that this strong relationship between children's mindsets and their learning and academic achievement is present even in preschool-aged children (Smiley & Dweck, 1994). Furthermore, these types of programs target metacognitive beliefs and knowledge. As discussed in depth in this chapter, this is likely to enhance children's learning, particularly when taught or facilitated using appropriate scaffolding integrated with other SRL and cognitive factors. Broadly, this is what my DA intervention was designed to accomplish with the preschool-aged children- the same underlying principles apply to children's McK related to a cognitive task.

Borkowski et al. (2000) further proposed how the characteristics they identified (based on literature review and empirical evidence) develop and interrelate. They suggest that these factors successfully develop overtime and are applied to learning tasks through "high quality, interactive strategy instruction in both home and school" (p. 5). This facilitative instruction focuses on teaching children to use strategies appropriately, learning about when and how to best use them and how and when to recruit specific skills and metaskills (e.g., cognitive skills such as activating and applying prior knowledge as well as metaskills such as exertion of effort focusing of attention and inducing effective motivation affect and beliefs for greater learning). The authors have created a model (see Figure 1.5) to illustrate this process that is cyclical and interactive. This model reflects the framework I envision occurring even in the youngest of learners. One goal of my future research will be to empirically examine the components of this model in preschoolers using similar measures as have been described in this chapter. Though this is beyond the scope of these dissertation studies, such research plans will be discussed in Chapter V. Through gaining a better understanding of how these crucial components interrelate, interact and predict academic achievement, we will be better equipped to inform, design and evaluate early interventions for young learners (at-risk as well as typically developing and achieving) that may enhance learning trajectories on a long-term basis.
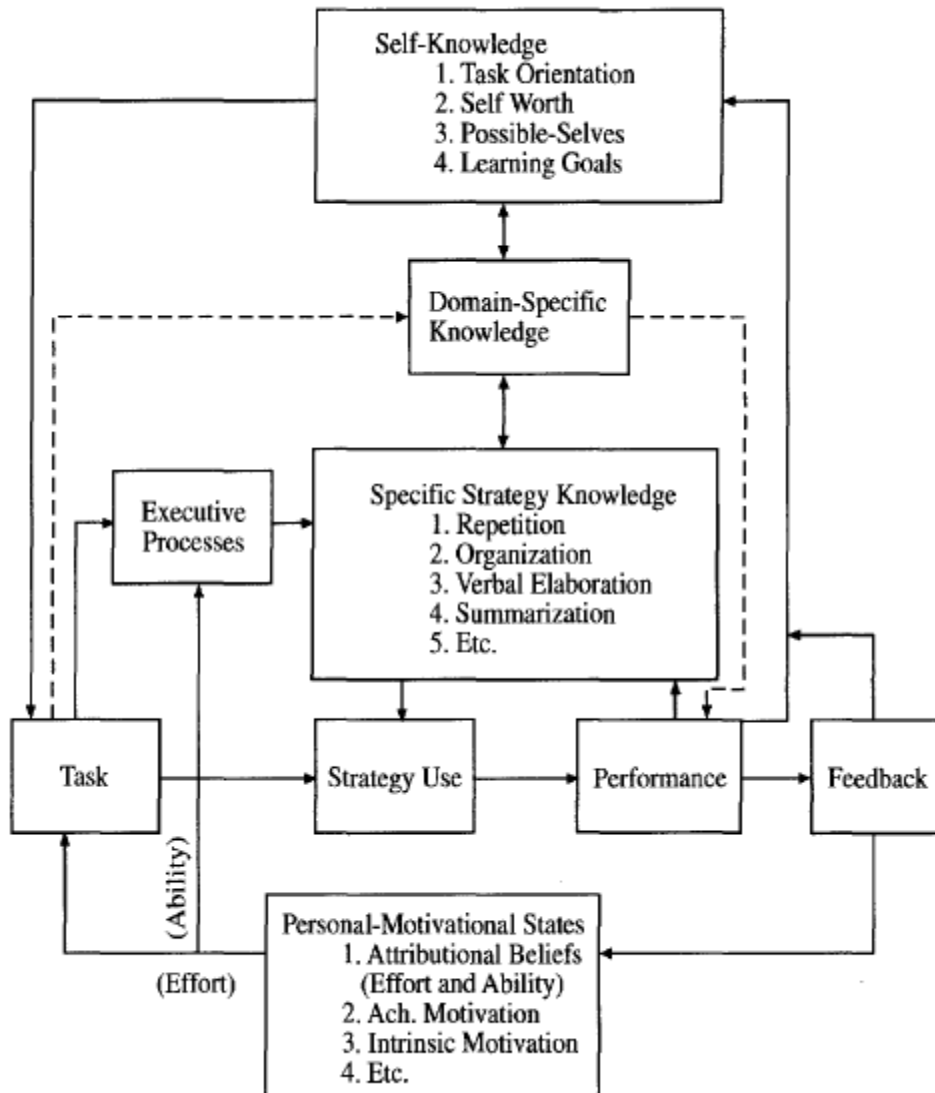
Figure 1.5. Cognitive, motivational, and self-system metacognitive components: The complete

model. From Borkowski, Chan, & Muthukrishna, 2000, p. 10

Metacognitive Learning Opportunities. The last factor in this non-exhaustive review of how

Mc is best facilitated is the metacognitive learning opportunities children are provided within

their classrooms. These opportunities include reflective and evaluative (e.g., formative

assessment) teaching, feedback, modeling and support, teacher's metacognitive behaviors,

interactions and dialogue, as well as varied learning tasks within their ZPDs that are conducive to

reflection and evaluation. Larkin (2000) analyzed teacher's level of metacognitive facilitation in a first grade science classroom. She created a coding scheme (see Figure 1.6) to assess the types of metacognitive learning opportunities provided across 10 classrooms and found that a positive correlation between these types of opportunities and the children's Mc and science learning.

Coding of Teacher Behaviours which appear to influence metacognitve processing in students.

Code	Explanation	Example
TS	Refers to self-learning strategies	"What could you do if you've got problems ?"
TK	Questions acquisition of knowledge	"How do you know that ?"
TI	Teacher prompts regarding information provided	"We found the biggest, what else could we do ?"
TE	Teacher aids explanations	"X explained putting the biggest to smallest very well"
TQ	Teacher questions/ comments on strategies	"How are you putting them in order"
TP	Teacher asks for predictions of success	"Will this make it easier ?"
TL	Teacher shows expectations of planning	"How are we going to do this, what do we need to think about ?"
TO	Teacher expects checking	"Check what you are counting in"
TC	Teacher refers to own cognitive processes	"I don't understand it either"
TT	Teacher refers to thinking	"Let's put on our thinking caps"
TU	Teacher refers to universals of cognition	"We are learning how to solve problems"

Figure 1.6. Coding scheme of teacher metacognition-facilitating behaviors.

From Larkin, 2000, p. 8.

Ornstein and his colleagues have also examined the association between classroom contexts and metacognitive development. In a recent study (reported in Ornstein, Grammer, Coffman, 2010), they examined 14 1st grade teachers' use of Mc language (focused on metamemory or "mnemonic style"). They described "high mnemonic teachers" as those who provide a metacognitive framework in the classroom and explicitly prompt strategy development (e.g., by suggesting strategies in particular domains and discussing why they could be effective) in their students. These teachers used both explicit prompts/suggestions (e.g., *Remember when you write, you have to go back and read what you wrote out loud"* and questions designed to elicit self-explanation and metacognitive awareness (e.g., *"How did you solve that problem?"*). The authors found significantly greater Mc, cognitive performance (on a card recall task) and effective strategy usage in the 1st graders with "high mnemonic" than "low mnemonic" teachers, and this difference was still present *three years later* when the children were assessed in 4th grade. Thus, these children were able to maintain their improved metacognitive awareness and strategy usage through the transition to three new teachers/classroom contexts (which may or may not have been facilitative of metacognitive processes or highly mnemonic in focus). In the same volume, researchers (Waters & Kunnmann, 2010)—who found evidence of the facilitation of metamemory through subtle prompting as early as in 1st graders—suggested that this transfer (or abstraction) both research groups found was possible because of cognitive changes occurring at the metalevel. They further proposed a "two-pronged" intervention approach that would provide training aimed at enhancing the "metacognitive-savviness" for both teachers and students (Waters & Kunnmann, 2010, p. 20).

Deanna Kuhn has also emphasized the importance of these types of opportunities for the development and enhancement of Mc, which she has implicated as key to critical thinking and

higher level reasoning and learning (Kuhn, 1999; Kuhn, 2000; Shaughnessy, 2004) and to the

greatest goal of education: transfer:

> If students participate in discourse in which they are frequently asked, 'How do you
> know?' or 'What makes you say that?' they become more likely to pose such questions to
> themselves. Eventually, we hope, they interiorize the structure of argument as a
> framework for much of their own individual thinking. (D. Kuhn interview: Shaughnessy,
> 2004, p. 275).

These metacognitive learning opportunities can also be made more explicit. My current

view of the most effective way to facilitate Mc, particularly in young children, is a combination

of metacognitive learning opportunities scaffolded by significant adults and explicit instruction

regarding Mc (similar to the Dweck interventions mentioned previously). Specifically this

explicit information would focus on the three branches of McK: how the mind works or the

"universals of cognition" (Flavell, 1979), how learning tasks generally operate across domains,

and how effective strategies work across tasks and domains. In addition, Kuhn has emphasized

the importance of teachers addressing *why* certain strategies are more effective and appropriate

than others in certain contexts or domains making it more likely that children will internalize and

abstract/transfer the information and knowledge they have learned to new situations

(Shaughnessy, 2004). These are the design principles that built the foundation of the Dynamic

Assessment intervention that I have designed in Study 3 that will be discussed in Chapter IV.

Other researchers, both at the genesis of theorizing about and empirically examining Mc

(e.g., Vygotsky, 1978) as well as the contemporary (e.g., Efklides & Misailidi, 2010) have

provided support for the view that Mc is best facilitated in both implicit (e.g., socialization,

social communication, collaboration and interactions, imitation and modeling) and explicit (e.g.,

direct informal and formal instruction) ways.

In sum, metacognitive instruction/training, socialization and peer assisted interactions along with individual factors (e.g., construction of knowledge, language ability and other cognitive and SRL variables) and contextual factors (e.g., developmentally appropriate cognitive tasks, scaffolded environments, metacognitive learning opportunities and dialogue, contextualized strategy instruction) may act as bootstrapping mechanisms for children, helping them to become more conscious and metacognitive in their knowledge and comprehension of their own thoughts and those of others (Bransford et al., 2005; Schraw & Moshman, 1995; Shamir et al., 2009; Whitebread et al., 2009).

Interim Conclusion

In summary, Mc is a complex cognitive- and learning-related process that is crucial to enhanced learning that can be facilitated through learning opportunities and appropriate environments as well as taught to children as early as preschool. Though Mc is an important construct, it is also a challenging one both in its conceptualization and assessment as has been reviewed in this introductory chapter. Accordingly, along with aiming to clarify the conceptualization and assessment of early metacognitive development, a key aspiration of this dissertation research is to examine whether and how metacognitive processes can be facilitated with young children.

Theoretical Grounding

The literature reviewed thus far (e.g., work of Flavell, Brown, Kuhn and their colleagues) falls mostly under the information-processing theory of cognitive development within which constructs like metamemory, Mc, and metacognitive strategies originated (e.g., beginning with research on cognitive processing and memory; Miller, 1956). Within this perspective,

development is viewed mostly through the lens of maturational changes in children's minds and brains (e.g., executive functioning or memory components that develop in line with the developing prefrontal cortex). These changes (i.e., development) are influenced by the way an individual processes incoming information; As children mature (and their brains/mind become more mature and developed), their ability to cognitively process becomes more advanced. Traditionally, a model of the mind from an information-processing perspective is analogous to that of a computer, though the evidence supporting this straightforward comparison is limited. Reliance solely on this perspective and its tenets, along with the issues inherent in the way Mc has traditionally been measured in young children, may be related to the pervasive view (with ample—though not comprehensive—supporting evidence) that Mc does not develop until middle childhood (approximately age 7-8). This work and theoretical grounding provides one of the frames for my series of dissertation studies informing my theoretical perspective, approach, and interpretation.

The other important framework for my research—that broadens the way I approach the current studies—is sociocultural theory (Vygotsky, 1978) which has a tradition of literature that focuses mostly on what is conceptualized as self-regulatory processes (including metacognitive aspects). Similar to Whitebread and colleagues (2009), my research is guided by an integration of these (traditionally disparate) theoretical lines. Within the sociocultural framework is the idea that children's learning and development is enhanced through social interaction with more developed members of their culture (e.g., adults and "more capable peers"). Children are thought to develop from an external to an internalized focus mediated through this social interaction. A concept central to this perspective is the Zone of Proximal Development (ZPD) or "*the distance between the actual developmental level as determined by independent problem solving and the*

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level of potential development as determined through problem solving under adult guidance or

in collaboration with more capable peers" (Vygotsky 1978, p. 86). Thus, mediated participation

(e.g., scaffolded or supportive instruction) and interactions with adults or more able peers is

reputed to can have a large impact on children's cognitive development that subsequently affects

their long-term academic achievement (and much research including Vygotsky's own and that of

his followers and beyond has supported this principle). These interactions often result in

qualitative changes or "revolutionary breakthroughs" (Vygotsky, 1984, p. 249) in learning that

are crucial to higher levels of development. Proposed mechanisms underlying these changes

include a scaffolding transition in which the adult (or more capable peer) takes on the bulk of the

metacognitive and self-regulatory processing (e.g., monitoring and regulating of cognition) but

makes it explicit to the child/novice and gradually relinquishes these processes (with support and

guidance) to the child so that the child begins to internalize the metacognitive and self-regulatory

processes and apply them to learning contexts and tasks (Brown 1987; Palincsar & Brown,

1984).

Another prominent researcher, Reuven Feuerstein, has developed parallel (developed

independently of Vygotsky's work) and converging theories with similar underlying beliefs and

mechanistic explanations. Feuerstein's theories (e.g., the Structural Cognitive Modifiability with

a focus on Mediated Learning Experience) center on the idea that cognitive development is

dependent on the "quality of the mediated learning that the child experiences" (Feuerstein, 1979,

p. 102). Inherent in both Vygotsky and Feuerstein's theories and beliefs is the fundamental

assumption that cognitive development and capabilities/competences are dynamic and malleable

rather than static or fixed. Relatedly, both researchers emphasize the importance of qualitative

(conceptual) changes to reaching higher levels of cognitive functioning, development and

learning.

Feuerstein empirically supported many of Vygotsky's arguments by showing that mediated instruction—or "mediated learning experiences"—provided to young children (particularly those at risk for learning difficulties such as those living in poverty or children who had been labeled "mentally retarded"), greatly enhanced their cognitive development and learning. He showed that specific adult-mediated interactions helped children develop higher mental functions (that, in turn, fostered higher cognitive processing and progress) (Poehner, 2005). Feuerstein subsequently developed an educational program called the "Instrumental Enrichment Program" (Feuerstein, 1980) that has robust empirical support of its benefits in enhancing the cognitive functions requisite for academic learning and achievement. Similar to the concept of the ZPD, Feuerstein's work centers on the idea that social interactions mediate develop and learning and in order to appropriately and comprehensively assess a child's level of development or cognitive functioning, both her or his independent and mediated performance should be examined. In fact, an examination of the effects of the Instrumental Enrichment Program (i.e., proving a rich mediated learning experience for children at-risk) indicates that children's learning with adult-mediated support is more predictive of their knowledge/understanding/achievement than assessments of their independent performances (Poehner, 2005).

Much empirical work supports the idea underpinning the sociocultural/cognitive modifiability theories that adult-mediated interactions and instruction, when strategic and based on theories of cognitive change, is robustly effective across domains not only in increasing metacognitive and self-regulatory processes but also transfer to the performance task even for young children (e.g., Brown, Pressley, Van Meter & Schuder, 1996; Fuchs, Compton, Fuchs,

Bouton, & Caffrey, 2011; Perels, Merget-Kullmann, Wende, Schmitz, & Buchbinder, 2009),

which is particularly true for children with lower initial metacognitive or self-regulatory abilities

(Tominey & McClelland, 2011; Whitebread, et al., in preparation). There is also evidence that

similar results occur within peer-mediated contexts (when peers are trained in group regulatory

and explanatory dialogue) (e.g., Palincsar & Brown, 1984; Shamir, et al., 2009; Whitebread, et

al., in preparation).

An integration of the information-processing and sociocultural/cognitive modifiability

theories will guide my series of dissertation studies (cumulating in Dynamic Assessment) in the

following ways. The information-processing theory posits that information is organized and

processed in specific ways by minds/brains. Accordingly, I will investigate how young children

process instructional information regarding metacognitive processes and strategies and how

presenting/mediating this information in various ways affects subsequent development and

learning (Haywood & Lidz 2007). The sociocultural/cognitive modifiability theoretical

perspective suggests that the types of interactive environments children encounter can have a

large impact on their cognitive development, subsequently affecting their learning and academic

achievement. And, furthermore, that mediated-learning experiences are not only supportive of

conceptual change and development, but indicative of a child's developmental capacities and

understanding (aligned with the ZPD).

Importantly, for the current studies, an integration of these theoretical perspectives is

well-suited to addressing the overarching aim of investigating why some children are more

responsive to education, experience, instruction and intervention than others (or, conversely, why

some educational contexts, pedagogical orientations, types of experiences, instruction and

intervention enhance the responsiveness of young children) and what is particularly important to enable and encourage children to be successful academically.

Research Methods

My programmatic dissertation studies employ multiple methods culminating in the use of Dynamic Assessment (DA). These methods align with the sociocultural theoretical perspective by emphasizing the importance of scaffolding and mediated instruction in cognitive development and allowing for the precise investigation of its effects. DA involves a pre-test—mediated intervention—post-test format that examines how instruction facilitates higher levels of learning and understanding (Haywood & Lidz, 2007). Assessment and instruction are conducted simultaneously to examine how mediated interaction affects learners' capabilities and competences (Poehner, 2008). Unlike traditional assessment, DA aligns with Vygotsky's conceptualization of the ZPD as a more comprehensive indicator of children's cognitive abilities, levels of development and predicted performance in school. To precisely investigate the mechanistic research questions, the DA will be approached through a microgenetic (i.e., direct and in-depth observation of the underlying process of change occurring in learning and development) lens. This method has been strongly advocated as the best way to investigate learning at a fine level of specificity and for the purposes of studying change over time, particularly when scaffolding or instruction is involved (e.g., Siegler, 2006; Vygotsky, 1978).

Studying Early Learning Skills

Studying preschool children's learning is an important avenue of research for two reasons. First, interventions during the preschool years have been shown to be considerably more effective than those provided during kindergarten and later (Camilli, Vargas, Ryan, & Barnett,

2010; Heckman & Masterov, 2007). Second, there is robust evidence indicating that the power of quality early childhood education extends far beyond the intervention to impart long-term (through adulthood) improvements in academic and life outcomes, particularly for children living in poverty (Barnett, 2011). Further, researchers have found individual differences in SRL well before children begin formal schooling and early childhood education has been identified as an important site for developing these skills (e.g., Bronson, 2000). Therefore, studying these developing skills and ways they are best supported early in a child's educational trajectory (i.e., just before or at the transition to schooling) has strong implications for early childhood policy and, because this research will contribute to understanding how metacognition is associated with learning for diverse children, it may advance knowledge about its ability to serve as a protective factor for children at risk of learning difficulties (Sektnan, McClelland, Acock, & Morrison, 2010). In addition, the preschool classroom, a naturalistic setting, allows for greater opportunities to view naturally-occurring Mc both in individual and group settings than would a lab or other artificial-learning setting. Thus, it was important for me to find a preschool setting within which I would be able to become familiar to the children and conduct my assessment in a naturalistic manner.

Moreover, studying early metacognitive processes is of particular importance based on the robust evidence of associations found between Mc and learning and academic achievement across domains reviewed earlier. If these associations are found in preschool (i.e., prior to formal schooling), there would be important implications for improving developmental and educational trajectories, as well as school readiness (Blair, 2002; Duncan et al., 2007; Ramano, Babchishin, Pagani, & Kohen, 2010).

Consequently, in a series of programmatically-linked studies, this multiple manuscript dissertation was designed to contribute such knowledge by elucidating characteristics of early Mc and examining—at a fine-grain level—how it is facilitated. I undertook three studies in my dissertation research that focused on the comparative and comprehensive assessment of Mc. Specifically, in Chapter II, a metacognitive knowledge interview (McKI) is presented that I developed and tested for its feasibility and sensitivity to development with 42 preschoolers. In Chapter III, the convergent validity between the McKI that I developed and an established valid and reliable measure of early metacognition (ChAT; Bryce & Whitebread 2012; Whitebread, et al., in preparation) is empirically examined. In Chapter IV, the facilitation of emerging Mc will be elucidated using a Dynamic Assessment Intervention. Lastly, in Chapter V, limitations of my dissertation research, the current status of research in early metacognitive development and early childhood education, and directions for future research will be discussed.

The findings from my programmatic series of three dissertation research studies are designed to contribute to the field of cognitive development/developmental psychology and education in two significant ways. First, a clearer and more comprehensive conceptualization of Mc—a critical developmental capacity—will be revealed through Studies 1 and 2, including whether and how observational and direct assessment of Mc are associated and provide shared or unique elucidation. This information will address important gaps in our current knowledge specific to Mc measurement and conceptualization and to the larger context of how articulation may affect cognitive development and learning, which is central to moving forward in examining this concept and its importance to development, learning, and academic success. Clarifying this concept has been called for by prominent researchers (e.g., Brown, 1987, Kuhn & Dean, 2004)

and empirical evidence has shown that it is the least defined in research on SRL (e.g., Dinsmore, et al., 2008).

Second, beyond the need for explicating the measurement of Mc, the extant research on early Mc offers limited elucidation of the mechanisms of change. This is precisely the aim of Study 3, where I seek to understand how early Mc develops and is facilitated by varied instruction and support using DA (Lidz, 1991). The results of Study 3 will provide information critical to the later design and enactment of effective early Mc intervention programs with the long-term goal of improving educational and life outcomes for all children and informing early educational curriculum and policy.

Appendices
Appendix 1.A Whitebread et al., 2007 C.Ind.Le Coding Scheme: Verbal and Nonverbal Indicators of Metacognition and Self-regulation in 3- to 5-Year-Olds

C.Ind.Le Coding Scheme: Verbal and Nonverbal Indicators of Metacognition

and Self-Regulation in 3- to 5-Year-Olds

<u>Metacognitive knowledge</u>

CATEGORY NAME	DESCRIPTION OF BEHAVIOR	EXAMPLES
Knowledge of persons A verbalization demonstrating the explicit expression of one's knowledge in relation to cognition or people as cognitive processors. It might include knowledge about cognition in relation to: - *Self*: Refers to own capabilities, strengths and weaknesses, or academic/ task preferences; comparative judgments about own abilities - *Others*: Refers to others' processes of thinking or feeling toward cognitive tasks - *Universals*: Refers to universals of people's cognition	▪ Refers to his/her own strengths or difficulties in learning and academic working skills ▪ Refers to others' strengths or difficulties in learning and academic working skills ▪ Talks about general ideas about learning	▪ *I can write my name* ▪ *I can count backwards* ▪ *I don't know how to sing the song*
Knowledge of tasks A verbalization demonstrating the explicit expression of one's own long-term memory knowledge in relation to elements of the task.	▪ Compares across tasks identifying similarities and differences ▪ Makes a judgment about the level of difficulty of cognitive tasks or rates the tasks on the basis of pre-established criteria or previous knowledge	▪ *They need to put their boots on. And when they put their boots on, they dig a hole*
Knowledge of strategies A verbalization demonstrating the explicit expression of one's own knowledge in relation to strategies used or performing a cognitive task, where a strategy is a cognitive or behavioral activity that is employed so as to enhance performance or achieve a goal.	▪ Defines, explains or teaches others how she/he has done or learned something ▪ Explains procedures involved in a particular task ▪ Evaluates the effectiveness of one or more strategies in relation to the context or the cognitive task.	▪ *We don't need to use the sticky tape, we can use the glue* ▪ *You have to point it up this end so that it is going to grow*

Metacognitive regulation

CATEGORY NAME	DESCRIPTION OF BEHAVIOR	EXAMPLES
Planning Any verbalization or behavior related to the selection of procedures necessary for performing the task, individually or with others	▪ Sets or clarifies task demands and expectations ▪ Sets goals and targets ▪ Allocates individual roles and negotiates responsibilities ▪ Decides on ways of proceeding with the task ▪ Seeks and collects necessary resources	▪ *I'm going to make a big circle* ▪ *I know... me and Harry could be the knights and you could be the peasant* ▪ Child compares two objects before deciding which to use on task
Monitoring Any verbalization or behavior related to the ongoing on-task assessment of the quality of task performance (of self or others) and the degree to which performance is progressing towards a desired goal	▪ Self- commentates ▪ Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far) ▪ Rates effort on-task or rates actual performance ▪ Rates or makes comments on currently memory retrieval ▪ Checks behaviors or performance, including detection of errors ▪ Self-corrects ▪ Checks and/or corrects performance of peer	▪ *I think we've got one left* ▪ *This bit doesn't fit anywhere* ▪ *Hang on, we've got it a bit wrong here* ▪ Child stops mid-way through an action (placing puzzle piece), pauses and re-directs action to place it somewhere else
Control Any verbalization or behavior related to a change in the way a task had been conducted, as a result of cognitive monitoring	▪ Changes strategies as a result of previous monitoring ▪ Suggests and uses strategies in order to solve the task more effectively ▪ Applies a previously learnt strategy to a new situation ▪ Repeats a strategy in order to check the accuracy of the outcome ▪ Seeks help ▪ Uses nonverbal gesture as a strategy to support own cognitive activity ▪ Copies from or imitates a model ▪ Helps or guides another child using gesture	▪ *Let's have a practice* ▪ *Can you help me do it?* ▪ Child points to spots on a die as he counts ▪ Child looks at a physical model (example: word on whiteboard) repeatedly while completing a task ▪ Child points at computer screen or interactive whiteboard to indicate where another child should click the mouse
Evaluation Any verbalization (REFL-V)	▪ Reviews own learning or explains the task	▪ *He's done really well* ▪ *We learnt how to cut,*

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	Evaluates the strategies used	and how to stick things
or behavior (REFL-NV) related to reviewing task performance and evaluating the quality of performance.	• Evaluates the strategies used • Rates the quality of performance • Observes or comments on task progress • Tests the outcome or effectiveness of a strategy in achieving a goal	*together* • Child rotates scissors in hands while opening and closing them before initiating cutting activity

Emotional and motivational regulation

CATEGORY NAME	DESCRIPTION OF BEHAVIOR	EXAMPLES
Emotional/ motivational monitoring Any verbalization or behavior related to the assessment of the current emotional and motivational experiences regarding the task	The child: • Express awareness of positive or negative emotional experience of a task • Monitors own emotional reactions while being on a task	• That wasn't very nice • It's a bit sad • I don't want to be a peasant
Emotional/ motivational control Any verbalization or behavior related to the regulation of one's emotional and motivational experiences while on task	The child: • Controls attention and resists distraction or returns to task after momentary distraction • Self-encourages or encourages others • Persists in the face of difficulty or remains in task without help	• Mine is going to be a lovely one • Child looks towards activity of others in the classroom, then re-focuses on task at hand and resumes activity

Appendix 1.B Shamir et al., 2009 Examples of Children's Metacognitive Behaviors

Example 1: *Children's Declarative Meta-cognition (Self-reports)*
    Question: "What did you do in order to remember?

I said the picture lots of times. (Repetition).

I put them together frog and cat (in two's) and tried to remember.

I thought about it hard; I used my head to see what I remember.

I don't know I just remembered.

Example 2: *Children's Procedural meta-cognition (IL)*

The child organizes the cards on the table and looks at them, saying: "I have to see all of them, to remember."

The child says again and again the name of each picture ("a table, a table, a table…") (rehearsal/repetition).

The child organizes the cards into two's and says "a table and a chair" (verbal behavior).

The child organizes the cards in two's and points to the (non-verbal behavior).

The child organizes the cards in three's and says "a cat, a frog, a turtle" (verbal behavior).

The child puts the cards on opposite sides (in two's or three's) and checks if he remembers (non-verbal behavior).

The child looks at one of the three cards he put on one sides and checks if he remembers the rest, saying: "Ah, this is the third one… (verbal behavior).

The child checks the cards and says: "This I remembered this I didn't" (verbal behavior).

Example 3: *Procedural meta-cognition (PAL)*

"Look, look at the pictures; you have to remember the pictures."

"No, start first with the animals."

"You can put them together, frog and cat, in two's."

"Put them together—trousers, shirt and jacket—in three's."

"Put it like this (a cat and a turtle) and see if you remember."

"Try to remember; you should say the names of the animals aloud again and again, many times."

The tutor points to three pictures and says: "One, two, three."

"Check if you remember, look and see if you remember a cat."

"Put the cards in opposite side and see if you remember the clothing."

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CHAPTER II

The Development of a Metacognitive Knowledge Interview (McKI) for Preschoolers

Abstract

Historically, early cognitive skills have been underestimated, largely as a function of the ways these competencies have been measured, which is particularly pervasive in the area of metacognition. Only recently have researchers begun to detect evidence of metacognition in preschool-aged children through the use of observational assessment tools (e.g., Whitebread et al., 2007, 2009). While these observational methods are a more sensitive way to capture metacognition in young children, their exclusive use may not result in a comprehensive depiction of early metacognitive competency. In this study, we describe the development of a metacognitive knowledge interview (McKI) and what it reveals about metacognitive processes in preschool-aged children. The McKI was tested for feasibility and sensitivity with 42 preschoolers. Findings indicate that the McKI is (a) a developmentally appropriate sensitive measure for 3-5 year olds, (b) capable of eliciting articulated metacognition when engaging in a contextualized problem-solving task, (c) shows the expected developmental trend (i.e., older children perform at a higher level and scores increased over the course of a school year), and (d) provides sufficient variation across children. Implications for future research are discussed, including the importance of using multiple measurement tools when studying early metacognitive development.

Keywords: Metacognition, Metacognitive Knowledge, Early Childhood, Interview, Assessment

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The Development of a Metacognitive Knowledge Interview (McKI) for Preschoolers

Toward a Conceptualization of Metacognition

Clarifying the important but often conceptually confused construct of metacognition (Mc; knowledge, monitoring, and regulation of cognition) has been called for by prominent researchers (e.g., Brown, 1987; Kuhn & Dean, 2004) and empirical evidence has shown that it is the least defined in research on self-regulated learning (SRL; e.g., Dinsmore, Alexander, & Loughlin, 2008). The association between Mc and learning has been well established by primary research (e.g., Borkowski, Carr, & Pressley, 1987; Bransford, Brown & Cocking, 2000; Desoete, Roeyers, & Huylebroeck, Georghiades, 2004; White & Frederiksen, 1998), including more recent evidence with preschool-aged children (Shamir, Mevarech, & Gida, 2009; Whitebread, Bingham, Grau, Pasternak, & Sangster, 2007; Whitebread et al., 2009), and meta-reviews (Dignath, Buettner, & Langfeldt 2008; Wang, Haertel, & Walberg 1990). Furthermore, there is preliminary evidence that, even at the neurological level, Mc is associated with enhanced indicators of learning (i.e., error detection and correction responses related to progress monitoring) in primary school children (Rueda, Pozuelos, Paz-Alonso, Combita-Merchan, & Abundis, 2011) and preschool-aged children (Marulis, Kim, Grammer, Carrasco, Morrison, & Gehring, 2013). However, in order to precisely examine whether and how Mc predicts learning and academic achievement, a clearer operationalization of Mc must be established. This is the issue that this examination of a new interview tool (the Metacognitive Knowledge Interview [McKI]) was therefore: an endeavor to make a contribution toward the conceptualization and measurement of early metacognitive processes.

Developmental Trajectory of Metacognition

Traditionally, Mc has been argued to emerge around age 7-8 (e.g., Flavell, 1979; Kreutzer, Leonard, & Flavell, 1975; Veenman, Van Hout-Wolters, & Afflerbach, 2006) though a few of these researchers proposed that this could have been due—at least in part—to limited experiences, training or instruction and that intervening in relation to these skills was both "feasible as well as desirable" (Flavell, 1979, p. 910). Nevertheless, often the conclusion drawn from these studies (by the authors themselves or other researchers) was that young children are unable to be metacognitive, or be thoughtful about their own thinking. However, these assessment approaches and tools were often decontextualized (i.e., the children were asked abstract questions about hypothetical situations). Other contemporaneous studies revealed that, in a familiar context (i.e., listening to storybooks read by their mothers), 2.5-3 year olds showed ample evidence of comprehension monitoring and even explicit communication of how to resolve comprehension discrepancies (J. Karabenick, 1981). In fact, as early as 1992, Flavell himself indicated that children as young as 6 were able to accurately reflect on their own thinking *within a domain in which they have previous knowledge* (Flavell, 1992). Nearly two decades later, Lyons & Ghetti (2010) broadly concluded that "young children may be much more adept at monitoring their mental activity than is often assumed" (p. 265). These authors pointed to the emergence of the use of mental state verbs—particularly *know, think,* and *I don't know*— by the end of age 2 as indications of preliminary Mc. Lyons and Ghetti (2010) further discussed research indicating that as early as 30 months of age, infants have shown rudimentary forms of Mc by being able to successfully assess whether or not they knew something (e.g., Marazita & Merriman, 2004; Moore, Furrow, Chiasson, & Patriquin, 1994). Recently, researchers (Brinck & Liljenfors 2013) have speculated that origins of metacognitive awareness and skills may be

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present in infants as young as 2-4 months of age (at which time they begin to be able to participate in joint monitoring and control interactions with adults).

Also, questions posed to children in the earlier (and some current) studies were often not developmentally appropriate or sensitive enough to detect Mc or McK in young children. A recent review of the literature suggests that differing methodologies are likely responsible for early (and some recent) studies' limited evidence of Mc in children under age 7-8 (Efklides & Misailidi, 2010). Furthermore, the idea that Mc doesn't develop until later childhood likely stems from the manner it was conceptualized through a Piagetian lens in which 'higher ordered levels of thought operating on lower ordered levels' is categorized within formal operations, which are slated to emerge well into adolescence. In line with this, for example, Tunmer & Herriman (1984) argued that, in order to be capable of metacognitive processes, children would have needed to have transitioned from automatic to controlled processing, which, according to the Piagetian stage theory of cognitive development, occurs around age 7-8 (at the shift to concrete operations). Moreover, the recent evidence suggesting Mc develops much younger than originally believed (e.g., Shamir et al., 2009; Whitebread et al., 2007; 2009; 2010) is coherent with findings several decades after Piaget's original research (e.g., Gelman & Baillargeon, 1983) indicating that many conclusions from his work substantially underestimated the abilities and understandings of young children, and that these discrepancies arose from measurement issues of the same kind as in early Mc research

Measuring Early Learning Skills

The underestimation (for a review of such underestimation Gelman & Baillargeon, 1983) of early cognitive skills is particularly pervasive in the area of early Mc (e.g., Veenman, et al., 2006). Only recently have researchers begun to reveal evidence of Mc in preschool-aged children

through the use of more sensitive diagnostic tasks (e.g., Shamir et al., 2009; Whitebread et al., 2007, 2009). For example, Whitebread and his colleagues (2007) observed 1,440 3-5 year old preschoolers in their classrooms over a two-year period and coded their naturally occurring behaviors (verbal and non-verbal). They found extensive evidence of Mc in these 3-5 year olds. Specifically, they coded at least one—and for many children several—instances of Mc for every child in the sample[1] which were more frequent in particular instructional contexts (e.g., cooperative learning; teacher modeling). Over a period of ten days, Shamir and her colleagues (2009) examined indications of 64 4-5 year old children's verbal and non-verbal McK related to a cognitive task (recalling nine picture cards) in both individual learning and peer-assisted learning contexts in their preschool classrooms, using primarily observational assessments including one self-report interview question ("Please tell me what you did in order to recall the cards"). Shamir et al. 2009 found similar levels of Mc as did Whitebread et al., 2007[2], particularly in a peer-assisted learning context, and also found associations to cognitive skills. Taken together, the findings of these research groups have provided empirical evidence to support the proposal that earlier findings of later emerging Mc were—at least partially—a function of measurement. The issue of measurement of Mc is multidimensional in that it is crucial to consider not only the measurement instrument (e.g., employing observational assessments in place of or in addition to self-reports or think alouds), but also the context in which the measurement takes place (e.g., targeting naturalistic or authentic settings such as classrooms) and the methodology (e.g., contextualizing the assessment within a developmentally appropriate task or classroom situation and allowing for circumstances that are more likely to be

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[1] Examples of behaviors that were coded as being metacognitive are included in Appendix 2.A and 2.B.

[2] Examples of behaviors/ responses that were coded as being metacognitive are included in Appendix 2.C.

conducive to Mc). However, these studies focused mainly on verbal and non-verbal

metacognitive behaviors and did not include structured questions posed to the children. While

these observational methods are better able to capture Mc in young children in a more sensitive

to development way, their *exclusive* use may not result in a comprehensive depiction of early Mc

competency.

When children are engaged in a meaningful task (e.g., scientific inquiry in a classroom

setting), they naturally display considerable examples of metacognitive awareness and

knowledge in addition to behaviors (Lomangino, 2000). However, to comprehensively

understand children's early metacognitive processes, it is important to assess not only their

behavior or knowledge at an observational level, but also to assess their articulated knowledge in

a developmentally appropriate, comprehensive and direct, contextualized way. There are other

researchers who have recently become interested in studying young children related to

metacognitive processing and found preliminary evidence that preschool-aged children, in the

right conditions, are able to articulate McK about themselves, tasks, or strategies (R. Butler,

personal communication May 8, 2012). However, comprehensive assessment tools designed to

systematically measure children's articulated McK have not been developed for preschool-aged

children. Just as researchers have recently developed comprehensive observational tools

(including a single declarative interview question in Shamir et al., 2009) that are sensitive to

capturing Mc capabilities of young children, the Metacognitive Knowledge Interview (McKI)

was designed to comprehensively capture the declarative McK of young children sensitively and

developmentally appropriately.

Current Study

In the current study we investigated the appropriateness, feasibility, and reliability of a measurement tool designed to assess metacognitive knowledge (the Metacognitive Knowledge Interview; McKI) in 3-5 year olds and what it would reveal about early metacognitive processes. Specifically, we had three research questions.

Our first research question was: Will the McKI (Metacognitive Knowledge Interview, a measure of declarative metacognitive knowledge) be sensitive to young children's development and feasible enough to elicit preschool-aged children's metacognitive knowledge about a cognitive task (puzzles)? We predicted, based on previous pilot work, that the McKI would be sensitive to development and a feasible assessment tool that would elicit 3-5 year olds metacognitive knowledge about a puzzle task in a way that was developmentally appropriate. As discussed earlier, we predicted that this tool would be more successful than previous interviews largely because it was contextualized within children's preschool classroom, accompanied a familiar and enjoyable puzzle task and was conducted by an experimenter who was familiar to the children within their preschool classroom.

Our second research question was: Will 3-5 year olds show significant improvement on the McKI over a school year? We predicted that the 3-5 year olds would show significant growth on the McKI over the preschool year for several reasons. First, the preschool years are a time of rapid learning-related cognitive development (Rimm-Kaufman & Pianta, 2000). Second, the children were all participating in a high quality preschool program with a highly qualified teacher (with a Bachelor of Science degree in child development and a Master of Arts degree in Reading Instruction). This teacher and her paraprofessional were reflective about their own teaching and their students' learning and highly engaged and motivated to teach and learn. Furthermore, they both taught and created learning opportunities and environments that allowed

for the facilitation and elicitation of metacognitive processes. Third, when declarative McK has been examined in previous studies using interview tools in older children (e.g., Annevirta & Vauras, 2001), it has been shown to significantly increase over the course of each school year.

Our third and final research question was: Will the McKI provide data that are useful for predictive analyses (e.g., sufficient variance of scores and general reliability) among preschoolers? Because this was the first study to examine preschool children's declarative McK, this was an open question. However, we hypothesized that children's scores on the McKI would vary to some degree based on pilot work.

Method

Participants

Participants were 46 (42 in the final sample) children (35-64 months; 51% female) from three preschool classes in Southeastern Michigan. The original sample was 46 but three children were excluded due to being English Learners and one child was unable to complete the McKI. Even with encouragement, this child was only able to complete half of the interview, and most of this child's responses were shrugs, or "because" responses. This child was one of the youngest in the sample (37.20 months) which might explain why the interview was so challenging. The same teacher and paraprofessional taught all three classes in the same preschool classroom; the children came on different days/times based on age groups. There was a 3 to young-4 year old group which attended preschool on Monday and Wednesday mornings, a 4 year old group which attended preschool on Monday and Wednesday afternoons, and a 4.5-late 5 year old group which attended preschool on Tuesday, Thursday and Friday morning to early afternoons. Approximately 30% of families who returned consent forms reported their family income and 46% reported maternal education. The mean family income from this sample was $151,818

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(median: $135,000), with incomes ranging from $34,000 to $650,000; all mothers who reported their level of education had some college education and 29% (*n*=5) had obtained a master's degree (one mother reported a doctoral degree). The sample was 62% White, 24% Asian, 9% Bi-racial, 2% Chaldean, 1% Hispanic, and 2% did not report their child's race. Out of the parents who returned the questionnaires, the majority (73%) reported English as their child's first language.

Procedure

In addition to the Metacognitive Knowledge Interview (McKI), children were assessed on pre-academic performance (standardized pre-academic achievement measures in language arts and mathematics), individual and group motivation, and individual and group executive function. They were assessed over four sessions (two individual 30-45 minute sessions with the first author in a quiet area within the preschool classroom and two 25 minute group sessions with three experimenters (the first author and two other experimenters), the children's preschool teacher and a paraprofessional). These sessions were conducted in the fall (Time 1; 6 weeks after school started) and spring (Time 2; 3 weeks before the end of the school year) giving a total of 8 assessment sessions as part of a larger study (see Berhenke, 2013; Berhenke, Marulis, & Neidlinger, 2012). Because the focus of this study is on the development of the McKI, this paper will focus on that task.

Measures.

Wedgits problem-solving puzzle task. As we have argued, it is crucial that when young children are interviewed about their cognitive processes, it is done in a contextualized way (i.e., they are asked questions about a familiar cognitive task that they have just completed, that is ideally still within their view). This, in addition to ensuring that the wording was

developmentally appropriate, were the main foci in developing the McKI. In order to Re and ask

the children about their metacognitive knowledge regarding something familiar and relevant, we

adapted a mastery motivation puzzles task (from Smiley & Dweck, 1994) that we had previously

piloted and found to be appropriate and enjoyable for preschool-aged children. We chose the

puzzle cards based on this pilot work. Children were shown a card with a puzzle design and

asked to make Wedgit blocks (a set of building blocks) that match the design card to build a

puzzle (see Appendix 2.D for puzzle design cards and specific procedure). Each child completed

the first puzzle; if needed, help was provided (for the first puzzle only as this was a "warm-up").

Our protocol was that if the child finished the second puzzle in under four minutes, she or he

would be given a third (more challenging) puzzle, then a fourth puzzle, and so forth, until he or

she was unable to solve the puzzle in four minutes (only one child completed the third puzzle in

under four minutes). After trying a puzzle for four minutes unsuccessfully, each child was told

that the time was up for the game and the metacognitive knowledge questions began. The design

of the Wedgits puzzle task was based on guidelines set forth by mastery motivation researchers

for appropriately challenging tasks (Morgan, Busch-Rossnagel, Maslin-Cole, & Harmon, 1992).

Our task successfully met these guidelines including providing tasks of increasing difficulty so

that children were assessed working on tasks where they could complete part, but not all, of the

solution in the time allotted. Furthermore, our goal was to design the task so that it was just

challenging enough to elicit problem-solving strategies and thinking about those strategies such

that tasks were within the children's ZPDs (Vygotsky, 1978) when Mc is most likely recruited

(Prins, Veenman, & Elshout, 2006).

Metacognitive Knowledge Interview (McKI). Following the completion of the final

(most challenging/not successfully completed in 4 minutes) Wedgits-block puzzle, children's

metacognitive knowledge was individually assessed by the first author using the Metacognitive

Knowledge Interview (McKI). The McKI was developed to assess what could be revealed by a

developmentally appropriate contextualized interview based on Flavell's original

conceptualization of metacognitive knowledge of: people, tasks, and strategies. Children were

therefore asked a series of 11 questions related to the Wedgits task such as: *"Do you think you

did a good, okay, or not so good job on the puzzles? Why/Why not?"; "Would this puzzle be

hard for another kid your age?"* (knowledge about people) and *"Would the puzzle be easier if all

of the pieces were the same color?"; "Would the puzzle be easier with bigger or smaller pieces?

Why?"* (knowledge about tasks); *"Would talking to yourself during the puzzle be helpful?

Why/Why not?"; "If I think about how the pieces would fit together before I try, will the puzzle

be easier? Why?/Why not?"* (knowledge about strategies). Furthermore, in order to make the

interview sensitive to children's development, we asked children to respond to a puppet named

"Gogi" (an unusual gender-neutral name; the puppet was given the gender of each child) for the

last seven questions. The back story was that Gogi was from a far-away land and thus had never

seen puzzles or blocks and wanted to learn about them. We then asked the children to help Gogi

learn about the puzzles/blocks by answering questions about them (in a sense, teaching Gogi,

about the puzzles/blocks and the child's thinking, which many children respond to more readily

than when asked to respond directly to questions about their thinking). See Appendix 2.E for the

complete McKI; questions 5-11 included Gogi.

Responses were rated on a 0-2 scale as follows: 0=not at all metacognitive, 1=partially

metacognitive (e.g., they agreed that talking to oneself can be helpful in solving a task but their

reason was not related to cognition or they didn't know why), 2= appropriate metacognitive

response (see Appendix 2.F for annotated codebook). For the first question regarding whether

the children thought they did a good, okay, or not such a good job, children's responses were compared to researcher-perceived scores (on the same scale of good, okay, or not-so-good; see Appendix 2.G). If the child's response was aligned with the researcher; that is, the child said she or he did a good job on the puzzle and the researcher scored the child as doing a good job on the puzzle, the child received an appropriate metacognitive score (2 points). If the child's response was off by one level; that is the child said she or he did a good job on the puzzle whereas the researcher scored the child as doing an okay job on the puzzle, the child received a partially metacognitive score (1 point). If the child's response was off by two levels; that is, the child said she or he did a good job on the puzzle whereas the researcher scored the child as doing a not-so-good job on the puzzle, the child received a not at all metacognitive score (0 points). Two researchers independently coded 25% of the sample on all 11 questions as well as how the child did on the puzzle itself. Agreement between coders was high (intraclass correlation coefficient=.86).

The McKI was pilot tested with 55 children in a similar preschool and from a similar background economically, racially, and educationally. The pilot children were also similar in age and gender proportions. Four questions were removed based on the pilot study because the children either did not understand the question or the majority responded in a way that was not aligned with the meaning of the question (even when the question was revised several times) or there was not enough variation in children's responses, or most children responded non-verbally. For example, one original question asked the child to explain the best way to do the puzzle; most children just demonstrated rather than verbally explained even when asked to verbalize. Because this was designed to be an articulated metacognitive knowledge interview, these responses were not codeable. Additionally, a question prompt was removed from several questions due to

children's lack of meaningful response choices. In the original McKI, when children were asked whether something would make the puzzle easier or not (e.g., "Would the puzzle be easier with bigger or smaller pieces?"), if they responded in the affirmative, they were then asked if the puzzle would be *a little* or *a lot* easier (counter balanced). Because this choice was counter-balanced, it was determined that most children were consistently choosing the last option regardless of meaning (i.e., if *"a lot"* was stated last, children would consistently choose that option and vice versa). Thus, it appears that, this distinction between aspects of the puzzle task or various strategies making the puzzle a little or a lot easier was too nuanced for preschool-aged children.

Pre-academic performance. The Woodcock-Johnson III tests of Letter-Word Identification and Applied Problems (Woodcock, McGrew, & Mather, 2001) were used to assess children's pre-academic performance (pre-academic achievement) in language arts and mathematics.

Analytic Plan

To address our research questions, we used both qualitative (descriptive analyses of the children's experiences with the McKI) and quantitative (examining descriptive statistics and growth over time; examining reliability indices) analyses.

<div align="center">

Results

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Feasibility and Elicitation of Metacognitive Knowledge

First, we will describe qualitative results related to our first research question: Will the McKI be sensitive to young children's development and feasible enough to elicit preschool-aged children's metacognitive knowledge about a cognitive task (puzzles)? After several pilot

iterations (with 55 children), the McKI was used in this study with 42 children aged 3-5 (51% female; M=48.6; SD=6.49 months). The interview took between 5-8 minutes and did not appear to have elicited "test anxiety" or other negative emotions. Most children enjoyed being able to talk about their ideas or had neutral emotional responses, and there were no missing data. There were moderate instances of "I don't know" responses (10% of all responses: 43 out of a possible 396 overall at Time 1; 14% of all responses: 59 out of a possible 407 at Time 2), but as reviewed previously, the emerging use of terms such as "I don't know" may be preliminary indicators of metacognitive processing (Lyons & Ghetti, 2010), which these authors found to begin by the end of children's 2nd year.

When asked about the interview afterwards most children said it was fun and asked if they could do it again. They were asked what they would tell their friends about the McKI, and most children said they "liked helping Gogi [the puppet] learn about the puzzles". Some went on to say they would like to be friends with Gogi. Many children told the first author that they liked helping her learn about how children learn and several children remarked that it was like "being a teacher!" Thus, the preschool children seemed to enjoy having a chance to display what they know about their own knowledge, thinking, and learning and "teaching" it to others. It seemed to be a novel situation for the majority of the children in this way but the questions were viewed as a naturalistic extension of the puzzle game rather than a "test." It is important to note that the first author spent several weeks in the children's classroom getting to know the teachers and children, thus they viewed her as similar to a teacher, making the McKI a naturalistic task which occurred in the children's classroom. In sum, to address our first research question, the McKI was feasible and sensitive to development enough for preschool-aged children as it was brief, enjoyable, and adaptable to naturally occurring learning tasks in the classroom. The majority of

children were able to articulate their metacognitive knowledge in relation to a challenge puzzle task (Wedgits). Cognitive pretesting (a developmentally appropriate version of the type described in Karabenick et al., 2007) indicated that the children interpreted and had responded to the questions as intended. This was subsequent to the four pilot questions being removed based on the children's responses and cognitive pretesting in the pilot study. The 11 questions on the final version of the McKI used in this study were understood by the majority children and answered appropriately, to their capabilities. The McKI has subsequently been used with an additional 57 4-6 year old children in an ongoing study with similar findings (Marulis, et al., 2013; additional information can be obtained from the first author).

Quantitative Analyses

In addition to the qualitative analyses, we undertook quantitative analyses to address our second and third research questions: Will 3-5 year olds show significant improvement on the McKI over a school year? Will the McKI provide data that are useful for predictive analyses (e.g., sufficient variance of scores and general reliability) among preschoolers?

For the Time 1, the mean score on the McKI was 9.0 (*SD*=4.56) points out of a possible 22 points (2 points per question possible) and scores ranged from 1-18 points. Receiving one point per question—or a score of 11—would indicate, overall, responses that were "partially metacognitive" related to the puzzle task (see Appendix 2.D). Thirty-six percent of the children received a score of 11 or above (with 3 children receiving a score of 15 or above). For example, if a child responded to the question: *"Would it be helpful for Gogi* [the puppet 'from another land']*" to talk to herself/himself about the puzzle while doing the puzzle? Why?"* by saying *"Yes"* [agreeing that talking to oneself can be helpful in solving the puzzle] but their reason was

not related to cognition (e.g., "*because it's fun*") or the child displayed tautological reasoning (e.g., "*because it helps*"], the response would be given one point. An example of a response that received full points ("metacognitive") to this question was: "*Yes, because Gogi has to focus and get concentration to do the puzzle. Talking to yourself does that.*" Thus, at the beginning of the school year, children, on average, were displaying less than partially metacognitive knowledge but substantially more than "not at all metacognitive" on average (the mean score was significantly greater than zero, $t(30)=10.63$, $p<.001$). Furthermore, a sizeable number of children ($n=12$) were scored as displaying "partially metacognitive" knowledge across the McKI. The Time 1 and Time 2 McKI scores were significantly correlated ($r=.59$, $p=.001$) and, as predicted, children showed significant growth over the school year, $t=3.75$ ($M_{diff}=2.81$), $p=.001$. At Time 2, the mean score was 11.81 ($SD=4.67$) with a range from 5-22. As can be seen from the standard deviations and ranges at Time 1 and Time 2, there was considerable variation in children's scores. There was a positive trend toward age differences at Time 1 ($r=.36$, $p=.06$ and Time 2 ($r=.28$, $p=.09$) where older children tended to have higher scores on the McKI. Boys had significantly higher McKI scores at Time 1, $t=2.61$, ($M_{diff}=4.04$), $p=.01$, but not time Time 2, $t=1.06$, ($M_{diff}=1.75$), $p=.30$.

Thus, by the end of the school year (approximately 7 months after the first testing session), children, on average, were displaying "partially metacognitive" knowledge regarding the puzzle task with one child receiving a full 22 points (it is important to note, however, that she was the oldest child in the preschool at 6.1 years and this score may indicate a ceiling effect in which the McKI may not be appropriate for typically developing children above 6 years; all other children in the sample were under 6 years old). However, 55% of the children scored above

11 points (24% between 15-19). Thus, a considerable number of children displayed greater than partial metacognitive knowledge on the McKI at the end of their preschool year.

We also examined the McKI responses categorically. Specifically, we assessed the children's use of mental state terms such as *brain, think, learn, know,* and *I don't know*, and other related mental state terminology looking for evidence of children's awareness of and reference to cognitive processes.

Because there were 11 questions on the McKI, each child had at least 11 opportunities to use mental state terms. Overall, we found that at Time 1, 49% of the children used mental state terms at least once and there were 36 total instances of mental state term usages by the children. At Time 2, 59% of the children used mental state terms at least once and there were 60 total instances of mental state term usages by the children.

Breaking this down by age groups, in the youngest group (the 3 to young-4 year olds; *M*=40.65 months at Time 1; 47.57 at Time 2), at Time 1, only one child used mental state terms in his or her responses with two total instances. One example of this child's mental state utterance accompanying the statement, "Puzzles are easier for me than Gogi" was "because I *know* how to do them already." At Time 2, in the youngest class, 27% (3) of the children used mental state terms for a total of six instances. Examples included: "I think I did a great job on the puzzles because I *learned* how to do them"; Puzzles are easier for me than Gogi because he doesn't *know* about puzzles."

In the middle age group (4 year olds; *M*=52.13 months at Time 1; 59.07 at Time 2), 3 children (33%) used mental states for a total of seven instances; for example, "Yes (it would be helpful for Gogi to talk to himself) because it will help him *know* how to do it." At Time 2, five

children (63%) used mental states for a total of ten instances. Example included: "No, talking to yourself would not be helpful to the puzzle because you need to *think* about stuff; the puzzle would be harder if the pieces were all the same color because you would *forget* which color they are."

In the oldest group (4.5-late 5 year olds *M*=58.35 months at Time 1; 65.27 at Time 2), 13 children (76%) used mental state with a total of 27 instances including: "I *think* I did a good job on the puzzles, what helped me do a good job was my *brain*; I was *thinking* in my *brain* and I *figured* out how to do it." At Time 2, 14 children (82%) used mental state words with a total of 44 instances including "I *think* so (that the puzzles would not be hard for another child); if they were *smart* at puzzles like me"; "Yes, it would help to talk to yourself during the puzzle because you need to *focus* and get *concentration* to do the puzzle, Talking to yourself does that."

Some of the questions were answered at a higher level than others overall. At Time 1, Questions 2 (*"Did you think anything was hard? Why?/Why not? What would have made it easier?"*) and 6 ("*What should Gogi do if she/he is having trouble with the puzzle?*") had the highest overall averages (.82 and .97 respectively). Furthermore, 24% of children received a full score of 2 points on Question 2 (33% received 1 point) and 42% received 2 points on Question 6 (12% received 1 point). For most other questions at Time 1, less than 10% of the children received the full 2 points. At Time 2, children once again had the highest overall average scores on Questions 2 (1.28 points; 39% of children received 2 points and 48% received 1 point) and 6 (1.16 points; 49% of children received 2 points and 19% received 1 point). Additionally, for Question 1 (*Do you think you did a good job, an okay job or not so good of a job on the puzzles?*), 42% of the children received 2 points (but 46% received 0 points, so this question seemed to be dichotomizing; the average score was .94). Similarly, 42% of the children received

2 points on Question 4 ("*How did you know if you were getting the puzzles right?*") while 48% received 0 points.

In sum, as predicted, the McKI elicited children's metacognitive knowledge about the puzzle task. This included both continuous McK as coded on the 0-2 scale (see Appendix 2.F), as well as categorical mental state terms, both of which increased over time and with age. In addition, there was substantial variance in the quantitative and qualitative responses of the 3-5 year old children on the McKI.

Reliability

The internal consistency of the McKI was acceptable at both Time 1 (α=.76) and Time 2 (α=.77) (Kline, 1999). Further, the test-retest correlation was significant (r=.59, p=.001; controlling for language using the Woodcock-Johnson letter-word identification scale: r=.50, p=.016) and age: r=.57, p=.003). These analyses, paired with the cognitive pretesting and elicitation of metacognitive knowledge responses in children as young as 3, indicate an acceptable level of reliability and practicality to continue using the McKI in further studies. As mentioned earlier, the McKI has subsequently been used in conjunction other studies with similar reliability statistics (Marulis et al., 2013).

Discussion

To our knowledge, this is the first study to assess preschool-aged children's metacognitive knowledge using an interview tool. We were able to show that—similar to the efforts of recent researchers (e.g., Shamir et al., 2009; Whitebread et al., 2007, 2009) to develop and test more sensitive and developmentally appropriate assessment observation tools— preschool-aged children are far more metacognitive than previously thought (e.g., Flavell, 1979;

Kreutzer, Leonard, & Flavell, 1975; Veenman et al., 2006). Supporting the research of Whitebread and colleagues and Shamir and colleagues, our study provided evidence that young children are not only capable of greater metacognitive behaviors in the right contexts, but also of articulating McK about a cognitive task. Because of their similarity to school-related learning skills, being able to articulate knowledge about metacognitive skills *and* apply those skills to a learning task (i.e., the types of behaviors displayed in Shamir et al., 2009 and Whitebread et al., 2007 and 2009) beginning in the preschool years is likely to predict later developmental, cognitive, and academic success more than either one alone, though this should be empirically investigated. The development and assessment of the McKI measurement tool in this study allowed for a more comprehensive depiction of early metacognitive processes to be revealed- the types, frequency and levels of McK present in a sample of preschool-aged children.

This study also provides evidence in line with research pointing to the traditional underestimation of early cognitive and learning-related/SRL skills (e.g., Gelman & Baillargeon, 1983) related to measurement issues. We found that this McKI was a developmentally appropriate, sensitive to development measure for 3-5 year olds that elicited articulated Mc related to a contextualized problem-solving task (puzzles) that revealed significant growth on average over a preschool year along with sufficient variation across 42 young children to suggest that it is sensitive to inter-individual differences. As other researchers have found with older children (Annevirta, & Vauras, 2001), there were individual differences including a few children who did not show growth on the McKI and several who decreased on the McKI over the course of the school year. We found considerable variance in scores. At the high end, one child increased by 12 points, whereas on the low end, one child decreased on the McKI by 4 points.

From a practical perspective, we found that the McKI could feasibly be administered in a preschool classroom in less than 15 minutes including the puzzle task about which the children were asked the metacognitive knowledge questions (administration times ranged from 10-25 minutes with an average of 15 minutes); from a conceptual perspective, we found that, overall, children understood what they were being asked. Furthermore, the internal consistency and test-retest indices were adequate. Thus, the overarching answer to whether the McKI was reliable and practical for use with preschoolers is yes. Moreover, it could easily be adapted to most tasks and domains. For this study, we chose a puzzle problem-solving task due to most young children's familiarity/experience with and prior knowledge about these types of learning tasks. The McKI was designed to be used with a task with which all children in this sample had similar lack of experience (these particular Wedgit blocks were novel) but was a familiar task in general as it was a puzzle building task that is common in most preschool classrooms, For example, this particular preschool classroom included many puzzles that the children frequently used on their own and with their teacher.

We found substantially more evidence of McK than has previously been found with similar interviews related to metacognitive knowledge processes. For example, Kreutzer, Leonard, & Flavell (1975) found that children in kindergarten and first grade (compared to children in third and fifth grades) were largely unable to respond to questions regarding their memory abilities (i.e., metamemory knowledge questions). However, these questions were decontextualized in that they involved hypothetical situations such as "Do you remember things well? Are you a good rememberer? And "If I gave you 10 things to look at quickly and remember and you remembered six of them, how many do you think your friends would remember? Are there some kinds of things that are really hard to remember?" We believe that

the decontextualized / hypothetical nature of the questions, as well as the level of difficulty (e.g., long sentences and large working memoy load of many of the questions), are the primary reasons for the difference between the findings of this study and ours. The McKI was contextulized with a familiar and developmentally appropriate puzzle task, was concrete, and was accompanied by questions that were asked immediately after the puzzle task while the puzzle was still in view, and the questions were appropriate to the working memory and receptive verbal abilities of 3-5 year olds.

Limitations and Recommendations

There are several important limitations inherent in this research as well as recommendations for future research. First, because we had considerable variance in the McKI scores at both time points, it is likely that this variance could be explained by individual differences in demographics such as SES, racial background and so on. However, our sample did not allow for such analyses as a consequence of the small numbers of children from various racial and SES backgrounds for example. We suggest that future research with this metacognitive knowledge interview take place with a population that is more diverse across multiple factors not only to be able to explain the variance found but also to be able to examine whether metacognitive knowledge may be a protective factor for children at risk for learning difficulties, in the same manner as has been found for other SRL variables have been found to be (e.g., Sektnan, McClelland, Acock, & Morrison, 2010).

Second, because the only Mc measure included in this study tapped metacognitive knowledge only, we were not able to capture or examine early Mc comprehensively with this sample of children. For example, other aspects of Mc, such as metacognitive behavior, monitoring of or regulation of cognition, are important to consider to comprehensively capture

young children's metacognitive processing. The preschoolers in our sample may have been enacting many instances of metacognitive behaviors that we did not capture with our interview measure. Future analyses should include coding children's behavioral Mc such as verbal and non-verbal monitoring and control (e.g., Nelson & Narens, 1994; Whitebread et al., 2009), cognitive and metacognitive strategic behaviors (Strategic Behaviour Observation Scale [SBOS]; Dermitzaki, Leondari, Goudas, 2009), and affective metacognitive experiences (e.g., Efklides, 2008) during the Wedgit challenge puzzle tasks in order to analyze the associations between these components of Mc and the McKI.

Third, we did not include control variables beyond the Woodcock-Johnson Letter-Word test for language and age. We did not have an IQ test or proxy. Other studies have found that intelligence and McK are strongly related in young children (Alexander, Carr, & Schwanenflugel, 1995), though this hasn't yet been examined in preschool-aged children. Thus, future studies should measure children's intelligence, in addition to their McK when examining changes over time and, particularly, when examining associations with cognitive development and academic achievement, which is our next goal. Though measuring intelligence in preschoolers is difficult, there are verbal ability tests, such as the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) and non-verbal test such as Raven's Coloured Progressive Matrices (Raven, Raven, & Court, 2003) that have been used successfully with young children for these purposes.

Finally, we were not able to examine ceiling and floor effects in this study systematically though it appears that after 6 years, the McKI would be inappropriate and ceiling effects would be found (as the oldest child in our sample at just over 6 years at Time 2 received the full 22 points). On the other end of the continuum, at around 3 years or younger, it seems that the McKI

may be too difficult as in the pilot study there were 11 children who were under 3 or just turning 3-years who had a very difficult time with the questions or were unable to respond. These children all received less than three points in total and three of them were unable to finish more than half of the interview. Future studies should investigate ceiling and floor effects systematically along with other psychometric properties of the McKI.

Conclusion and Implications

Though this study provided valuable information regarding the measurement of early metacognitive knowledge, it was not designed to address the larger issue of conceptualizing and assessing early metacognitive development comprehensively (i.e., with multiple measurement tools). Rather, it was designed to address what would be revealed by a developmentally appropriate metacognitive knowledge interview for preschool-aged children. It is our position that this type of assessment tool would ideally be used in conjunction with a systematic behavioral observation tool (e.g., the SBOS developed by Dermitzaki et al., 2009[3] and the C.Ind.Le and CHILD observational coding systems developed by Whitebread et al., 2007, 2009[4]) to comprehensively assess young children's metacognitive processes.

Using both declarative and behavioral Mc measurement tools in tandem in future research will allow for comprehensive and precise assessment of metacognitive processes, which will subsequently allow for the examination of mechanisms underlying the development, facilitation, and predictive power of early Mc for enhancing learning and academic achievement. These types of studies would provide information critical to the later design and enactment of

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[3] See Appendix 2.H

[4] See Appendices 2.A and 2.B

effective early Mc intervention programs with the long-term goal of improving developmental and educational outcomes for all children and informing early educational curriculum and policy. However, prior to this, a clearer and more comprehensive conceptualization of metacognition must be revealed, which was a primary aim of this study though much work remains to be done in this area with young children. We believe that targeting Mc in preschool-aged children is paramount for researchers.

Appendices

Appendix 2.A. Cambridgeshire Independent Learning in the Foundation Stage

(C.Ind.Le)

C.Ind.Le Coding Scheme: Verbal and Nonverbal Indicators of Metacognition and Self-Regulation in 3- to 5-Year-Olds

Category name	Description of behavior	Examples
Metacognitive knowledge		
Knowledge of persons		
A verbalization demonstrating the explicit expression of one's knowledge in relation to cognition or people as cognitive processors. It might include knowledge about cognition in relation to: - *Self*: Refers to own capabilities, strengths and weaknesses, or academic/task preferences; comparative judgments about own abilities - *Others*: Refers to others' processes of thinking or feeling toward cognitive tasks - *Universals*: Refers to universals of people's cognition	Refers to his/her own strengths or difficulties in learning and academic working skills Refers to others' strengths or difficulties in learning and academic working skills Talks about general ideas about learning	*I can write my name* *I can count backwards* *I don't know how to sing the song*
Knowledge of tasks		
A verbalization demonstrating the explicit expression of one's own long-term memory knowledge in relation to elements of the task.	Compares across tasks identifying similarities and differences Makes a judgment about the level of difficulty of cognitive tasks or rates the tasks on the basis of pre-established criteria or previous knowledge	*They need to put their boots on. And when they put their boots on, they dig a hole*
Knowledge of strategies		
A verbalization demonstrating the explicit expression of one's own knowledge in relation to strategies used or performing a cognitive task, where a strategy is a cognitive or behavioral activity that is employed so as to enhance performance or achieve a goal.	Defines, explains or teaches others how she/he has done or learned something Explains procedures involved in a particular task Evaluates the effectiveness of one or more strategies in relation to the context or the cognitive task.	*We don't need to use the sticky tape, we can use the glue* *You have to point it up this end so that it is going to grow*
Metacognitive regulation		
Planning		
Any verbalization or behaviour related to the selection of procedures necessary for performing the task, individually or with others	Sets or clarifies task demands and expectations Allocates individual roles and negotiates responsibilities Sets goals and targets Decides on ways of proceeding with the task Seeks and collects necessary resources	*I'm going to make a big circle* *I know… me and Harry could be the knights and you could be the peasant* Child compares two objects before deciding which to use on task

Category name	Description of behavior	Examples
Monitoring		
Any verbalization or behaviour related to the ongoing on-task assessment of the quality of task performance (of self or others) and the degree to which performance is progressing towards a desired goal	Self- commentates Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far) Rates effort on-task or rates actual performance Rates or makes comments on currently memory retrieval Checks behaviors or performance, including detection of errors Self-corrects Checks and/or corrects performance of peer	*I think we've got one left* *This bit doesn't fit anywhere* *Hang on, we've got it a bit wrong here* Child stops mid-way through an action (placing puzzle piece), pauses and re-directs action to place it somewhere else
Control		
Any verbalization or behaviour related to a change in the way a task had been conducted (by self or others), as a result of cognitive monitoring	Changes strategies as a result of previous monitoring Suggests and uses strategies in order to solve the task more effectively Applies a previously learnt strategy to a new situation Repeats a strategy in order to check the accuracy of the outcome Seeks help Uses nonverbal gesture as a strategy to support own cognitive activity Copies from or imitates a model Helps or guides another child using gesture	*Let's have a practice* *Can you help me do it?* Child points to spots on a die as he counts Child looks at a physical model (example: word on whiteboard) repeatedly while completing a task Child points at computer screen or interactive whiteboard to indicate where another child should click the mouse
Evaluation		
Any verbalization or behaviour related to reviewing task performance and evaluating the quality of performance (by self or others).	Reviews own learning or explains the task Evaluates the strategies used Rates the quality of performance Observes or comments on task progress Tests the outcome or effectiveness of a strategy in achieving a goal	*He's done really well* *We learnt how to cut, and how to stick things together* Child rotates scissors in hands while opening and closing them before initiating cutting activity
Emotional and motivational regulation		
Emotional/motivational monitoring		
Any verbalization or behaviour related to the assessment of current emotional and motivational experiences regarding the task	Express awareness of positive or negative emotional experience of a task Monitors own emotional reactions while being on a task	*That wasn't very nice* *It's a bit sad* *I don't want to be a peasant*
Emotional/ motivational control		
Any verbalization or behaviour related to the regulation of one's emotional and motivational experiences while on task	Controls attention and resists distraction or returns to task after momentary distraction Self-encourages or encourages others Persists in the face of difficulty or remains in task without help	*Mine is going to be a lovely one* Child looks towards activity of others in the classroom, then re-focuses on task at hand and resumes activity

From Whitebread, Coltman, Pino-Pasternak, Sangster, Grau, Bingham, Almeqdad, & Demetrious, 2009, p. 79-80

Appendix 2.B. The Checklist of Independent Learning Development (CHILD) 3-5

Checklist of Independent Learning Development (CHILD) 3–5

Name of child: _____ Teacher: _____

Date: _____ School/setting: _____

	Always	Usually	Sometimes	Never	Comment
Emotional					
Can speak about own and others behaviour and consequences					
Tackles new tasks confidently					
Can control attention and resist distraction					
Monitors progress and seeks help appropriately					
Persists in the face of difficulties					
ProSocial					
Negotiates when and how to carry out tasks					
Can resolve social problems with peers					
Shares and takes turns independently					
Engages in independent cooperative activities with peers					
Is aware of feelings of others and helps and comforts					
Cognitive					
Is aware of own strengths and weaknesses					
Can speak about how they have done something or what they have learnt					
Can speak about future planned activities					
Can make reasoned choices and decisions					
Asks questions and suggests answers					
Uses previously taught strategies					
Adopts previously heard language for own purposes					
Motivational					
Finds own resources without adult help					
Develops own ways of carrying out tasks					
Initiates activities					
Plans own tasks, targets and goals					
Enjoys solving problems					

Other comments:

From Whitebread, Coltman, Pino-Pasternak, Sangster, Grau, Bingham, Almeqdad, & Demetrious, 2009, p. 81

Appendix 2.C. Examples of Children's Metacognitive Behavior during a Card Recall Task

Children's Declarative Metacognition (Self-reports)

Question: "What did you do in order to remember?

I said the picture lots of times. (Repetition).

I put them together frog and cat (in two's) and tried to remember.

I thought about it hard; I used my head to see what I remember.

I don't know I just remembered.

Children's Procedural Metacognition

The child organizes the cards on the table and looks at them, saying: "I have to see all of them, to remember."

The child says again and again the name of each picture ("a table, a table, a table...") (rehearsal/repetition).

The child organizes the cards into two's and says "a table and a chair" (verbal behavior).

The child organizes the cards in two's and points to the (non-verbal behavior).

The child organizes the cards in three's and says "a cat, a frog, a turtle" (verbal behavior).

The child puts the cards on opposite sides (in two's or three's) and checks if he remembers (non-verbal behavior).

The child looks at one of the three cards he put on one sides and checks if he remembers the rest, saying: "Ah, this is the third one... (verbal behavior).

The child checks the cards and says: "This I remembered this I didn't" (verbal behavior).

From Shamir, Mevarech, & Gida, 2009, p. 59

Appendix 2.D. Wedgits problem-solving puzzle task

Achievement Motivation (mastery/performance orientation): Wedgits puzzle and questions

Researcher instructions:

1. Make sure the camera is pointed at the child and recording; make sure that you will not block the camera when you sit down.
2. Show the child the blocks and the design on the first card. Say, **"First, I want you to make the blocks look exactly like the blocks in this picture. Can you make the blocks look like this picture?"**
3. Let the child work until he/she is finished. You can help him/her if he/she does not understand how to make the blocks look like the card.
4. Now show the child the design on the second card. Say, **"You did a great job with that! Now, I want you to make the blocks look exactly like this picture."**
5. Let the child work without helping him/her. Stop the child at 4:00 if he/she is still working.
6. If the child takes less than 4 minutes to finish puzzle 2 (most children), skip to step 7. Otherwise, tell the child, **"We are out of time. If we had more time, would you want to work more on this one** (*hold up the first picture*) **or this one** (*hold up the second picture*)**?"** Record child response. **"Why?"** Record child response.
7. Now show the child the design on the third card. Say, **"You did a great job with that one, too! Let's do another one. Make the blocks look exactly like this picture."**
8. Let the child work without helping him/her. Stop the child at 4:00 if he/she is still working. (virtually all children)
9. Tell the child, **"We are out of time. If you had more time to work, would you like to keep trying this one** (hold up the picture of the last completed puzzle) **or build this other one again** (hold up the last picture)? Record child response. **"Why?"** Record child response.
10. Ask the child, **"How hard was the last puzzle?** (*Point to it*) **Was it easy, a little hard, or very hard?"**

Puzzle #1 (Easy)	
Completed?	
Time to completion	
Time on task	
Puzzle #2 (Medium)	
Completed?	
Time to completion	
Time on task	
Puzzle #3 (Hard; if necessary)	
Completed?	
Time to completion	
Time on task	

"If you had more time to work, would you like to keep trying this one or build this other one again?"

☐ The easier, completed puzzle
☐ The harder, incomplete puzzle

Why did the child want to try that one again?

_____

_____

How hard did the child think the last puzzle was?
☐ Easy ☐ A little hard ☐ Very hard

Appendix 2.E. Metacognitive Knowledge Interview (McKI)

Use this protocol after children have completed the Wedgits puzzle task

Once the Wedgits puzzle task is complete, tell child: **"Thank you for working on those puzzles! I would like to talk to you about the puzzles you just did and about your thinking. My job is to learn about how kids learn and think and I have a few questions for you, Okay?"** Once child assents, say**: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer."** (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. **"Do you think you did a good job, an okay job or not so good of a job on the puzzles?"** Circle child's response. If they say they did a good job, ask **"What did you do to help you do a good job?"** If they answer okay or not so good, ask **"What do you think would have helped you do an even better job?**
2. **"Did you think anything was hard?"** If no, ask: **"Why not?"** If yes, ask **"Why? What would have made it easier?"**
3. **"Would these puzzles be hard for another kid your age? Why/why not?"**
4. **How did you know if you were getting the puzzles right?"**

Show child the 'alien' finger puppet and say: **"I have another friend to show you. This puppet's name is Gogi and he/she** (use same gender as the child) **is from another land. S/he does not go to a school like yours or have a teacher like yours and doesn't know anything about puzzles like the ones you just did. Will you help Gogi learn about these kind of puzzles?"** Wait for child to assent and say**: "Thank you."** (If they don't agree, try to prod them by saying that 'Gogi really needs your help and wants to learn about these kind of puzzles'.)

5. **"Would these puzzles be easier for Gogi or you? Why?"**
6. **"What should Gogi do if s/he is having trouble with the puzzle?"**
7. **"Would it be helpful for Gogi to talk to herself/himself about the puzzle while doing the puzzle? Why would/wouldn't that be a helpful thing to do?**
   "**Gogi has some questions for you about puzzles like this one. Okay?"** Have Gogi 'speak' directly to the child and ask the following:
8. **Would the puzzle be easier with bigger or smaller pieces? Why?"**
9. **"If all of the puzzle pieces were the same color, like in this picture** (show the Wedgits booklet of all purple Wedgits) **will the puzzle be easier?** If yes, ask: **"Why?"** If no, ask, **"Why not?"**
10. **"If I think about how the pieces would fit together before I try, will the puzzle be easier?** If yes, ask: **"Why?"** If no, ask, **"Why not?"**
11. **"If I close my eyes while I do the puzzle, will it be easier?** If yes, ask: "**Why?"** If no, ask, **"Why not?"**
    "Thank you for sharing all of your ideas and how you think with Gogi!

Appendix 2.F. Metacognitive Knowledge Interview (McKI) Codebook and Annotated Scoring

The Metacognitive Knowledge Interview (McKI) assesses children's metacognitive knowledge (or knowledge about individuals, tasks and strategies) individually using a series of 11 questions related to the Wedgits task [in which children are shown design cards of increasing difficulty and are asked to make the Wedgits building blocks look exactly like the picture on the card. All children completed the first puzzle. If they finished the second in less than four minutes, they were given a third card. After they had tried a puzzle for four minutes unsuccessfully, they were stopped, and asked, "If you had more time to work, would you like to keep trying this one (the uncompleted one, indicating a mastery goal) or build this other one again (the one they previously completed, indicating a performance goal)? Why?"]. For example, children were asked "Would talking to yourself during the puzzle be helpful? Why/why not?". Please see the last two pages of this document for background literature and theoretical framework to support the development and assessment of this interview measure.

TO SCORE:

Rate responses to questions on a 0-2 scale for each question where:

- 0=Not at all metacognitive
    - Response does not refer to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy.
        - E.g., child disagreed that talking to oneself can be helpful in solving a task without an appropriate explanation (e.g., said "I don't know" or "because I don't like to do it". *NOTE: child could receive the full score (2 points) for a negative response to this question IF she or he provided a metacognitive explanation such as talking to oneself is not helpful because it will distract their thinking or make them not be able to attend to the task. The full points refer to an "appropriate metacognitive response"; thus yes OR no could be a fully metacognitive response depending on the explanation.
- 1=Partially metacognitive
    - Response refers to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy but not completely/fully or without an explanation that backs up the response.
        - E.g., child agreed that talking to oneself can be helpful in solving a task but their reason was not related to cognition (e.g., because it's fun) or they didn't know why.

- 2= Appropriately/fully Metacognitive
  - Response refers to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy in a complete/full way or with a metacognitive explanation that backs up the response.
    - E.g., child agreed that talking to oneself can be helpful in solving a task because it helps them remember how to do the task/ helps their brain think better, etc.
    - **OR** child disagreed that talking to oneself is helpful because it would distract them.

If the child doesn't/won't answer, *he/she will be given 0 points for that response* (NR=no response) and coded as "999". If the child says "I don't know", she/he will be given 0 points for that question/portion of the question and coded as (DK=don't know) "999".

The full set of questions is below including example responses and scoring. The actual scores given for this child are indicated along with what would qualify for the other levels of scoring.

Metacognitive Knowledge Interview_CODED SAMPLE

Once the Wedgits puzzle task is complete, tell child: **"Thank you for working on those puzzles! I would like to talk to you about the puzzles you just did and about your thinking. My job is to learn about how kids learn and think and I have a few questions for you, Okay?"** Once child assents, say**: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer."** (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. **"Do you think you did a <mark>good</mark> job, an okay job or not so good of a job on the puzzles?"** Circle child's response. If they say they did a good job, ask **"What did you do to help you do a good job?"** If they answer okay or not so good, ask **"What do you think would have helped you do a better job? My brain-that controls my whole body.**

   2 points. His knowledge of how well he performed on the task was accurate. He performed above his age level by completing the second challenging puzzle accurately and quickly and nearly completed the 3rd puzzle (designed for children older than preschool and chosen to pose a challenge sufficient enough for children this age to be unable to complete accurately, particularly within four minutes). Further, he showed metacognitive knowledge about himself and what helped him/would help him do a good job on puzzles-his brain.

A score of 1 would be either an inaccurate assessment of one's performance on the puzzle or an accurate response to this with a non-metacognitive response to what would help do a good/better job such as "being good" or "doing a good job". If a child accurately assessed his/her Wedgit performance and gave a partial metacognitive response (such as: "liking the puzzle" because it is possible that higher enjoyment/interest in a task leads to higher performance but this response does not fully spell this out. Or responding to the question "What did you to do help you do a good job" with: "I tried hard" without elaboration.) He/she could get 1.5 on this question. 0 points would be given if the child was metacognitively inaccurate about his/her performance along with a non-metacognitive follow-up response.

2.   "Did you think anything was hard?" If no, ask: "Why not?" If yes, ask "Why? What would have made it easier?" My brain focuses when I'm doing puzzles

1 point. He said nothing was hard but other comments he made during the third puzzle indicated that there were parts he found very difficult. However, he had good metacognitive knowledge regarding why it didn't seem difficult-he was aware that by being able to concentrate and maintaining focus (with your brain), the task will likely be/seem easier.
A child whose response to whether anything was hard matches his/her comments/emotional response to the puzzle would get a full point for that part of the question and another full point for why he/she didn't find it hard-e.g., the type of response given here. If the child said something was difficult (and this matched his/her response to the puzzle) and also responded with a metacognitively aware answer regarding what would have made it easier-e.g., having help from an adult/older child or getting a hint, she/he would receive 2 points. A score of 0 would be given if the child was metacognitively inaccurate about his/her performance along with a non-metacognitive follow-up response to Why/Why not.

3.   "Would these puzzles be hard for another kid your age? Why/why not?" No, I don't know.

1 point. His answer matches the one above as to whether the task would be difficult depending on age but didn't give a response as to why he thought this.
In order to receive 2 points, a child would have to either match the response to Question #2 (e.g., if they said the puzzle was/wasn't difficult for them) and follow with a metacognitively aware response as to why such as "these puzzles are hard for 4 year olds" or "we have these in our classroom so they're not hard for us" OR, the child could have a different response with a metacognitively aware answer as to why such as "Yes, they would be hard for other kids my age because they don't have them at home like I do" or "No, they wouldn't be hard for other kids my age because they are

better at puzzles than me". 0 points would be given if the child gave an answer that didn't match #2 and gave a non-metacognitive follow-up response to Why/Why not.

4. **How did you know if you were getting the puzzles right?"** I looked at the picture.

   2 points. He was aware not only of what strategy would be helpful in accurately completing the task but of which strategy he actually used while doing the task (this can be discerned by watching the video or noting whether the child actually used this strategy during the task).
   A child would be given 1 point if gave a partially metacognitive response such as "I thought about it hard".
   0 points were given for non-plausible/ non-metacognitive responses such as "I just knew" or "because I'm smart/good".

   Show child the 'alien' finger puppet and say: **"I have another friend to show you. This puppet's name is Gogi and he/she** (use same gender as the child) **is from another land. S/he does not go to a school like yours or have a teacher like yours and doesn't know anything about puzzles like the ones you just did. Will you help Gogi learn about these kind of puzzles?"** Wait for child to assent and say: **"Thank you."** (If they don't agree, try to prod them by saying that 'Gogi really needs your help and wants to learn about these kind of puzzles'.)

5. **"Would these puzzles be easier for Gogi or you? Why?"** A lot; I focus a lot
   1 point. He was metacognitive in asserting that he (would had experience with puzzles and was from a school/had teachers who taught about puzzle and puzzle-related tasks) but not in his response as to why. It is metacognitive to understand that focusing helps improve performance, but in this instance, the question was about why he would have an easier time than Gogi.
   In order to receive 2 points, a child would have to say something like "I have already done those puzzle" or "I know all about puzzles and Gogi doesn't know about them at all". 0 points are given if the child chose Gogi without a metacognitive explanation. The child could receive 1 point by choosing Gogi but giving a metacognitive response as to why such as "He looks smarter with that big brain (the toy had a brain external to his head)."

6. **"What should Gogi do if s/he is having trouble with the puzzle?"** Ask someone.
   2 points. He his answer reflected metacognitive awareness of a good strategy to use when encountering trouble (e.g., help-seeking).
   To receive 1 point, a child could respond with an answer that indicates some awareness of cognitive states but not of a (potentially) successful strategy, such as

"Try it" (if the child had added "harder" or "again" after "Try", she/he would receive the full 2 points). A score of 0 would be a response such as "Be good" which is not at all indicative of awareness of cognitive strategy.

7. **"Would it be helpful for Gogi to talk to herself/himself while doing the puzzle? Why would/wouldn't that be a helpful thing to do?** Yes-he has to focus and get concentration. Talking to yourself does that.

   2 points. He is both metacognitively aware that talking to oneself about a task while performing it can be cognitively helpful and why.
   1 point would be given if the child answered "Yes" but didn't know why or gave a non-metacognitive response as to why such as "It helps" or "It's good". 0 points is given for an answer of No without a metacognitive explanation. The child could receive 1 point by responding "No" but giving a metacognitive response as to why such as "Because if you talk you might get distracted and do a bad job on the puzzle".

   "**Gogi has some questions for you about puzzles like this one. Okay?"** Have the puppet 'speak' directly to the child and ask the following:

   For the last 4 questions, there was an intended 'correct' answer in that one response would make the puzzle task easier (as confirmed by asking adults these same questions). Thus, the child would get 1 point for answering correctly/metacognitively accurately and another 1 point for giving a metacognitively aware response as to why this was true. *However,* it became apparent after conducting several interviews that children sometimes viewed the strategies differently. Thus, if they responded differently than the adults to which situation would make the puzzle easier but gave a metacognitive response that appropriately made the first response defensible, he/she received the full 2 points (if there was no response given to back up their answer or a non-metacognitive response given, the score would be 0. In contrast, if the child responded as adults did to the first part but did not respond to the second part or responded non-metacognitively, she/he received 1 point).

8. **"Would the puzzle be easier with bigger or smaller pieces? Why?"** Easier to hold in your hands.
   2 points. He responded like adults for bigger pieces and gave a response that, while not as cognitively related as adults answered-e.g., "less pieces to have to figure out how to fit together or less intricate designs", it was a plausible reason as to why bigger pieces make doing a puzzle easier.
   1 point would have been given if there was no response to "Why" or he had said something like "It's better". 0 points would have been given if he had said smaller was easier and given no response to "Why" or he had said something like "It's better".

However, 2 points would have been given if he had said "smaller" along with a metacognitive response such as "Smaller pieces would be easier for Gogi to hold/see" (Gogi is a small hand puppet).

9. **"If all of the puzzle pieces were the same color, will the puzzle be easier?** If yes, ask: **Why?** If no, ask, **"Why not?"** I can't figure out which one goes where.
   2 points. He responded like adults and gave a metacognitive response to "Why not". 1 point would have been given if there was no response to "Why" or he had said something like "It's harder like that". 0 points would have been given if he had said "Yes" with no response to "Why" or he had said something like "It's just easier". However, 2 points would have been given if he had said "Yes" along with a metacognitive response such as "Then you would be able to sort by size" (indicting less cognitive load because you don't have two dimensions on which to sort).

10. **"If I think about how the pieces would fit together before I try, will the puzzle be easier?** If yes, ask: **Why?** If no, ask, **"Why not?"** Because it is (*demonstrated 'thinking' and putting the pieces in the right places*).
    1 point. He responded as adults would but did not give a metacognitive response to "Why" (though his demonstration came close, but even after being prompted after this enactment, he did not respond with any indication of metacognitive awareness. 2 points would have been given if his second response was something like "because it helps me focus on the puzzle" or "I'd have more time to figure out the right place". 0 points would be given for a response of "No" with no response as to "Why not" or a non-metacognitive response such as this one "Because it isn't".

11. **"If I close my eyes while I do the puzzle, will it be easier?** If yes, ask**: Why?** If no, ask**, "Why not?"** No, he can't see what he's doing! He couldn't see if he had the right piece or the right place on the card (*pointed to the design picture card*)".
    2 points. He responded like adults and gave a metacognitive response to "Why not". He would have been given 1 point for not responding to "Why not" or giving a non-metacognitive response such as this one "Because it isn't easier". 0 points would be given for a response of "Yes" with no response to "Why" or without a metacognitive response to defend this (see above-adults were unable to come up with a way to metacognitively defend this answer except possibly by discussing how other senses may become more acute, but this still wouldn't make the puzzle easier though a case may be able to be made for equally easy").

"Thank you for sharing all of your ideas and how you think with Gogi!

Notes: *While he was building the puzzle, he made a lot of metacognitive (evaluative) comments such as "I built this one before so I'm good at it." And for the most challenging puzzle, he said "OOOh, I can't do that one!" Then as he worked on it, he said "I'm having trouble with this part" (he didn't successfully complete it but was close).*

Appendix 2.G. Wedgits Puzzle Scoring

1. Rate the accuracy of the child's performance on the Wedgits task. These coding categories were designed to match the Metacognitive Knowledge Interview (McKI) in which the child is asked how well she or he did on the puzzle (Question #1).

    a. **Good**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first and second puzzles within the time allotted (4 minutes). The child may have started (or completed) a third or even fourth puzzle, but this is not required to receive a score of "Good".

    b. **Okay**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first puzzle within the time allotted (4 minutes) and accurately completed at least half of the second puzzle (i.e., completed the bottom half— that looks like a pyramid—and the green piece that is placed vertically in the pyramid).

    c. **Not so good**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first puzzle within the time allotted (4 minutes) and started the second puzzle but did not accurately complete half of the second puzzle (i.e., did not complete the bottom half that looks like a pyramid).

Appendix 2.H. The Strategic Behaviour Observation Scale (SBOS)

The top-ranking criteria for observers on each of the strategic behaviours assessed

Cognitive Strategic Behaviours
1. Choosing between main and trivial: methodically selecting the substantial elements (e.g., form), ignoring the trivial ones (e.g., colour when it is not needed).
2. Analyzing and combining activities: joining small parts resulting from previous activity to make a meaningful whole.
3. Effective use of models: utilising sufficiently and effectively the card models.

Metacognitive Strategic Behaviours
1. Planning: working with a clear plan, using time effectively.
2. Monitoring of the activities: examining closely the solution process, selecting appropriate next step.
3. Awareness of errors, adjusting intermediate aims: detecting errors and trying to correct them.
4. Learning from one's own errors: not repeating same errors and taking full advantage of them by using effectively new knowledge.

Motivational/Volitional Strategic Behaviours
1. Concentration: perceives external stimuli but is not distracted by them.
2. Persistence: works persistently in face of difficulties till finding a solution.
3. Working autonomously: works autonomously, needs no intervention or reinforcement by the experimenter.
4. Maintaining motivation: motivates effectively himself/herself and retains interest for the activity.
5. Initiative (starts action on his/her own): shows initiative and high levels of self-activation, decides next step with no need for intervention.

Appendix B. Examples of the scoring criteria used for assessing strategic behaviours

Choosing between main and trivial information
1. All elements are considered of equal importance (Cannot select the critical elements).
2. Confused between trivial and critical parts (Sometimes selects the critical elements).
3. Often selects the critical elements (Not always exploiting them).
4. Methodically selects the substantial elements and ignores the trivial ones.

Planning
1. Approaching the task as trial and error (Waste of time).
2. Working with a plan only occasionally (Usually wasting time).
3. Building in gradual steps, however a clear plan is not always apparent
4. Working with a clear plan; using time effectively.

Working autonomously
1. Asks continuously for help or reinforcement/reward.
2. Often asks for help or reinforcement (verbal or nonverbal), feels uncertain.
3. Occasionally needs reinforcement by the experimenter.
4. Works autonomously, needs no intervention or reinforcement by the experimenter.

From Dermitzaki, Leondari, Goudas, 2009, p. 155-156

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CHAPTER III

The Convergent Validity between Two Measures of Metacognitive Processing in Preschoolers

Abstract

The focus of this study was to elucidate the conceptualization and measurement of early metacognitive skills and processes through the comparison of the data revealed by two different measures of metacognition in preschool-aged children. Specifically, the convergent validity between a metacognitive knowledge interview (McKI) and an observational metacognitive skills coding scheme (ChAT) was examined in 83 preschoolers (M_{age}=53.47 months SD=4.53; 41% female). The correlations between the measurement tools ranged from low to moderate and varied across sub-components. Furthermore, the convergent validity was moderated by the children's family socio-economic background (SES); children from low-SES family background had less nuanced metacognitive processing than did children from higher SES family backgrounds. Both measures revealed evidence of early emerging metacognition in this sample of young children; there was some overlap but a considerable number of unique elements left to explore. Implications of this research include the importance of precisely conceptualizing and measuring metacognitive constructs and of investigating the unique elements between different measurement tools in order to understand its association to learning and academic achievement.

Keywords: Metacognition, Metacognitive Knowledge, Early Childhood, Convergent Validity, Measurement, Observation, Interview

The Convergent Validity between Two Measures of Metacognitive Processing in Preschoolers

Metacognition (Mc) has been shown to be associated with and predictive of cognitive development and academic achievement across many domains and age levels (e.g., Bransford, Brown & Cocking, 2000; Brown & Kane, 1988; Davidson & Sternberg, 1998; Desoete, Roeyers, & Huylebroeck, 2006; Georghiades, 2004; Harris, Graham, Brindle, & Sandmel, 2009; Palincsar & Brown, 1984; Pressley, 2002; Prins, Veenman, & Elshout, 2006; White & Frederiksen, 1998). However, this association has rarely been studied prior to middle elementary school, (for exceptions see Whitebread, 1999; Shamir, Mevarech, & Gida, 2009). This positive association between Mc, cognition and academic achievement may be potentially encouraging for researchers who study cognitive development and education as well as for educational practitioners and curriculum and policy makers. However, there is considerable confusion and lack of clarity surrounding the way that Mc is conceptualized and measured. Furthermore, related constructs such as self-regulation (SR) and self-regulated learning (SRL) are frequently substituted for Mc both in conceptualization and assessment (e.g., for a review, see Dinsmore, Alexander, & Loughlin, 2008), and thus it is difficult to be confident about what is being studied. Consequently, prior to comprehensively examining the relations between Mc and development/academic achievement, it is essential to precisely conceptualize Mc and carefully assess it, beginning with young, preschool-aged children.[1] Accordingly, the overarching aim of

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[1] There are recent studies examining metacognitive processes in infants (e.g., Brinck & Liljenfors 2013) that are also important, but in order to examine the construct comprehensively is required with children old enough to understand mental verbs and verbalize their knowledge, which is approximately the beginning of preschool/3 years old (Johnson & Wellman, 1980; also see Marulis, Palincsar, Berhenke, & Whitebread, submitted related to the developmental appropriateness of the McKI for children under 3)

this study is to examine the convergent validity of two measures of early metacognitive

processes for what they reveal about the conceptualization and assessment of early Mc.

Measurement Issues in Metacognition for Young Children

As reviewed in detail previously (Marulis, Palincsar, Berhenke, & Whitebread,

submitted), assessing cognitive skills in young children has been a challenge for many decades,

and only in recent decades have previous underestimations (many based on Piaget's rigid stage-

theory of development) begun to be rectified (e.g., for a review of underestimations of early

cognitive skills, see Gelman & Baillargeon, 1983; Wang, Baillargeon, & Brueckner, 2004). This

issue has been slower to change in the area of Mc where researchers continue to argue that

metacognitive processes do not emerge until children reach the ages of 7-8 (e.g., Veenman, Van

Hout-Wolters, & Afflerbach, 2006). Hence, the influence of Piaget's conception of progression

into concrete operations around this age period continues to prevail, even though researchers for

decades have found indicators of specific metacognitive processes in preschool-aged children

(e.g., Karabenick, 1981; Moore, Furrow, Chiasson, & Patriquin, 1994)

More recently, several researchers have revealed robust evidence of earlier emerging Mc

in preschool-aged children (Marulis et al., submitted; Shamir et al., 2009; Whitebread, Bingham,

Grau, Pino-Pasternak, & Sangster, 2007; 2009). In each of these studies, however, the

preschoolers' metacognitive processes were primarily conceptualized and assessed using one

method. In Marulis et al., (submitted), children's Mc was conceptualized in the way it was

originally coined (i.e., Flavell, 1976): "knowledge about cognition" or "thinking about thinking"

and operationalized and assessed as metacognitive knowledge broken down into subcomponents:

knowledge about people, tasks, and, strategies (Flavell 1979). Specifically, after finishing a

problem-solving task, 3-5 year old children were asked developmentally appropriate

metacognitive knowledge interview questions about the task (see Marulis et al., submitted for details). In Shamir et al., Mc was conceptualized as procedural metacognition and assessed as metacognitive behaviors displayed by 3-5 year old children during a card recall task (e.g., organizing the cards on tables, along with such statements as "I have to see all of them to help me remember them."). In Whitebread et al., 2007 and 2009, children's Mc was conceptualized and assessed based on a model of cognitive self-regulation that included metacognitive knowledge (as described in Marulis et al., submitted), metacognitive regulation (Brown, 1987), which they defined as the cognitive processes taking place during ongoing activities, which involves planning, monitoring, control, and evaluation, and emotional and motivational regulation (Boekaerts, 1999; Corno, 2001; Zimmerman, 2000), which they defined as the learner's ongoing monitoring and control of emotions and motivational states during learning tasks. A systematic coding scheme was developed based on this comprehensive model of self-regulated cognitive activity. Using this coding scheme, 3-5 year old children's metacognitive behaviors (verbal and non-verbal) were assessed naturalistically in their preschool classrooms during learning activities that were designed to be meaningful for the children and facilitated their metacognitive behaviors. These learning activities included child-initiated play (individually and in small groups), as well as activities provided by the children's teachers (again, both individual and small group activities).

Because the different ways of conceptualizing and assessing Mc have not yet been included in the same study, particularly with young children, we do not know how these metacognitive processes are related to one another in the same children, on the same tasks, or whether they would even be properly labeled using the same overarching term "metacognition". How Mc should comprehensively be conceptualized and assessed, especially with young

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children, remains an open question. Therefore, the current study was designed to address this important limitation by including a metacognitive knowledge interview—designed to assess articulated metacognitive knowledge—and a systematic observational coding system—designed to assess metacognitive behavior—in the same investigation with 3-5 year old preschoolers.

Measurement Issues in Metacognition

Beyond identifying the age of emergence of and clarifying the conceptualization and assessment of Mc, there are larger challenges surrounding measurement for Mc researchers. The issue of measurement is particularly salient when examining "mysterious" constructs such as Mc (Brown, 1987) that have also been conceptualized and assessed in a multitude of ways. As Schraw (2000) has advised, researchers who choose to focus on Mc should be cognizant of the potential skepticism from other researchers as to the precision that can be accomplished in measuring this construct (which of course is essential to studying it). Schraw reminds us that even in our recent past (mid-1980's) there were researchers who believed that Mc was "too broad and elusive to be studied effectively" (2000, p. 304) (and it is likely that this continues to the present day). Fortunately, Schraw does not stop with this warning, but provided several concrete measurement suggestions (framed as cautions) to assuage this possible wariness as well as to improve the reputation, assessment and understanding of Mc (see Figure 3.1).

Four cautions: (from measurement experts) when studying metacognition:

1. Field needs a plan for comprehensive assessment of the construct
   a. Reliability and validity norms
   b. Plan for translating theory into instruments that can be appropriately evaluated
2. Generate and test models
   a. Translate metacognitive theory into testable models
3. Construct and evaluate instruments that assess specific components of the model
   a. Use multiple measures/using multiple methodologies (convergent validity)
4. Use diverse assessment models
   a. Use multitrait, multimethod (MTMM) approach. See Campbell & Fiske, 1959 and Cook & Campbell, 1979.
   b. Incorporate diverse approaches including neurophysiological.

Figure 3.1. Expected cautions from the measurement community regarding effectively examining metacognition. Adapted from Schraw, 2000, p. 304-308

In a similar vein, Baker & Cerro (2000) have discussed the importance of converging evidence from different methods (that have different sources of error) in examining Mc. They proposed that, if different methods (i.e., with divergent sources of error) produce similar results, this evidence can be considered valid, reliable, and robust: "we can be more confident that we have measured what we set out to measure" (Baker & Cerro, 2000, p. 129). Furthermore, they suggested that Mc should be assessed within the context of an instructional program and domain in order to obtain a more accurate picture. Schraw (2000) concurred and recommended that, even if a measurement instrument has been shown to have valid and reliable psychometric properties (which is the first important requisite), it may not have ecological validity or may not accurately capture how Mc operates in real-life complex learning situations. In their meta-analysis of recent (2004-2007) SR, SRL and Mc studies, Dinsmore et al. (2008) provided a frequency count of the types of measurement instruments used by Mc researchers (see Figure 3.2), which indicated that current Mc researchers have moved away from a reliance on self-reports, interviews and think-alouds that predominated the early research on Mc (e.g., Flavell, 1979; Kreutzer et al., 1975).

Measurement type	Construct	
	Metacognition	
	f	Percent
Self-report	29	24
Observation	24	20
Think-aloud	14	12
Interviews	16	13
Performance ratings	38	31
Diaries	00	00

Figure 3.2. Measurement tools used to assess metacognition from a meta-analysis; from

Dinsmore, Alexander, & Loughlin, 2008, p. 402

Many other researchers have come to a similar conclusion as Schraw (2000) and Baker &

Cerro (2000), that, in studying Mc—particularly in young children—using multiple divergent

measures is ideal. Gama (2005) charted several popular methods for measuring Mc in children as

an indication of this point (see Figure 3.3). She clearly demonstrated that each method has

relatively equitable advantages, as well as sources of error/limitations. This analysis implicates

the use of multiple methods with different types of limitations and sources of error to provide a

balanced and comprehensive assessment that is relatively free of bias (Gama, 2005). Thus there

appears to be convergence of agreement on this position, which is one that has been applied to

the current study.

Method	Description	Advantages	Sources of Error and Limitations
concurrent think-aloud	learner says outloud everything she thinks and everything that occurs to her while performing a task.	get rich data about processes that are "invisible" to other methods.	automated processes remain inaccessible; young children do not sustain verbalizations; reporting may be disruptive of processing; produces masses of data that needs careful analysis.
post-performance interviews	interview in which learner has to recall what she did and thought during a learning experience.	provides data from responses to specific, direct probes.	lack of awareness of processing for those processes that are automated; failure to remember cognitive events given the interval between processing and reporting; lack of verbal fluency (specially for children) and variation in adult-child use of language; investigator needs to be attentive for not cuing particular responses.
cross-age tutoring	ask subjects to tutor younger children to solve a problem to observe which strategies and behaviours they will encourage and teach.	non-verbal data; avoid subject guessing what the investigator wants to hear and answering accordingly.	useful in the investigation of specific strategies (e.g. awareness of usefulness of text reinspection strategy).
self-report inventory	self-questionnaire using Likert or continuous scale with multiple items.	structured and convenient: easy to apply and score.	answers may be given to please the investigator/teacher; difficult to answer about at least partially automated processes.

Figure 3.3. Comparison of methods used to examine metacognition. From Gama, 2005, p. 18

Influences on Metacognitive Development

Though this is not an exhaustive review, I will discuss several factors shown to be important to metacognitive development that are included in the current study as covariates or moderator variables: socioeconomic status (SES), executive functions (EF) and expressive language. There are other environmental (e.g., supportive teachers who facilitate a motivating classroom, Larkin, 2010; explicit teaching and modelling of metacognitive strategies, Palincsar & Brown, 1984), peer (e.g., shared regulation, Pino-Pasternak & Whitebread, 2013; social

interactions, Shamir et al., 2009), and individual (e.g., theory of mind, Flavell, 2000; private speech, Winsler & Naglieri, 2003) factors that have been shown to affect metacognitive processing, but they are beyond the scope of this study.

Socioeconomic status and metacognitive processes. Studies have found that low family SES has been moderately associated with a low quality home learning environment (e.g., Bornstein & Bradley, 2008). Moreover, family households of children from low-SES backgrounds often have more chaos, less structure and routine, and more exposure to multiple stressors (Evans & English, 2002) including background noise and crowding (Evans, 2006) than children from non-low-SES backgrounds. Beyond correlational studies, there have also been longitudinal studies conducted to examine the relations between SES and cognition/achievement. Data from the National Longitudinal Surveys of Youth (NLSY) showed that the home environments of children from low-SES families were of significantly lower quality (measured by parenting variables such as responsivity, emotional climate and material resources such as the physical environment, learning materials, and enrichment) (Bradley, Corwyn, McAdoo, & Coll, 2001). The same study also found that children's home environments mediated the relation between SES and child development (Bornstein & Bradley, 2003; Bradley et al., 2001).

Beyond learning opportunities and material resources in the home environment, there may be additional explanations for this SES-related achievement gap, which is widespread across cognitive and achievement indices from as early as infancy through adulthood (Bradley & Corwyn, 2002; Marulis & Neuman, 2010; 2013) related to the pervasiveness and concomitants of low-SES. For example, Noble, McCandliss, & Farah, (2007) found that the achievement gap between low- and middle-income children related to language was nearly one standard deviation, and that SES accounted for over 30% of the variance in language task performance (this was the

statistically largest portion of variance accounted for compared to all brain systems they examined looking for mediators between the SES-achievement gap). Noble et al. (2007) speculated that the association they found between SES and language may have been due to the perisylvian brain regions (which are involved in language processing) "undergoing a more protracted course of maturation *in vivo* than any other neural region" (Sowell, Peterson, Thompson, Welcome, Henkenius & Toga, 2003 as cited in Noble et al., 2007, p. 476). They further suggested that this prolonged developmental course opens the language system to more vulnerability (e.g., to the multitude of environmental factors that tend to co-occur with SES). In fact, a recent study (Rodriquez & Tamis-LeMonda, 2011) found that environmental factors associated with emergent literacy skills were already present among infants as young as 15 months old. Furthermore, studies have found that young children from low-SES backgrounds have significantly lower SR and executive functioning than children from higher SES backgrounds (Matthews, Kizzie, Rowley, & Cortina, 2010; Sektnan, McClelland, Acock, & Morrison, 2010). However, the children from low-SES backgrounds who did have similar SR skills as their higher SES peers also had similar academic functioning (unlike the children from low-SES backgrounds with low SR skills who had far lower academic functioning) thus these authors speculated that self-regulatory skills may act as a protective factor for children at risk for learning difficulties. These associations will be explored in the current study with the prediction that similar results will be found; that the children from low-SES families will obtain lower metacognitive scores than the children from the higher SES families and that these metacognitive skills may serve as protective factors.

Executive functioning. Research on regulation in young children includes the concept of *executive functioning (EF)*, which is of particular interest to those who study preschool-aged

children because this is the time when these processes emerge for most children. EF refers to a

set of cognitive components working together to regulate behavior. Recent literature on EF

primarily examines three such components: *attentional shifting (or cognitive flexibility),*

inhibitory control and *working memory* (Blair and Razza, 2007). Attentional shifting/cognitive

flexibility refers to the ability to flexibly move or shift between divergent aspects of an object or

response depending on the context or directions. The most common assessment measure of this

construct is the Wisconsin Card Sorting Task in which participants are asked to sort cards

according to one rule (e.g., on the basis of color) and then asked to switch focus to another

dimension of the cards (e.g., sort on the basis of shape). An ecological indicator of this construct

would be a child's flexibility in switching from their science teacher's expectation (e.g., accurate

representation of a physical object) to that of their art (e.g., creative interpretation of a physical

object). Inhibitory control refers to selecting and attending to relevant information while

inhibiting irrelevant or non-relevant information (Barkley, 1997). There are many instruments

that measure inhibitory control, most of which use a "Go/No-Go" paradigm that asks participants

to press a button for a certain condition (e.g., a middle arrow points the same way as the top and

bottom arrows) but to *not* press the button—thus inhibiting their dominant response—in the

opposite condition (e.g., the middle arrow points a different way from the top and bottom

arrows). A contextualized indicator of inhibitory control would be a child remembering to raise

a hand rather than call out (the dominant response) to answer a question. Working memory refers

to cognitively maintaining and manipulating information, such as remembering and carrying out

multi-step instructions. Measures include being given a set of digits to remember and being

asked to recall them backwards (thus requiring manipulation rather than simply short term

memory retrieval). In an applied setting, an indicator of working memory would be a child successfully enacting a three-step mathematical computation procedure.

These cognitive skills begin developing in infancy and improve markedly between the ages of three and five, particularly on tasks that require holding information in one's mind and exercising inhibitory control (Diamond, 2002). Thus, executive functioning is a prerequisite to self-regulation (Barkley, 1997). Self-regulation includes the manifestation of EF skills in overt, observable responses in the form of children's gross motor actions, which are also important for success in classrooms (Ponitz, McClelland, Matthews, & Morrison, 2009).

EF skills, similar to metacognitive skills, are susceptible to "conceptual clutter" and "measurement mayhem" (Morrison & Grammer, in press). These constructs are theoretically and conceptually similar in that each is a higher order cognition or a "meta" skill, and there is also empirical evidence that they are associated in young children (Roebers, Cimeli, Röthlisberger & Neuenschwander, 2012; Roebers & Spiess, 2013; Whitebread, 1999). Thus, when studying either, it is important to include both either as a covariate or potential moderating variable. The current study included an established measure of EF (discussed in the Method section) for this purpose.

Expressive language. Expressive language, or expressive vocabulary (i.e., the size of a child's vocabulary that he or she is able to articulate), has also been shown to be associated with metacognitive development (Lockl & Schneider, 2006; Lockl & Schneider, 2007). Expressive language tasks typically involve asking children to describe, label, or provide another name for a picture that is shown to them. Some studies have shown that the only non-environmental factor that contributes to a closely related construct, theory of mind (thought to be a precursor to Mc;

Flavell 2000), is verbal ability (Hughes, Jaffee, Happeˊ, Taylor, Caspi, & Moffitt, 2005). Intervention studies have also found that when young children were given language training, their theory of mind also improved (e.g., Lohmann & Tomasello, 2003). Because Mc is considered "applied theory of mind" by the researcher who first coined the term (Flavell, 2000), it is likely that the same results would be found with metacognitive processes.

Importantly, language has been viewed by researchers beginning with Vygostky (1986) as a precursor to metacognitive behavior, and has been conceptualized as "an instrument of thought" used to verbally mediate cognition and behavior to carry out solutions to problems (Vygotsky, 1986) or as "externalized thought." Thus language allows children to better monitor and plan thoughts and actions (i.e., be metacognitive) and eventually internalize a model of this reasoning, which is crucial to becoming more metacognitive (Zakin, 2007). Accordingly, an expressive language measure has been included in the current study as well that will be described in detail below.

Current Study

The main focus of the current study was to investigate the convergent validity between two measures of metacognitive processing in a diverse sample of preschool-aged children. In addition, this study investigates convergence/divergence across diverse populations (i.e., the tuition-based preschools compared to the Great Start Readiness Program [GSRP] need-based classrooms) and what each measure revealed about early emerging metacognitive processes. Three research questions were addressed.

Research Questions and Hypotheses

First, what is the convergent validity between two different measures (the McKI and the ChAT) in preschool-aged children? What types of unique and shared information do they provide about the depth, breadth and variation in metacognition among 3-5 year old children in a preschool classroom? I hypothesized that Mc would not function as a unitary factor; thus that there would be overlap between data obtained by the McKI and ChAT with a considerable amount of unique variance left to explain. This was an exploratory question because there are few studies that have assessed metacognitive processes in this age range (with the exception of those reviewed previously: Shamir et al., 2009; Whitebread et al., 2007, 2009; Whitebread, Pino-Pasternak, Marulis, Okkinga, & Vuillier, in preparation). Furthermore, there are no studies, to my knowledge, that have included both a full declarative interview such as the McKI along with a systematic observational tool such as the ChAT in the same study for comparative purposes. The closest analyses to this is reflected in my recent work with David Whitebread (Whitebread et al., in preparation). We found a significant correlation (r=0.33, p=.004) between children's responses to two direct metacognitive knowledge (McK) questions about a problem-solving Train Track Task (i.e.., *How did you work out how to make this track?"; "Which one was the hardest track to make? Why?"*) and their behavioral Mc (measured using ChAT). Informed by this study, I expected that the McKI and ChAT measures would be significantly correlated in my study but did not expect that there would be substantial overlap between them such that they could be said to be measuring the same construct (i.e., aspect of Mc). That said, the results may differ as the McKI is a comprehensive assessment tool whereas the previous analyses were done based on a few questions asked subsequent to a problem-solving task.

Second, is the convergent validity moderated by the children's family background (low income and/or parental education / socioeconomic status [SES])? Again, this was fundamentally

an exploratory question as it has not been explored in previous research. However, I hypothesized that children's SES would moderate the convergent validity between the two measures of Mc as children with lower SES backgrounds tend to have lower declarative skills (e.g., Hoff, 2003). Though expressive language was controlled for, there remained the issue that children from low-SES backgrounds would likely have less experience articulating their McK (thoughts, or any type of knowledge). Thus, I hypothesized that there would be less overlap between the McKI and ChAT for the low-SES children than the higher –SES children.

An important question is what measurement tools can reveal about early emerging metacognitive processes. Therefore, the third question was, what evidence of early-emerging metacognition can be observed in these two measures of metacognition? I hypothesized that both the McKI (declarative articulated metacognitive knowledge about the Wedgits puzzle task) and the ChAT (observed metacognitive behavior during the Wedgits puzzle task) would reveal greater evidence of metacognitive processes than what has traditionally been argued to be achievable prior to age 7-8 (e.g., Flavell, 1979; Kreutzer, Leonard, & Flavell, 1975; Veenman, et al., 2006). Based on more recent research (e.g., Marulis, et al., submitted; Shamir et al., 2009; Whitebread et al., 2007, 2009), I expected that children would show, on average, at least partially metacognitive responses on the McKI and that most children would show evidence of metacognitive skills (as coded by the ChAT) during the Wedgits puzzle task. I further expected that there would be substantial variance among children's scores on the McKI and ChAT and that this variance may be moderated by children's age, SES, and other cognitive and SRL variables. To a great extent, this was also an exploratory question in terms of how much evidence of metacognitive processes would be revealed by these measures, as well as how much variance would be present in this diverse sample of children. Furthermore, not only was the quantity of

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scores attained an open question but also the quality: it was not known what types of responses children would provide to the McKI or whether these types of responses would vary by age, SES, cognitive or SRL variables. Also, it was uncertain what types of metacognitive behaviors would be revealed during the Wedgits puzzle task and whether some children would not display any metacognitive behaviors while others displayed nearly continuously metacognitive behaviors while building the puzzle. This again, if found, may vary by age, SES, cognitive or SRL variables.

Method

Participants

Participants were 83 children (42.74-68.60 months, M_{age}=53.47 months SD=4.53; 41% female) from seven preschool classrooms in Southeastern Michigan. Four teachers—each with a dedicated paraprofessional—taught the preschool classes as follows: One teacher taught a PreK academy for 4-5 year olds, which was an all-day program held every week day. However, not every child attended every weekday; some children attended Mondays, Wednesdays, and Fridays only for example. Another teacher taught a typical half-day (tuition-based) preschool class in which children attended different days/times based on age. This program included a 3 through young-4 year old group which attended preschool on Monday and Wednesday mornings, a 4 year old group which attended preschool on Monday and Wednesday afternoons, and a 4.5-late 5 year old group which attended preschool on Tuesday, Thursday and Friday morning to early afternoons. The other two teachers taught a Great Start Readiness Program (GSRP), which is funded by the State of Michigan. Eligibility for this program is determined by age (children must be 4 years old not turning 5 before November 1st of the year of entrance), and by income and

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other need-based family situations. The GSRP classrooms were half-day programs that were held Mondays through Thursdays in the mornings and afternoons.

Across the seven classrooms, there were 108 eligible children based on age (between 3-5 years old). During the parent orientation for the PreK academy, preschool, and GSRP, I participated in the parent orientations, including a presentation of what my study would entail, how I would partner with the school and district and the potential benefits of the research. After the presentations, parents were asked to fill in the consent forms (indicating whether they Wedgits or were not interested in having their children participate in my study). Over 90% of the parents (99/108) returned the consent forms indicating they were interested in having their children participate in my study. Prior to beginning my assessments, I spent two weeks in the children's classrooms to build rapport and get to know the children and their teachers. During this time, it became apparent that another 15 children would not be eligible to participate—despite their parental permission—because they were English Language Learners (ELL) still learning basic English words. Furthermore, one child did not want to participate even with much encouragement from her teacher and me. Thus, the final sample was 83 children. There was no missing data or attrition over the month of this study. The final sample was 46% White, 27% Black, 8% Asian, 6% Bi-racial, 11% Chaldean, and 2% Hispanic.

Procedure

All children were individually assessed in two 10-15 minute sessions. The first session targeted metacognitive processes. Children were assessed using the Metacognitive Knowledge Interview (McKI) and the Children Articulating Thinking (ChAT) observational tool. The McKI, a direct interview, was administered individually with each child after they completed a Wedgits

challenge puzzle (to be described in detail below). These sessions were video recorded for all children. The Wedgits task and McKI together took approximately 10-15 minutes per child. The adapted ChAT coding scheme was administered to the video-taped Wedgits puzzle problem-solving task. Thus, the ChAT metacognitive behavior coding scheme was applied during the puzzle task and the McKI was administered directly afterward. The McKI is designed to be specific to a content area or learning task while the ChAT coding scheme is designed to be used across domains. A second researcher independently coded 30% of the McKI and ChAT to obtain inter-rater agreement indices.

The second session focused on self-regulated learning and cognitive assessment measures that were designed to be covariates and potential moderators. These included the Head, Toes, Knees, Shoulders (HTKS) measure of executive function and the Expressive Vocabulary Test (EVT). As described earlier, executive function skills are often related to metacognitive processes in children. Importantly for this study, these skills tend to be intertwined early in development and are difficult to parse apart. Thus, in order to obtain a "purer" measure of metacognitive processes across the two assessment tools (i.e., McKI and ChAT), the HTKS was used as a covariate in the convergent validity analyses. Expressive language is a strong predictor of metacognitive skills, particularly declarative/articulated metacognition (e.g., Lockl & Schneider, 2006, 2007). Thus, it was essential to include an expressive language measure as a covariate in the current convergent validity analyses. The EVT was chosen for this purpose as it is appropriate and normed for use with preschool aged children and includes both labeling and synonym segments providing a comprehensive depiction of young children expressive vocabulary.

Measures

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Wedgits problem-solving puzzle task. One of the limitations of previous assessment approaches with young children has been the use of decontextualized, abstract, or retrospective interviews. I not only endorse the use of *developmentally appropriate* interviews with young children, but advocate for their importance in directly eliciting children's metacognitive knowledge. Ideally, interviews, such as the McKI developed in this study, would be used in conjunction with other assessment tools such as systematic observation (e.g., Whitebread et al., 2007, 2009, in preparation) to capture young children's metacognitive processes comprehensively. However, it is crucial that when young children are interviewed about their cognitive processes, it is done in a contextualized way (i.e., they are asked questions about a familiar cognitive task that they just completed, that is ideally still within their view). This, in addition to ensuring that the wording was developmentally appropriate, were the main foci in developing the McKI. As Papert aptly titled his 2005 paper on teaching children to think: "You can't think about thinking without thinking about thinking about something" (Papert, 2005); this is particularly important for young children.

In order to contextualize the McKI and ask the children about their metacognitive knowledge regarding something familiar and relevant, a mastery motivation puzzles task was adapted from Smiley & Dweck (1994) that had previously been piloted and found to be appropriate and enjoyable for preschool-aged children. The puzzle cards were chosen based on previous pilot work. Children were shown a card with a puzzle design and asked to make Wedgits blocks (a set of building blocks) that match the design card to build a puzzle (see Appendix 3.A for puzzle design cards and specific procedure). Each child completed the first puzzle; if needed, help was provided (for the first puzzle only as this was a "warm-up"). If the child finished the second puzzle in under four minutes, she or he would be given a third (more

challenging) puzzle, then a fourth puzzle, and so forth, until he or she was unable to solve the puzzle in four minutes (only one child completed the third puzzle in under four minutes). After trying a puzzle for four minutes unsuccessfully, each child was told that the time was up for the game and the metacognitive knowledge questions began. The design of the Wedgits puzzle task was based on guidelines set forth by mastery motivation researchers for appropriately challenging tasks (Morgan, Busch-Rossnagel, Maslin-Cole, & Harmon, 1992). The Wedgits puzzle task successfully met these guidelines including providing tasks of increasing difficulty so that children were assessed working on tasks where they could complete part, but not all, of the solution in the time allotted. Furthermore, the task was designed so that it was just challenging enough to elicit problem-solving strategies and thinking about those strategies such that the children were in their ZPDs (Vygotsky, 1978) when Mc is most likely recruited (Prins, et al., 2006).

Metacognitive Knowledge Interview (McKI). Following the completion of the final (most challenging/not successfully completed in four minutes) Wedgits-block puzzle, children's metacognitive knowledge was individually assessed by the first author using the Metacognitive Knowledge Interview (McKI; Marulis, Kim, Grammer, Carrasco, Morrison, & Gehring, 2013; Marulis, et al., submitted). The McKI was developed to assess what could be revealed by a developmentally appropriate contextualized interview based on Flavell's original conceptualization of metacognitive knowledge of: people, tasks, and strategies. Children were therefore asked a series of 14 questions[2] related to the Wedgits task such as: "Do you think you

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[2] Three questions were added to the McKI from Study 1: "Will it be harder/easier when you're older? Why?", "If you gather (demonstrate) the pieces you will need first and then build the puzzle, will it be easier? Why/Why not?" and, "What if you were watching TV while you were building it, will it be easier? Why? /Why not?" These were added based on feedback I received from Henry Wellman and the Gelman/Wellman language lab.

did a good, okay, or not so good job on the puzzles? Why/Why not?"; "Would this puzzle be

hard for another kid your age?" (Knowledge about people: Questions 1, 4, 5, and 6 were in this

category) and "Would the puzzle be easier if all of the pieces were the same color?"; "Would the

puzzle be easier with bigger or smaller pieces? Why?" (Knowledge about tasks: Questions 2, 3,

9, 10, 13, and 14 were in this category); "Would talking to yourself during the puzzle be helpful?

Why/Why not?"; "If I think about how the pieces would fit together before I try, will the puzzle

be easier? Why?/"Why not?" (Knowledge about strategies: Questions 7, 8, 11, and 12 were in

this category). Furthermore, in order to make the interview sensitive to children's development,

children were asked to respond to a child named "Gogi" (an unusual gender-neutral name; the

child was given the gender of each child) for the last eight questions. The back story was that

Gogi was from a far-away land and thus had never seen puzzles or blocks and wanted to learn

about them[3]. The children were then asked to help Gogi learn about the puzzles/blocks by

answering questions about them (in a sense, teaching Gogi, about the puzzles/blocks and the

child's thinking, which many children respond to more readily than when asked to respond

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The first question was added to address whether children understood the distinction between whether the puzzles were hard for themselves, children their own age, and their older selves (the effects of age/development and experience on the difficulty of a problem-solving task). The second question was added to address whether children would understand that an organization strategy would be helpful in making the puzzle task easier to solve. The third question was added to address whether children understood how attention affects performance on a learning task.

[3] In Study 1, I used a Gogi puppet for the McKI. However, though it did work as intended related to the sensitivity to development and children responded appropriately and sufficiently to the questions, a considerable amount of children became over-interested in and absorbed with the puppet and got off-task or had to be redirected back to the interview questions several times. In addition, several children initially responded to the children based on Gogi's size. For example, a child said that they puzzle would be easier with smaller pieces for Gogi's small hands; another child said that Gogi would have trouble with the puzzle because he was too small to hold the pieces and they would fall over. These children were re-directed to think about the puzzle pieces related to him or herself, but to avoid such situations, the backstory was changed slightly so that Gogi was described instead as a child the same age as the child in the study but from a faraway land who had no experience or knowledge of puzzles (in the same way as the puppet).

directly to questions about their thinking). See Appendix 3.B for the complete McKI; questions 6-14 were related to Gogi.

Responses were rated on a 0-2 scale as follows: 0=not at all metacognitive, 1=partially metacognitive (e.g., they agreed that talking to oneself can be helpful in solving a task but their reason was not related to cognition or they didn't know why), 2= appropriate metacognitive response (see Appendix 3.C for annotated codebook) . For the first question regarding whether the children thought they did a good, okay, or not such a good job, children's responses were compared to researcher-perceived scores (on the same scale of good, okay, or not-so-good; see Appendix 3.D). If the child's response was aligned with the researcher's judgments; that is, the child said she or he did a good job on the puzzle and the researcher scored the child as doing a good job on the puzzle, the child received an "appropriate" metacognitive score (2 points). If the child's response was off by one level; that is, the child said she or he did a good job on the puzzle whereas the researcher scored the child as doing an okay job on the puzzle, the child received a "partially" metacognitive score (1 point). If the child's response was off by two levels; that is, the child said she or he did a good job on the puzzle whereas the researcher scored the child as doing a not-so-good job on the puzzle, the child received a "not at all" metacognitive score (0 points). Two researchers independently coded 30% of the sample on all 14 questions, as well as how the child did on the puzzle itself. Agreement between coders was high (intraclass correlation coefficient [ICC] =.86).

The McKI was pilot tested with 55 children in a similar preschool and from a similar background economically, racially, and educationally. They were also similar in age and gender breakdown. Four questions were removed based on the pilot study because the children either did not understand the question or the majority responded in a way that was not aligned with the

meaning of the question (even when the question was revised several times) or there was not enough variation in children's responses, or most children responded non-verbally. For example, one original question asked the child to explain the best way to do the puzzle; most children just demonstrated rather than verbally explained even when asked to verbalize. Because this was designed to be an articulated metacognitive knowledge interview, these responses were not code-able, therefore, this question was removed from the interview. Additionally, a question prompt was removed from several questions due to children's lack of meaningful response choices. In the original McKI, when children were asked whether something would make the puzzle easier or not (e.g., "Would the puzzle be easier with bigger or smaller pieces?"), if they responded in the affirmative, they were then asked if the puzzle would be a little - or a lot - easier (counter balanced). Because this choice was counter-balanced, it was determined that most children were consistently choosing the last option regardless of meaning (i.e., if "a lot" was stated last, children would consistently choose that option and vice versa). Thus, it appears that this distinction between aspects of the puzzle task, or various strategies making the puzzle a little or a lot easier, was too nuanced for preschool-aged children.

Children Articulating Thinking (ChAT) coding scheme. The ChAT observational coding scheme was designed to assess metacognitive behavior during (quasi)naturalistic problem-solving tasks. It was first used in Bryce & Whitebread (2012) with 5-7 year olds and involved a series of indicators of monitoring and control as well as lack of monitoring and control (see Appendix 3.E) behaviors. The coding scheme was designed to address both children's monitoring and regulation of their performance *and* their failure to do so in order to understand the fuller picture of their metacognitive processes (and lack thereof). Children's verbal and non-verbal behaviors were both accounted for: this metacognitive skills coding was

originally developed by identifying 21 verbal and non-verbal behaviors from other coding

schemes (Deloache and Brown 1987; Lambert 2001; Larkin 2000; Sangster 2010; Whitebread et

al., 2009) and a pilot study. Bryce & Whitebread (2012) approached their study from an

information-processing framework; thus, behaviors were coded as either Monitoring (13) or

Control (8) processes, based on Nelson and Narens' (1990) model. Monitoring behaviors were

conceptualized as behaviors that serve to "update the mental representation of the task", while

Control behaviors assert "some action at the level of the task", Bryce & Whitebread, 2012, p.

202. Behaviors were coded as they occurred, and then frequencies were transformed into rates by

dividing the number of occurrences by the number of minutes spent on the task rather than

approached as interval coding (for details, see Bryce & Whitebread, 2012).

Bryce & Whitebread (2012) used a quasi-naturalistic method involving a controlled

observation of children while they completed a problem-solving task called the Train Track Task

(TTT). The ChAT observational coding scheme was applied during this task. The TTT was

modified from Karmiloff-Smith's (1979) closed-circuit railway task. In the TTT, children were

asked to build a train track to match a predefined shape from a plan (they were given a model

picture and asked to make the tracks look the same to the best of their ability. Children were also

told that they could use as many tracks as they needed and that they needed to tell the

experimenter when they were finished. The experimenter did not interact with the child during

the task except to provide "gentle encouragement" if needed. There was no time limit and, if

children finished without saying anything, they were reminded "remember to tell me when

you're finished." Providing a plan of the train track shape to be constructed was not included in

the original task (Karmiloff-Smith, 1979) and allowed for subcomponents of monitoring/lack of

monitoring to be observed more easily (i.e., "Checking the plan"; see Appendix 3.E).

In a more recent study (Whitebread et al., in preparation) an adapted version of this coding scheme was used with a simpler version of the same TTT with younger children (3-5 year olds). The ChAT coding scheme was found to be appropriate for the 3-5 year olds and predictive of their metacognitive and self-regulatory processes. The coding scheme was used in the same way as in Bryce & Whitebread (2012) though some items were dropped based on their post-hoc analyses (see Appendix 3.F). However, for the purposes of conceptual analysis, a metacognitive composite (Mc) score was created by adding the mean rates of Monitoring (MON) and Control (CONT) and subtracting the mean rate of Lack of Monitoring and Control (LMC). See Appendix 3.G (Whitebread et al., in preparation).

ChAT adapted for Wedgits task. For the purposes of this study, the (adapted) ChAT coding scheme (Whitebread et al., in preparation) was adapted to be appropriate for the Wedgits task (Appendix 3.H). Conceptually, the Wedgits task is similar to the TTT. Both tasks are problem-solving tasks wherein children are given a model plan that they were asked to follow. In both instances, they are given pieces and asked to make them look like the model plan, are not given assistance from the experimenter beyond gentle encouragement to "keep trying" or "do your best," and are asked and reminded to tell the experimenter when they are finished with the task (i.e., when they believe that what they've built look exactly like the model plan). The main difference is that the Wedgits task is timed because it is designed to be a challenge mastery motivation task. Thus, children were given progressively more challenging puzzles until they were unable to complete them within four minutes (as described in detail earlier). This did not pose a problem for the coding scheme as behaviors were coded as they occurred in the same way but frequencies did not need to be transformed into rates because all children spent four minutes on the last (most challenging) Wedgits puzzle. Thus, the main adaptations for the coding scheme

involved changing the specific behavior examples to fit the Wedgits puzzle tasks as opposed to the TTT. The general categories across Monitoring (e.g., "Checking Construction": The child checks his/her own puzzle construction), Control (e.g., Planning: Verbalizations that precede the actual behavior and indicate future actions such as "I am going to put the red piece on bottom before this green one"), and Lack of Monitoring and Control (e.g., Finishing Error: The child claims to be finished when there is a discrepancy between the puzzle he/she built and the model plan) all aligned with the Wedgits puzzle tasks. Children received 1 point per instance of each metacognitive behavior displayed amongst the ChAT codes (e.g., if a child Checking her or his constructed four times during the Wedgit task, she or he would receive 4 points). Specifically, the last Wedgit puzzle was coded because that was the most challenging puzzle for each child. Two researchers independently coded 30% of the sample on all ChAT codes. Agreement between coders was high (intraclass correlation coefficient [ICC] =.91).

Head-Toes-Knees-Shoulders (HTKS). The HTKS assessment task (Ponitz, McClelland, Connor, Jewkes, Farris, & Morrison, 2008; Ponitz et al., 2009) is an established and validated behavioral self-regulation instrument that is administered to individual children to measures executive function skills (see Appendix 3.I). Using the HTKS task, an experimenter asked children to remember behavioral commands (e.g., "touch your toes") and respond with an action that is in conflict with these commands (e.g., child must touch their head when they hear the command "touch your toes"). In this way, children would need to recruit their working memory regarding the commands and response inhibition in order to inhibit their dominant response to follow the command. Furthermore, as the task gets increasingly difficult, children must recruit cognitive flexibility (i.e., the commands switch at the end so that when asked to "touch your toes," the child must touch their shoulders instead of their head).

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Expressive Vocabulary Test (EVT). The EVT (Williams, 1997) is a standardized norm-referenced (conormed with the Peabody Picture Vocabulary Test-III; PPVT-III; Dunn & Dunn, 1997) test of expressive vocabulary for children through adults (ages 2.5-90). The EVT is indivivdually administered and takes approximately 5-10 minutes for preschool-aged children. The EVT has two sections: labeling and synonyms. Using the EVT, the experimenter asked the children to look at pictures (see Appendix 3.J) and provide a one-word response describing what was in the picture. In the next section, children were asked for synonyms. They were told a one-word name for a picture and were asked to provide another one-word word for the same picture (see Appendix 3.J).

Analytic plan

To examine the shared and unique variance/analyze the convergent validity of the two measures of Mc in this preschool sample, Pearson correlations were performed, controlling for age, executive function (HTKS) and expressive language (EVT).

Results

Descriptive Results

The results for the entire sample on the metacognitive assessment tools, as well as the sample split by GSRP and tuition-based classrooms, can be seen in Tables 3.1 and 3.2. In general, these tools both revealed more metacognitive capabilities in these preschool-aged children than previous studies—particularly involving interviewing children—with the exception of several studies reviewed (e.g., Karabenick, 1981; Shamir et al., 2009; Whitebread et al., 2007, 2009). It is important to note that two subcomponents needed to be removed from the ChAT observational coding scheme. Within the CONT code, the Sorting code needed to be removed

because there was only one instance of one child who was coded as sorting during the Wedgits

puzzle tasks in the entire sample of 83 children. Additionally, the Goal neglect code within the

LMC subcomponent was removed because there were only four instances across three children

in the entire sample who displayed this code. Specifically, there were numerous instances in

which children seemed to neglect the goal of building the model puzzle, however, to qualify for

this code, the child was required to verbalize (see Appendix 3.H). For example, to be coded as

"Goal neglect", the child would need to say something to indicate that he or she was neglecting

the goal, such as: "I am going to build a house now!" as he or she started to build off-task and

neglect the model card puzzle task.

Table 3.1

Metacognitive Assessment Scores on the McKI and ChAT Measurement Tools

Tool	*n*/ Age	*M(SD)*	Range	Gender/Age
McKI	83 M_{age}=53.47 months	11.55(4.90)	0-24.50 (max=28)	Greater with age R=.32, b=.35, p=.003 No gender diff: $t(81)$=.47 (M_{diff}=-1.68), p=.64
ChAT	83 M_{age}=53.47 months	18.22(15.82)	-18-48	Greater with age R=.30, b=1.04, p=.006 No gender diff: $t(81)$=.27 (M_{diff}=.-30), p=.78

The lower-SES classes (i.e., the GSRP classes) had significantly lower scores on both the

McKI (GSRP M=9.49, SD=4.43; Tuition M=13.66, SD=4.49), $t(81)$=4.26, p<.001 (M_{diff}=4.17)

and the ChAT (GSRP M=14.71 SD=17.42; Tuition M=23.85, SD=12.60), $t(81)$=2.74, p=.008

(M_{diff}=9.14). See Figure 3.4.
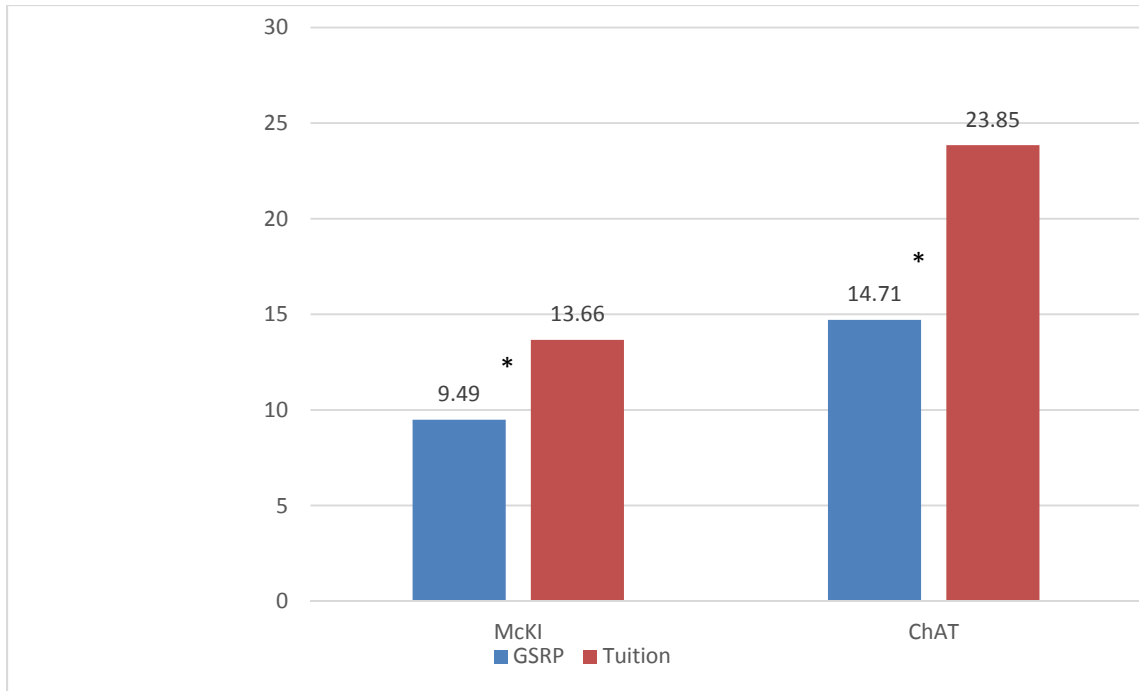
Figure 3.4. Mean scores on the metacognitive assessment measures (McKI and ChAT) for the
GSRP and Tuition preschool classes controlling for age, executive function (HTKS), and
expressive vocabulary (EVT).

In addition, the subcomponents of the McKI and ChAT measurement tools (see Table
3.2) showed a similar pattern of results wherein the GSRP classes scored significantly lower on
all assessment measures (McKI_People, $t(81)=2.86$, $p=.005$ $M_{diff}=4.51$, McKI_Task $t(81)=4.52$,
$p<.001$ $M_{diff}=2.27$, McKI_Strategies, $t(81)=2.69$, $p=.009$ $M_{diff}=.83$; MON $t(81)=2.76$, $p=.007$
$M_{diff}=1.07$, and LMC $t(81)=2.60$, $p=.01$ $M_{diff}=3.39$) except for one subcomponent within the
ChAT codes: CONT $t(81)=1.24$, $p=.22$ $M_{diff}=1.64$.

Table 3.2.

McKI and ChAT Subcomponent Assessment Scores for GSRP and Tuition Preschool Classrooms

	McKI			**ChAT**		
M(SD); Range	People	Tasks	Strategies	MON	CONT	LMC
All children n=83 M_{age}=53.47 months	2.97(1.84); 0-8	5.36(2.55); 0-12	3.22(1.45); 0-6.5	15.33 (7.49); 2-33	8.12 (6.03); 0-24	5.16 (6.15); 0-22
GSRP n=42 M_{age}=53.17 months	2.44(1.69); 0-8	4.23(2.28); 0-10	2.80(1.47); 0-6.5	13.09(1.17); 2-29	7.03(6.64);0-22	6.83(3.44);0-22
Tuition n=41 M_{age}=53.77 months	3.51(1.84); 0-8	6.51(2.30); 0-12	3.64(1.31); 0-6.5	17.61(6.74);3-33	8.95(5.28);0-24	3.43(3.88);0-15

Correlations: Convergent Validity

To address the first research question: What is the convergent validity between two different measures (the McKI and the ChAT) in preschool-aged children? a Pearson correlational analyses was performed controlling for expressive vocabulary (using the EVT) and executive function (using the HTKS) and using familywise Bonferroni correction for multiple comparisons. The overall correlation between the McKI and ChAT measurement tools was low, r=.39, p<.001 (See Figure 3.5 for a correlation scatterplot), and the McKI overall had a low association to the main subcomponents of the ChAT as follows: r=.30, p=.007 for Monitoring

(MON); $r=.25$, $p=.03$ for Control (CONT), and $r=.26$, $p=.02$ for Lack of Monitoring and Control (LMC).

Figure 3.5. Scatterplot showing the correlation between the metacognitive assessment measures (McKI and ChAT) controlling for age, executive function (HTKS), and expressive vocabulary (EVT).

Furthermore, correlational analyses were performed on the subcomponent of the McKI and ChAT measurement tools, it became clear that the low correlation was being driven by a few subcomponents. Specifically, the only significant correlations between the McKI and the sub-subcomponents of the ChAT can be seen in Table 3.3 and subcomponents of the ChAT and

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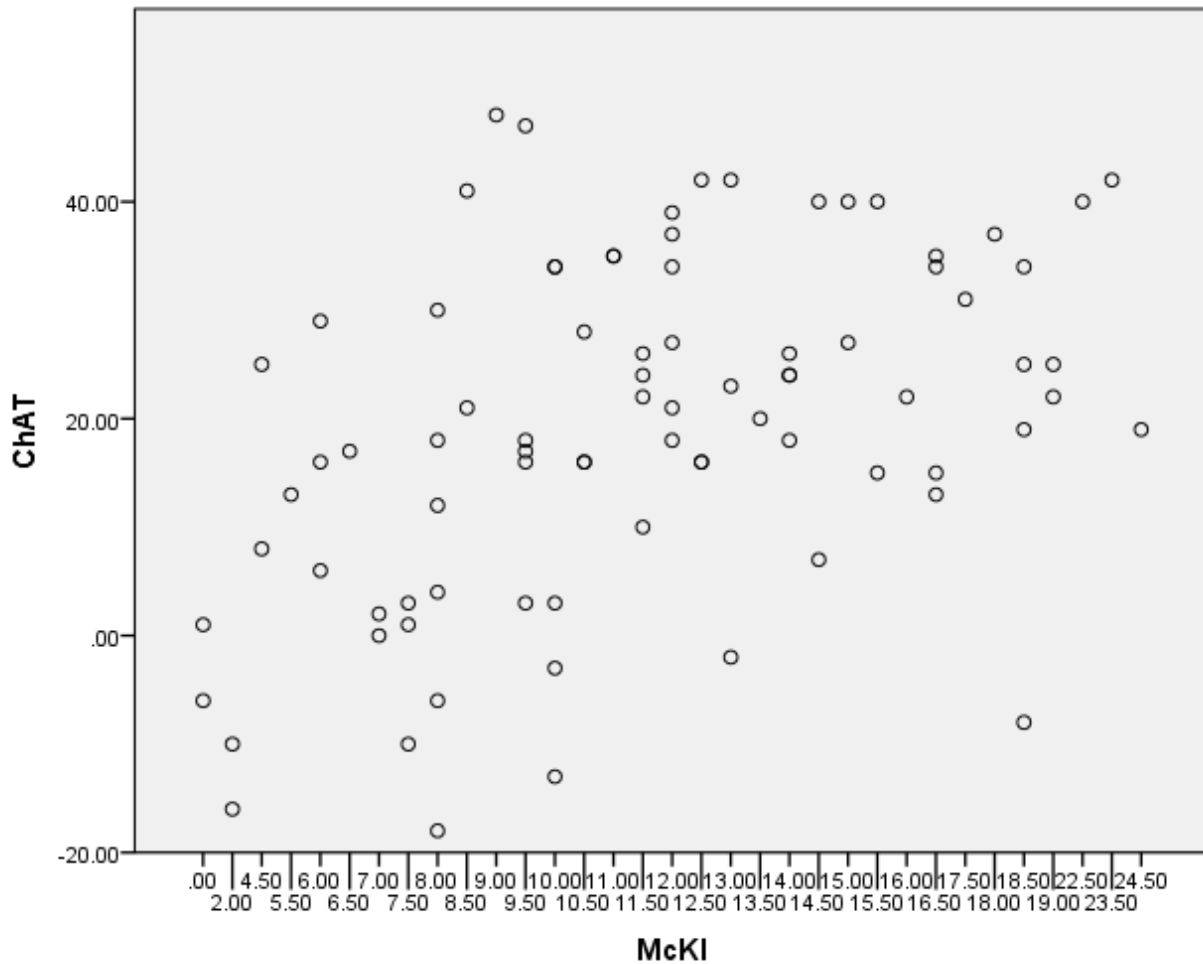McKI can be seen in Table 3.4 (for the complete correlation table, see Table 3.5 for more details).

Table 3.3.

Correlations between the metacognitive assessment measures (McKI and ChAT) controlling for age, executive function (HTKS), and expressive vocabulary (EVT).

	ChAT (overall)	MON	CONT	LMC
McKI	*r*=.39, *p*=.001	*r*=.30, *p*=.007 Awareness **.10, *p*=.39** CheckConst: **.04, *p*=.71** CheckPlan: **.27, *p*=.01** Eval **.15, *p*=.18**	*r*=.25, *p*=.03 Plan **.11, *p*=.34** Seek **.30, *p*=.007**	*r*=-26, *p*=.02 BrutForce **.04, *p*=.75** FocJoin **-.33, *p*=.002** FinError **-.001. *p*=.90** Repetition .**22, *p*=.04**

Next, the subcomponents of the McKI were examined: The metacognitive questions related to people (Questions 1, 4, 5, and 6)[4], the metacognitive questions related to tasks (Questions 2, 3, 9, 10, 13, and 14), and the metacognitive questions related to strategies (Questions 7, 8, 11, and 12) (See Appendix 3.B for all McKI questions). As can be seen in Table 3.4, significant and low to low-moderate correlations were found between the overall ChAT measure and the three McKI subcomponents. Furthermore, there were several significant

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[4] These subcomponents have not been validated nor do I consider them subfactors. As described earlier, conceptually, I designed the McKI to follow Flavell's original conceptualization (Flavell 1979) of metacognitive knowledge being broken into knowledge about people, tasks, and, strategies, and thus I included sub-groups of questions to address each category. The subcomponents were moderately reliable (α=.55 for McKI_Strategies; .62 for McKI_People; and .68 for McKI_Tasks, all *p*s<.001) though this is an area that needs to be rigorously examined in future research, such as a factor analysis with a larger sample.

relations found between the subcomponents of the McKI and the ChAT, particularly between the

McKI strategies subcomponent and at least one of each of the ChAT subcomponents.

Table 3.4.

Correlations between the McKI and ChAT subcomponent assessment scores controlling for age,

executive function (HTKS), and expressive vocabulary (EVT).

	ChAT (overall)	MON	CONT	LMC
McKI_ People	*r*=.32, *p*=.004	*r*=.28, *p*=.011 Awareness .15, *p*=.19 CheckConst: .11, *p*=.34 CheckPlan: .19, *p*=.09 Eval .19, *p*=.08	*r*=.22, *p*=.05 Plan .12, *p*=.29 Seek .24, *p*=.03	*r*=-.23, *p*=.03 BrutForce .04, *p*=.74 FocJoin -.25, *p*=.02 FinError -.06. *p*=.62 Repetition .01, *p*=.90
McKI_ Tasks	*r*=.24, *p*=.03	*r*=.23, *p*=.04 Awareness .004, *p*=.97 CheckConst: .05, *p*=.64 CheckPlan: .18, *p*=.10 Eval .17, *p*=.12	*r*=.13, *p*=.25 Plan .03, *p*=.80 Seek .18, *p*=.11	*r*=-.15, *p*=.18 BrutForce .006, *p*=.96 FocJoin - .23, *p*=.04 FinError - .04. *p*=.75 Repetition .27, *p*=.02
McKI_ Strategies	*r*=.44, *p*<.001	*r*=.31, *p*=.005 Awareness .11, *p*=.32 CheckConst: .02, *p*=.84 CheckPlan: .39, *p*<=.001 Eval -.04, *p*=.76	*r*=.36, *p*=.001 Plan .18, *p*=.10 Seek .41, *p*<=.001	*r*=-.32, *p*=.004 BrutForce .04, *p*=.72 FocJoin -.40, *p*<=.001 FinError .001. *p*=.94 Repetition .23 *p*=.04

Table 3.5

Correlations for all children controlling for age, executive function (HTKS), and expressive vocabulary (EVT).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. McKI	-	.39**	.30*	.25*	-.26*	.10	.04	.27*	.15	.11	.30*	.04	-.33*	-.001	.22*	.76**	.90**	.73**
2. ChAT		-	.88**	.78**	-.75**	.36**	.35*	.83*	.15	.50**	.78**	-.09	-.74**	-.13	-.03	.32*	.24*	.44**
3. Monitoring (MON)			-	.58**	-.51**	.29*	.45**	88**	.33*	.30*	.64**	-.10	-.46**	-.13	-.05	.28*	.23*	.31*
4. Control (CONT)				-	-.39**	.34*	.13	.62**	-.08	.80**	.87**	-.13	.25*	-.37**	-.17	.22t	.13	.36*
5. Lack of Monitoring & Control (LMC)					-	-.29*	-.30*	-.50**	.05	-.18	-.45**	.31*	.92**	.25*	.11	-.23*	-.15	-.32*
6. MON_ Awareness						-	-.07*	.09	.22*	.46**	.14	-.14	-.27*	.10	-.13	.15	.004	.11
7. MON_Checking Construction							-	.29*	-.24*	.27*	.24*	-.02t	-.24*	.05	-.22*	.11	.05	.02
8. MON_Checking Plan								-	-.01	.27*	.73**	-.10	-.46**	-.12	-.13	.19	.18	.39**
9. MON_Evaluation									-	.09	-.08	.16	.04	-.18	.06	.19	.17	-.04
10. CONT_Planning										-	.40**	-.12	-.15	.14	-.21t	.12	.03	.18
11. CONT_ Seeking											-	-.10	-.45**	.05	-.08	.24*	.18	.41**
12. LMC_Brute Force												-	-.01	-.06	.36**	.04	.006	.04
13. LMC_Focus Joining													-	.09	-.14	-.25*	-.23*	-.40**
14. LMC_Finishing Error														-	-.15	-.06	.04	.001
15. LMC_Repetition															-	.01	.27*	.23*
16. McKI_People																-	.54**	.33*
17. McKI_Task																	-	.24*
18. McKI_Strategies																		-

Note: $^t p = .05$; $^* p < .05$, $^{**} p < .001$

Convergent validity moderated by SES. To address whether the children's SES background would moderate the convergent validity between the McKI and ChAT measures, the relations between the measures were examined separately for the GSRP classes and the Tuition classes (see Tables 3.6 and 3.7). Focusing first on the overall correlations between the McKI and ChAT, while there was a significant (but low) correlation between the scores on the McKI and ChAT tools or the children in the GSRP classrooms, this was not true for the children in the Tuition-based classrooms (see Table 3.7). Furthermore, amongst the subcomponents of the ChAT measure, there were four significant correlations for the children in the GSRP classrooms' scores (rs between .25-.40), while there was only one significant correlation for the children in the Tuition-based classrooms' scores (r=.26, p=.01)

Table 3.6.

Correlations between the McKI overall and ChAT subcomponent scores for GSRP and Tuition preschool classrooms controlling for age, executive function (HTKS), and expressive vocabulary (EVT).

		ChAT (overall)	MON	CONT	LMC
McKI		**GSRP** r=.38, p=.01 **Tuition** r=.25, p=.12	Awareness CheckConst: CheckPlan **GSRP & Tuition** Eval	**GSRP** Plan Seek **GSRP**	BrutForce FocJoin **GSRP** FinError Repetition

A similar pattern of results was found for the subcomponents of the McKI measure. Eleven significant correlations were found for the children in the GSRP classrooms' scores (all

*r*s between .25-.46), while there was only three significant correlations for the children in the

Tuition-based classrooms' scores (*r*s=.26-.46).

Table 3.7.

Correlations between the ChAT overall and McKI subcomponent assessment scores for GSRP

and Tuition preschool classrooms controlling for age, executive function (HTKS), and expressive

vocabulary (EVT).

	ChAT (overall)	MON	CONT	LMC
GSRP **McKI_ People** *Tuition*	*r*=.40, *p*=.01	*r*=.27, *p*=.09 Awareness .19, *p*=.24 CheckConst: .002, *p*=.99 CheckPlan: .29, *p*=.06 Eval .02, *p*=.93	*r*=.46, *p*=.003 Plan .35, *p*=.02 Seek .46, *p*=.003	*r*=-.22, *p*=.18 BrutForce .09, *p*=.59 FocJoin -.25, *p*=.12 FinError -.08. *p*=.65 Repetition .06, *p*=.71
	r=.09, *p*=.59	*r*=.15, *p*=.36 Awareness .06, *p*=.70 CheckConst: .10, *p*=.54 CheckPlan: -.08, *p*=.61 Eval .36, *p*=.02	*r*=-.10, *p*=.54 Plan -.01, *p*=.95 Seek -.17, *p*=.32	*r*=-.20, *p*=.23 BrutForce -.09, *p*=.57 FocJoin -.17, *p*=.28 FinError -.04, *p*=.83 Repetition -.05, *p*=.76
GSRP **McKI_ Tasks** *Tuition*	*r*=.07, *p*=.65	*r*=.03, *p*=.85 Awareness -.27, *p*=.09 CheckConst: .02, *p*=.89 CheckPlan: .08, *p*=.64 Eval .02, *p*=.91	*r*=-.01, *p*=.95 Plan -.05, *p*=.76 Seek .03, *p*=.87	*r*=-.07, *p*=.69 BrutForce .06, *p*=.72 FocJoin -.16, *p*=.32 FinError -.04. *p*=.82 Repetition .46, *p*=.003
	r=.22, *p*=.19	*r*=.20, *p*=.23 Awareness .12, *p*=.46 CheckConst: -.06, *p*=.56 CheckPlan: .02, *p*=.89 Eval .38, *p*=.02	*r*=.15, *p*=.37 Plan .11, *p*=.53 Seek .13, *p*=.42	*r*=-.09, *p*=.56 BrutForce -.06, *p*=.73 FocJoin -.16, *p*=.33 FinError -.03. *p*=.87 Repetition .17, *p*=.31

GSRP **McKI_Strategies**	r=.44, p=.005	r=.32, p=.004 Awareness .15, p=.34 CheckConst: -.45, p=.78 CheckPlan: .40, p=.01 Eval .001, p=.99	r=.39, p=.01 Plan .28, p=.08 Seek .41, p=.01	r=-.29, p=.07 BrutForce .05, p=.77 FocJoin -.25, p=.03 FinError -.07. p=.67 Repetition .28, p=.08
Tuition	r=.33, p=.04	r=.16 p=.33 Awareness .01, p=.94 CheckConst: .01, p=.95 CheckPlan: .23, p=.15 Eval -.05, p=.78	r=.36, p=.10 Plan .13, p=.45 Seek .31, p=.05	r=-.32, p=.04 BrutForce .10, p=.54 FocJoin -.46, p=.003 FinError -.08. p=.64 Repetition .18, p=.28

Discussion

As described earlier, this is the first study to examine the convergent validity between two measures of early metacognitive processing in preschool-aged children though measurement experts have been recommending the use of a multitrait, multimethod (MTMM; Campbell & Fiske 1959 & Cook & Campbell 1979) approach for many decades. Moreover, at the Buros Symposium dedicated to research on Mc (see Schraw, 2000), this point was emphasized as being particularly important for the often conceptually and methodologically messy construct of Mc. The use of diverse assessment methods was recommended, with the idea of first examining convergent validity between measurement tools. Similar recommendations were still being made more recently for metacognition researchers focused on "understanding the construct being measured", "selecting the outcome that matches the construct being studied", and "using multiple outcome measures whenever possible" (Schraw 2009, p. 40). Despite these continued recommendations, most research focused on Mc does not follow these proposals put forth, particularly regarding multiple measurement tools or carefully aligning the tool with the construct being examined.

This study was designed to begin to address these issues by examining multiple measurement tools of early Mc, which has provided evidence in support of these recommendations. Had only one of the measurement tools been included in this study, very different information would have been inferred about children's metacognitive processing based on the Wedgits problem-solving puzzle task. This information will also allow future researchers to make more precise decisions about the selection of their outcome measures so that they align the construct that they are studying. For example, if a researcher would like to focus on children's McK about a task and how well they are able to articulate it, the McKI would be an appropriate tool whereas the ChAT would not. In contrast, if a researcher were searching for a tool to measure children's online/applied metacognitive behaviors (or how well children were able to apply metacognitive principles to a problem-solving task), the ChAT would be appropriate whereas the McKI would not. And, judging by the correlation of .39, these outcome measures should not be substituted for one another. This is particularly important to note because there are few instruments for assessing metacognitive processing at the preschool-aged level (Basilio & Marulis, 2014), thus, researchers must be careful when choosing among the few that do exist or further examine and validate the tools that exist. This caution comes on top of the general concern inherent to measuring early learning skills (e.g., Gelman & Baillargeon, 1983).

Therefore, this study has not only provided new measurement-related evidence for researchers studying early metacognitive processes but also evidence that preschool-aged children are far more metacognitive than previously thought. Overall, both measures revealed greater evidence of early emerging metacognition than previous studies (e.g., Flavell, 1979; Kreutzer, Leonard, & Flavell, 1975; Veenman et al., 2006) would have predicted. This was true for all classrooms, though the children in the Tuition-based preschool classrooms (from middle

to high-SES families) had significantly greater scores on both metacognitive assessments. The assessments were administered within the first few weeks of school, thus, it is probable that children between the GSRP and Tuition-based classroom had considerably divergent experiences prior to entering preschool. The children in the GSRP classrooms likely had considerably less experience with learning opportunities (e.g., Hart & Risley, 1995, 2003; Hoff, 2003; quality mother-child interactions, being read to and communicated with interactively, hearing decontextualized language, cognitive stimulation and support) than the children in the Tuition-based classrooms, which may partially explain the differences in early metacognitive processes. And, as described earlier, there are many other factors associated with low-SES family backgrounds (e.g., limited material resources; brain changes related to environmental factors) that are likely to be related to the differences in the GSRP and Tuition-based classroom metacognitive scores across the McKI and ChAT tools.

As hypothesized, a significant, but small (r=.39 overall) correlation between the interview measure (McKI) and the observational measure (ChAT) of metacognitive processes in young, preschool-aged children was found. The correlations between the components/subcomponents of the McKI and ChAT measurement tools varied, with several being significant, but only one correlation that was above .39 (r=.44 between the ChAT tool and the McKI_Strategies subcomponent. This was not surprising, as conceptually the questions regarding McK about the puzzle task strategies were the most similar to the use of metacognitive behaviors/strategies during the puzzle task. Though, it was interesting that even when there was conceptual similarity, the correlation still remained low-moderate; it was not true that the same children who were able to articulate their declarative McK about puzzle strategies were the same children who were able to successfully perform behaviors/strategies during the puzzle. Thus,

there was some overlap between the measures and their subcomponents but substantial unique elements left to explore. This indicates that early metacognitive processes—related to a problem-solving puzzle task—were not functioning as a unitary general skill.

The second, related, research question was whether the convergent validity (or lack thereof) between the McKI and ChAT measures would be moderated by the children's family background (SES). This was examined by comparing the McKI and ChAT (and subcomponent) scores from the children in the GSRP preschool classrooms to those of the children in the Tuition-based preschool classrooms. The metacognitive processes were substantially more nuanced for the children in the Tuition-based preschool classrooms than the children in the GSRP preschool classrooms. It seems that the metacognitive processes of the children from the low-SES family backgrounds functioned more generally that those of the children from higher SES families. However, even with the children in the GSRP preschool classrooms, there was still a considerable amount of unique variance to explore; the overlap between these metacognitive processes was not substantial even though there were far more instances of overlap than for the children in the Tuition-based preschool classrooms. This may be because the children in the GSRP preschool classrooms, from low-SES homes, have not have the same learning opportunities and experiences as the children in the Tuition-based preschool classrooms, and thus have not developed particular skills to be applied to particular tasks (or the knowledge regarding when and how to apply skills and knowledge to specific tasks). When separated into classroom groups, the metacognitive processes (McKI and ChAT) of the children in the Tuition-based preschool classrooms were not correlated. Thus, it appears that, with experience and knowledge, metacognitive skills become more nuanced (possibly mirroring the development of executive function skills from a unitary model of executive function at preschool-early

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elementary age to a multiple dimension model in older children and adults, e.g., Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000; Wiebe, Espy, & Charak, 2008). A review study that examined associations between Mc and giftedness in children support these results as well finding that giftedness was differentially associated with metacognitive skills (depending on what type of metacognitive skill was being investigated across studies reviewed; there were only developmental effects but no effects of giftedness found for cognitive monitoring but there were giftedness effects for declarative metacognitive knowledge for example). Mc should not be considered unidimensional term (Alexander, Carr, & Schwanenflugel 1995).

Limitations and Recommendations

There are several limitations to address, as well as recommendations for future research. First, though the ChAT observational measurement tool and its subcomponents have previously been examined and validated psychometrically (Bryce & Whitebread, 2012; Whitebread et al., in preparation), this is not yet true for the McKI and the subcomponents. Though the McKI has been found to have adequate reliability (re-test and the subcomponents hung together moderately, Marulis et al., submitted), it has not been comprehensively examined psychometrically or validated, such as through factor analysis. Thus, the McKI subcomponents that have been described and analyzed in this study are more conceptually-based than statistically validated. However, this type of validation analysis is planned for future studies with a larger sample[5]. Moreover, though the ChAT observational coding scheme has previously been

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[5] Another option would be to combine the samples from Study 1 (*n*=42; Marulis et al., submitted), from this study (*n*=83), and from my neurocognitive study (*n*=61; Marulis et al., 2013), which would result in nearly 200 children, which may be enough for a factor analysis study.

validated (Bryce & Whitebread, 2012; Whitebread et al., in preparation), this validation was conducted using a different, though similar, problem-solving task, the TTT described earlier. In the current study, the Wedgits problem-solving task, and the ChAT codes functioned similarly to the TTT and there is no reason to think that the validation would be different, however this should be investigated in future studies with larger samples as well[6].

Second, the children's metacognitive behavior that was assessed (using the ChAT observational coding scheme) was metacognitive skills specific to the Wedgits problem-solving puzzle task. Thus, my focus was relatively constrained. Children's monitoring or controlling of emotions or motivation were not coded, for example, during the Wedgits task; rather only the metacognitive behaviors they displayed related to the cognitive task were targeted. To control for children's emotional and motivation regulation, as much as possible, the Wedgits task was designed (including several pilot iterations) to be inherently motivating, fun, and the appropriate level of challenge for preschool-aged children (Berhenke, 2013; Marulis et al, submitted). However, children's monitoring and control of their emotions and motivation were not accounted for in this coding scheme even though being able to monitor and control emotions and motivation is important to being able to successfully apply metacognitive skills to a cognitive task like the Wedgits problem-solving puzzle task. This is something that I plan to take into consideration in future studies.

Third, because both of the metacognitive measurement tools were applied to one specific cognitive task (the Wedgits puzzle task), it is not possible to know whether these findings of low

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[6] In addition, because I had to eliminate two of the ChAT codes (CONT_Sorting and LMC_Goal Neglect) due to limited child behaviors qualifying for these codes, the ChAT coding scheme adapted for the Wedgits task with these codes eliminated should be validated in the same way that the original ChAT scheme has been validated.

overlap between the McKI and ChAT would generalize beyond this specific task. However, previous studies (Bryce & Whitebread, 2012; Whitebread et al., in preparation) have similar metacognitive findings regarding the ChAT tool, suggesting the current findings may generalize. Furthermore, this task does not require previous knowledge and is designed to be relatively domain-general. Accordingly, it seems likely that the findings would generalize to other problem-solving tasks, though future investigations should empirically examine this. Future studies should also be designed using cognitive tasks that tap different areas of cognition such as attention or memory and specific content areas such as mathematics or science. The McKI and ChAT can fairly easily be adapted to these different areas and domains of cognition, though it is important that the task have a plan for the child to follow. However, it remains an open question whether early metacognitive processes are similarly nuanced across domains and aspects of cognition as they are specific to the Wedgits problem-solving task. These are important developmental questions to pursue.

Fourth, though some general overlap was found (potentially, a general metacognitive functioning skill), there was a considerable amount of unique variance across the McKI and ChAT measurement tools, that could not be fully explained by articulation or verbal skills due to the expressive language covariate (the correlation including these covariates was $r=.39$; without these included, it was $r=.50$, both ps<.001). Furthermore, this variance was not explained by general EF skills (including working memory, response inhibition, and cognitive flexibility). However, it may be that including a general IQ or cognitive development covariate would help explain the variance, though this is challenging to assess at the preschool-level. It seems more likely that these metacognitive skills are relatively independent of one another and should be viewed in that way rather than labeled under the same umbrella term. For this reason, researchers

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should be more precise about labeling metacognitive terms and using these constructs (i.e., conceptualizing and assessing) in their research. For example, using metacognitive knowledge for the McKI and metacognitive behaviors/skills for the ChAT.

Finally, ceiling and floor effects were not able to be examined in either the McKI or the ChAT measures. Based on a previous study (Marulis et al., submitted) it does seem that, after 6 years of age, the McKI would be inappropriate and ceiling effects would be found, and that the McKI may be too difficult for children under the age of 3. The ChAT has previously been used and validated with children from 3-7 years old (Bryce & Whitebread, 2012; Whitebread et al., in preparation). Because the ChAT involves frequency counts and there are no standards for this age group, there are no ceiling or floor effects. As in the previous studies, the coding scheme was developmentally appropriate for the children in this study. Future studies should investigate ceiling and floor effects systematically along with other psychometric properties of the McKI and ChAT specific to the Wedgits puzzle task.

Conclusion and Implications

Regardless of the limitations described—many of which I plan to address in future investigations—this study examined an important area of early cognitive development: how early metacognitive processes function in preschool-aged children and whether Mc is a singular or more nuanced construct. This study provided valuable information regarding the measurement of early metacognitive processing and was designed to address the broader issue of conceptualizing and assessing early metacognitive development comprehensively. Using a structured interview tool like the McKI combined with a systematic behavioral observation tool like ChAT is the ideal way to comprehensively assess young children's metacognitive processes.

This allows for the "best of both worlds" by limiting verbalization requirements during the observation task (ChAT) while also providing opportunities for children to elaborate on and explain their behavior and thinking about the task after completing the cognitive task (which is only four minutes long, so there was not a lot of time in between the task and the interview questions). Furthermore, from a psychometrics perspective, as discussed previously, this allows for a MTMM approach with different sources of error.

This is important for conceptualizing as well as measuring this important skill, which is potentially vital to moving forward in examining this construct for its association to and predictive power for cognitive development and academic success, particularly for children at risk for learning difficulties (Matthews et al., 2010; Sektnan et al., 2010). In turn, this is crucial to my long-term goal of informing and designing effective metacognitive interventions to affect the developmental and academic trajectories for all young children, beginning in preschool when these skills may be most malleable and interventions most sustainable (Heckman & Masterov, 2007; Li, Farkas, Duncan, Burchinal, & Vandell, 2013).

Appendix 3.A. Wedgits problem-solving puzzle task

Achievement Motivation (mastery/performance orientation): Wedgits puzzle and questions

Researcher instructions:
1. Make sure the camera is pointed at the child and recording; make sure that you will not block the camera when you sit down.
2. Show the child the blocks and the design on the first card. Say, **"First, I want you to make the blocks look exactly like the blocks in this picture. Can you make the blocks look like this picture?"**
3. Let the child work until he/she is finished. You can help him/her if he/she does not understand how to make the blocks look like the card.
4. Now show the child the design on the second card. Say, **"You did a great job with that! Now, I want you to make the blocks look exactly like this picture."**
5. Let the child work without helping him/her. Stop the child at 4:00 if he/she is still working.
6. If the child takes less than 4 minutes to finish puzzle 2 (most children), skip to step 7. Otherwise, tell the child, **"We are out of time. If we had more time, would you want to work more on this one** (*hold up the first picture*) **or this one** (*hold up the second picture*)**?"** Record child response. **"Why?"** Record child response.
7. Now show the child the design on the third card. Say, **"You did a great job with that one, too! Let's do another one. Make the blocks look exactly like this picture."**
8. Let the child work without helping him/her. Stop the child at 4:00 if he/she is still working. (virtually all children)
9. Tell the child, **"We are out of time. If you had more time to work, would you like to keep trying this one** (hold up the picture of the last completed puzzle) **or build this other one again** (hold up the last picture)**?** Record child response. **"Why?"** Record child response.
10. Ask the child, **"How hard was the last puzzle?** (*Point to it*) **Was it easy, a little hard, or very hard?"**

Puzzle #1 (Easy)	
Completed?	
Time to completion	
Time on task	
Puzzle #2 (Medium)	
Completed?	
Time to completion	
Time on task	
Puzzle #3 (Hard; if necessary)	
Completed?	
Time to completion	
Time on task	

"If you had more time to work, would you like to keep trying this one or build this other one again?"

☐ The easier, completed puzzle
☐ The harder, incomplete puzzle

Why did the child want to try that one again?

_____

_____

How hard did the child think the last puzzle was?
☐ Easy ☐ A little hard ☐ Very hard

Appendix 3.B. Metacognitive Knowledge Interview (McKI)

Use this protocol after children have completed the Wedgits puzzle task: Once the Wedgits puzzle task is complete, tell child: **"Thank you for working on the puzzles! I would like to talk to you about the puzzles you just did and about your thinking. My job is to learn about how kids learn and think and I have a few questions for you, Okay?"** Once child assents, say**: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer."** (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. **"Do you think you did a good job, an okay job or not so good of a job on the puzzles?"** Circle child's response. If they say they did a good job, ask **"What did you do to help you do a good job?"** If they answer okay or not so good, ask **"What do you think would have helped you do an even better job?**
2. **"Did you think anything was hard?"** If no, ask: **"Why not?"** If yes, ask **"Why? What would have made it easier?"**
3. **"Will it be harder/easier when you're older? Why?"**
4. **"Would these puzzles be hard for another kid your age? Why/why not?"**
5. **How did you know if you were getting the puzzles right?"**

I know a kid named Gogi and he/she (use same gender as the child) **is from another land. S/he doesn't know anything about puzzles like the ones you just did. Will you help Gogi learn about these kind of puzzles?"** Wait for child to assent and say**: "Thank you."** (If they don't agree, try to prod them by saying that 'Gogi really needs your help and wants to learn about these kind of puzzles'.)

6. **"Would these puzzles be easier for Gogi or you? Why/Why not?"**
7. **"What should Gogi do if s/he is having trouble with the puzzle?"**
8. **"Would it be helpful for Gogi to talk to herself/himself about the puzzle while doing the puzzle? Why would/wouldn't that be a helpful thing to do?"**
9. **"Would the puzzle be easier with bigger or smaller pieces? Why?**
10. **"If all of the puzzle pieces were the same color, like in this picture** (show the Wedgits booklet of all purple Wedgits) **will the puzzle be easier?** If yes, ask: **"Why?"** If no, ask, **"Why not?"**
11. **"If you think about how the pieces would fit together before I try, will the puzzle be easier?** If yes, ask: **"Why?"** If no, ask, **"Why not?"** What if you figured out how to do it first? Why/Why not?"**
12. **"If you gather (demonstrate) the pieces you will need first and then build the puzzle, will it be easier? Why/Why not?"**
13. **"What if you were watching TV while you were building it, will it be easier? Why? /Why not?"**
14. **"If you close your eyes while doing the puzzle, will it be easier?** If yes, ask: "**Why?"** If no, ask, **"Why not?"**

"Thank you for sharing all of your ideas and how you think with Gogi!"

Appendix 3.C. Metacognitive Knowledge Interview (McKI) Codebook and Annotated Scoring

The Metacognitive Knowledge Interview (McKI) assesses children's metacognitive knowledge (or knowledge about individuals, tasks and strategies) individually using a series of 14 questions related to the Wedgits task [in which children are shown design cards of increasing difficulty and are asked to make the Wedgits building blocks look exactly like the picture on the card. All children completed the first puzzle. If they finished the second in less than four minutes, they were given a third card. After they had tried a puzzle for four minutes unsuccessfully, they were stopped, and asked, "If you had more time to work, would you like to keep trying this one (the uncompleted one, indicating a mastery goal) or build this other one again (the one they previously completed, indicating a performance goal)? Why?"]. For example, children were asked "Would talking to yourself during the puzzle be helpful? Why/why not?"

TO SCORE:

Rate responses to questions on a 0-2 scale for each question where:

- 0=Not at all metacognitive
    - Response does not refer to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy.
        - E.g., child disagreed that talking to oneself can be helpful in solving a task without an appropriate explanation (e.g., said "I don't know" or "because I don't like to do it". *NOTE: child could receive the full score (2 points) for a negative response to this question IF she or he provided a metacognitive explanation such as talking to oneself is not helpful because it will distract their thinking or make them not be able to attend to the task. The full points refer to an "appropriate metacognitive response"; thus yes OR no could be a fully metacognitive response depending on the explanation.
- 1=Partially metacognitive
    - Response refers to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy but not completely/fully or without an explanation that backs up the response.
        - E.g., child agreed that talking to oneself can be helpful in solving a task but their reason was not related to cognition (e.g., because it's fun) or they didn't know why.
- 2= Appropriately/fully Metacognitive
    - Response refers to knowledge about the child's thinking or cognitive ability/capability; the difficulty of the task itself or the efficacy/efficiency of a strategy in a complete/full way or with a metacognitive explanation that backs up the response.

- E.g., child agreed that talking to oneself can be helpful in solving a task because it helps them remember how to do the task/ helps their brain think better, etc.
- **OR** child disagreed that talking to oneself is helpful because it would distract them.

If the child doesn't/won't answer, *he/she will be given 0 points for that response* (NR=no response) and coded as "999". If the child says "I don't know", she/he will be given 0 points for that question/portion of the question and coded as (DK=don't know) "999".

The full set of questions is below including example responses and scoring. The actual scores given for this child are indicated along with what would qualify for the other levels of scoring.

Once the Wedgits puzzle task is complete, tell child: **"Thank you for working on those puzzles! I would like to talk to you about the puzzles you just did and about your thinking. My job is to learn about how kids learn and think and I have a few questions for you, Okay?"** Once child assents, say**: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer."** (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. **"Do you think you did a good job, an okay job or not so good of a job on the puzzles?"** Circle child's response. If they say they did a good job, ask **"What did you do to help you do a good job?"** If they answer okay or not so good, ask **"What do you think would have helped you do a better job?** My brain-that controls my whole body.
   2 points. His knowledge of how well he performed on the task was accurate. He performed above his age level by completing the second challenging puzzle accurately and quickly and nearly completed the 3rd puzzle (designed for children older than preschool and chosen to pose a challenge sufficient enough for children this age to be unable to complete accurately, particularly within four minutes). Further, he showed metacognitive knowledge about himself and what helped him/would help him do a good job on puzzles-his brain.
   A score of 1 would be either an inaccurate assessment of one's performance on the puzzle or an accurate response to this with a non-metacognitive response to what would help do a good/better job such as "being good" or "doing a good job". If a child accurately assessed his/her Wedgit performance and gave a partial metacognitive response (such as: "liking the puzzle" because it is possible that higher enjoyment/interest in a task leads to higher performance but this response does not fully spell this out. Or responding to the question "What did you to do help you do a good job" with: "I tried hard" without elaboration.) He/she could get 1.5 on this question. 0 points would be given if the child was metacognitively inaccurate about his/her performance along with a non-metacognitive follow-up response.

2. **"Did you think anything was hard?"** If no, ask: **"Why not?"** If yes, ask **"Why? What would have made it easier?"** My brain focuses when I'm doing puzzles
   1 point. He said nothing was hard but other comments he made during the third puzzle indicated that there were parts he found very difficult. However, he had good metacognitive knowledge regarding why it didn't seem difficult-he was aware that by being able to concentrate and maintaining focus (with your brain), the task will likely be/seem easier.

A child whose response to whether anything was hard matches his/her comments/emotional response to the puzzle would get a full point for that part of the question and another full point for why he/she didn't find it hard-e.g., the type of response given here. If the child said something was difficult (and this matched his/her response to the puzzle) and also responded with a metacognitively aware answer regarding what would have made it easier-e.g., having help from an adult/older child or getting a hint, she/he would receive 2 points.
A score of 0 would be given if the child was metacognitively inaccurate about his/her performance along with a non-metacognitive follow-up response to Why/Why not.

3. **"Will it be harder/easier when you're older? Why?"** Easier, because I will be bigger and more growned up. I will learned more in school and I will know more about puzzles then so it will be easier.
2 points. He was aware and responded that the puzzle will get easier as he gets older, not only because of maturation, but because he will learn more (about strategies/problem-solving) which is learned in school as he mentioned, and with this knowledge, these puzzles will be easier.
A score of 1 point would be obtained if the child had responded that the puzzle would be easier without an explanation (or with an explanation such as "I don't know" or "I like it").
A score of 0 would be obtained if the child had responded that the puzzle would be harder without a metacognitive explanation.

4. **"Would these puzzles be hard for another kid your age? Why/why not?"** No, I don't know.
1 point. His answer matches the one above as to whether the task would be difficult depending on age but didn't give a response as to why he thought this.
In order to receive 2 points, a child would have to either match the response to Question #2 (e.g., if they said the puzzle was/wasn't difficult for them) and follow with a metacognitively aware response as to why such as "these puzzles are hard for 4 year olds" or "we have these in our classroom so they're not hard for us" OR, the child could have a different response with a metacognitively aware answer as to why such as "Yes, they would be hard for other kids my age because they don't have them at home like I do" or "No, they wouldn't be hard for other kids my age because they are better at puzzles than me".
0 points would be given if the child gave an answer that didn't match #2 and gave a non-metacognitive follow-up response to Why/Why not.

5. **How did you know if you were getting the puzzles right?"** I looked at the picture.

2 points. He was aware not only of what strategy would be helpful in accurately completing the task but of which strategy he actually used while doing the task (this can be discerned by watching the video or noting whether the child actually used this strategy during the task).

A child would be given 1 point if gave a partially metacognitive response such as "I thought about it hard".

0 points were given for non-plausible/ non-metacognitive responses such as "I just knew" or "because I'm smart/good".

"**I know a kid named Gogi and he/she** (use same gender as the child) **is from another land. S/he is the same age as you but has never seen puzzle like the ones you just did and doesn't know anything about puzzles like these ones. Will you help Gogi learn about these kinds of puzzles?**" Wait for child to assent and say: "**Thank you.**" (If they don't agree, try to prod them by saying that 'Gogi really needs your help and wants to learn about these kind of puzzles'.)

6. "**Would these puzzles be easier for Gogi or you? Why?**" A lot; I focus a lot
   1 point. He was metacognitive in asserting that he (would had experience with puzzles and was from a school/had teachers who taught about puzzle and puzzle-related tasks) but not in his response as to why. It is metacognitive to understand that focusing helps improve performance, but in this instance, the question was about why he would have an easier time than Gogi.
   In order to receive 2 points, a child would have to say something like "I have already done those puzzle" or "I know all about puzzles and Gogi doesn't know about them at all".
   0 points are given if the child chose Gogi without a metacognitive explanation. The child could receive 1 point by choosing Gogi but giving a metacognitive response as to why such as "He looks smarter with that big brain (the toy had a brain external to his head)."

7. "**What should Gogi do if s/he is having trouble with the puzzle?**" Ask someone.
   2 points. He his answer reflected metacognitive awareness of a good strategy to use when encountering trouble (e.g., help-seeking).
   To receive 1 point, a child could respond with an answer that indicates some awareness of cognitive states but not of a (potentially) successful strategy, such as "Try it" (if the child had added "harder" or "again" after "Try", she/he would receive the full 2 points).
   A score of 0 would be a response such as "Be good" which is not at all indicative of awareness of cognitive strategy.

8. **"Would it be helpful for Gogi to talk to herself/himself while doing the puzzle? Why would/wouldn't that be a helpful thing to do?** Yes-he has to focus and get concentration. Talking to yourself does that.

2 points. He is both metacognitively aware that talking to oneself about a task while performing it can be cognitively helpful and why.

1 point would be given if the child answered "Yes" but didn't know why or gave a non-metacognitive response as to why such as "It helps" or "It's good".

0 points is given for an answer of No without a metacognitive explanation. The child could receive 1 point by responding "No" but giving a metacognitive response as to why such as "Because if you talk you might get distracted and do a bad job on the puzzle".

"**Gogi has some questions for you about puzzles like this one. Okay?"** She/he would like to know more about puzzles like this one.

For the last 4 questions, there was an intended 'correct' answer in that one response would make the puzzle task easier (as confirmed by asking adults these same questions). Thus, the child would get 1 point for answering correctly/metacognitively accurately and another 1 point for giving a metacognitively aware response as to why this was true. *However,* **it became apparent after conducting several interviews that children sometimes viewed the strategies differently. Thus, if they responded differently than the adults to which situation would make the puzzle easier but gave a metacognitive response that appropriately made the first response defensible, he/she received the full 2 points (if there was no response given to back up their answer or a non-metacognitive response given, the score would be 0. In contrast, if the child responded as adults did to the first part but did not respond to the second part or responded non-metacognitively, she/he received 1 point). For example, if the child responded that the puzzle would be easier with smaller pieces because** *smaller* **pieces are easier to manipulate/hold in their hands (because children have smaller hands) for example.**

9. **"Would the puzzle be easier with** ==bigger== **or smaller pieces? Why?"** Easier to hold in your hands and make the puzzle with.

2 points. He responded like adults for bigger pieces and gave a response that, while not as cognitively related as adults answered-e.g., "less pieces to have to figure out how to fit together or less intricate designs", it was a plausible (metacognitive) reason as to why bigger pieces make doing a puzzle easier.

1 point would have been given if there was no response to "Why" or he had said something like "It's better".

0 points would have been given if he had said smaller was easier and given no response to "Why" or he had said something like "It's better".

10. **"If all of the puzzle pieces were the same color, will the puzzle be easier?** If yes, ask: **Why?** If no, ask, **"Why not?"** I can't figure out which one goes where.

2 points. He responded like adults and gave a metacognitive response to "Why not". 1 point would have been given if there was no response to "Why" or he had said something like "It's harder like that". 0 points would have been given if he had said "Yes" with no response to "Why" or he had said something like "It's just easier". However, 2 points would have been given if he had said "Yes" along with a metacognitive response such as "Then you would be able to sort by size" (indicting less cognitive load because you don't have two dimensions on which to sort).

11. **"If I think about how the pieces would fit together before I try, will the puzzle be easier?** If yes, ask: **Why?** If no, ask, **"Why not?"** Because it is (*demonstrated 'thinking' and putting the pieces in the right places*).

1 point. He responded as adults would but did not give a metacognitive response to "Why" (though his demonstration came close, but even after being prompted after this enactment, he did not respond with any indication of metacognitive awareness. 2 points would have been given if his second response was something like "because it helps me focus on the puzzle" or "I'd have more time to figure out the right place". 0 points would be given for a response of "No" with no response as to "Why not" or a non-metacognitive response such as this one "Because it isn't".

12. **"If you gather (demonstrate) the pieces you will need first and then build the puzzle, will it be easier? Why/Why not?"** No, that won't be easier. I don't know why.

0 points because the child was not aware and did not respond that gathering the pieces you would need first would make the task easier (using an organizational strategy) and also did not explain his answer metacognitively to justify his negative response.

1 point could have been given if he had said Yes, it would have made the puzzle easier but he didn't know why.

2 points could have been given if he had said Yes, it would have made the puzzle easier to gather the pieces first before building with an explanation related to organizing the pieces/his thinking or helping him think about how the puzzle would go together.

13. **What if you were watching TV while you were building it, will it be easier? Why? /Why not?"** No, I don't think so…. I don't think it would be easier.

1 point. He was aware and responded that watching TV at the same time as building the puzzle would not make it easier. However, he did not have an explanation as to why this would be beyond tautological reasoning.

A child could receive 2 points if he or she had responded that No the puzzle would not

be easier because they would be distracted or it would be harder to concentrate or something along those lines.
0 points would be given if the child responded that the puzzle would be easier without a metacognitive explanation.

14. **"If you close your eyes while doing the puzzle, will it be easier?** If yes, ask**: Why?** If no, ask**, "Why not?"** No, he can't see what he's doing! He couldn't see if he had the right piece or the right place on the card *(pointed to the design picture card*)".
2 points. He responded like adults and gave a metacognitive response to "Why not". He would have been given 1 point for not responding to "Why not" or giving a non-metacognitive response such as this one "Because it isn't easier". 0 points would be given for a response of "Yes" with no response to "Why" or without a metacognitive response to defend this (see above-adults were unable to come up with a way to metacognitively defend this answer except possibly by discussing how other senses may become more acute, but this still wouldn't make the puzzle easier though a case may be able to be made for equally easy").

"Thank you for sharing all of your ideas and how you think with Gogi!

*Notes***:** *While he was building the puzzle, he made a lot of metacognitive (evaluative) comments such as "I built this one before so I'm good at it." And for the most challenging puzzle, he said "OOOh, I can't do that one!" Then as he worked on it, he said "I'm having trouble with this part" (he didn't successfully complete it but was close).*

Appendix 3.D. Wedgits Puzzle Scoring

1. Rate the accuracy of the child's performance on the Wedgits task. These coding categories were designed to match the Metacognitive Knowledge Interview (McKI) in which the child is asked how well she or he did on the puzzle (Question #1).

    a. **Good**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first and second puzzles within the time allotted (4 minutes). The child may have started (or completed) a third or even fourth puzzle, but this is not required to receive a score of "Good".

    b. **Okay**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first puzzle within the time allotted (4 minutes) and accurately completed at least half of the second puzzle (i.e., completed the bottom half— that looks like a pyramid—and the green piece that is placed vertically in the pyramid).

    c. **Not so good**= Child accurately (e.g., the puzzle looked exactly like the picture card) finished the first puzzle within the time allotted (4 minutes) and started the second puzzle but did not accurately complete half of the second puzzle (i.e., did not complete the bottom half that looks like a pyramid).

Appendix 3.E. Children Articulating Thinking (ChAT) coding scheme.

Code name and description	Example
Monitoring behaviors	
Checking Own, a pause to review whole of own construction. Not checking only one area.	Child pauses and looks at whole train track they have made so far.
Checking Plan, checking the original train track plan.	Child glances back to plan of train track they are working on.
Prospective Monitoring, judgement of task before task begins.	*This is going to be a challenge!*
Clarification, clarifying task demands. Can be before or during task.	*Do I use all the pieces?*
Reviewing, a pause to look at different pieces before or during task, not seeking any particular piece. Lasts for at least 3 s.	Child glances around all the pieces of train track.
Self-questioning, child highlights a problem to be solved, poses themselves a question.	*How will it curve around?* (to self)
*Task Difficulty, child comments on task difficulty during task.	*This one is actually very difficult!*
*Error Detection, a pause or comment that clearly shows they have noticed an error. Could follow checking or be spontaneous.	Child pauses and makes a face while looking at problem area. *That's not right!*
Commentary, comment on success, what has been achieved so far.	*There, that's a tiny bit better. Right, that bit is done…*
*Using Other for Monitoring, identifying help is needed but not asking, looking to experimenter.	*I can't do this bit* (child looks to experimenter but does not ask for help).
Evaluation, spontaneous evaluation of product at the end of the task.	*But that bit isn't right.*
Justified Termination, child announces task is finished, without being prompted, is correct.	*There. Finished!*
Memory Monitoring, child comments or indicates that they are struggling with their memory.	*Oh, I can't remember…* Makes a 'memory' face.
Control behaviors	
Clearing Space, child clears space in which to work or starts working in an already empty space.	Child clears a space on the table with hands before placing first piece down.
Planning, explicitly stating a plan. Can be before, or during the task.	*I'm going to do these straight bits first.*
Sorting, organising or grouping materials before and during task. Includes adding pieces symmetrically.	Child compares the lengths of two straights.
Seeking, searching for materials before and during task. Lasts for at least 2 s.	Child searches for large curve. *Do you have straights?*
*Requesting Help, realising at an appropriate point that they cannot do something and asking for help.	*Can you help me join them up?*
Change Strategy, using a different strategy or piece than before. Not just first strategy or piece chosen.	Child reverses piece of track so that it curves in the correct way.
*Gesture, the use of gesture to support cognitive activity or communication.	Child traces the shape they need with their finger.
Memory Aid, the use of a memory aid or labeling the train track shape.	*It's the shape of B* (about goggle shape).

From Bryce & Whitebread, 2012, p. 203

Appendix 3.F. ChAT coding scheme from Bryce & Whitebread 2012: Codes used

	Number (%) of 5-year-old children who show this behaviour (total N=34)	Number (%) of 7-year-old children who show this behaviour (total N=32)
Monitoring Codes		
Checking Own	34 (100)	32 (100)
Checking Plan	31 (91)	31 (97)
Prospective Mon	8 (24)	5 (16)
Clarification	2 (6)	5 (16)
Reviewing	24 (71)	18 (56)
Self-questioning	4 (12)	4 (13)
Task Difficulty	10 (29)	6 (19)
Error Detection	19 (56)	21 (66)
Commentary	10 (29)	11 (34)
Use other for Mon*	20 (59)	9 (28)
Evaluation	5 (15)	3 (9)
Justified Termination*	21 (62)	25 (78)
Memory Monitoring	2 (6)	6 (19)
Control Codes		
Clearing Space*	18 (53)	28 (88)
Plan*	19 (56)	15 (47)
Sorting	17 (50)	12 (38)
Seeking*	27 (79)	31 (97)
Request Help	3 (9)	1 (3)
Change Strategy	33 (97)	31 (97)
Gesture	16 (47)	14 (44)
Memory Aid	7 (21)	2 (6)
Failure of Monitoring and Control		
Perseveration	27 (79)	24 (75)
Distraction	8 (24)	3 (9)
Off-task*	9 (26)	2 (6)
PersAndDis	30 (88)	26 (81)

Number and percentage of children in each group who showed each of the individual behavior codes. Those shaded grey were shown by less than 25% of children in each group, and although they contribute to the macro-level codes they will not be analyzed in terms of individual behaviors. Those with * show a significant chi-squared result between the age groups

From post-hoc analyses conducted by Donna Bryce and Deborah Pino-Pasternak 2013

Appendix 3.G. Adapted ChAT coding scheme.

		Description	Example (Verbal)	Example (Non-Verbal)
MONITORING		**Awareness:** Reference to previous knowledge or current understanding about the task	"It is good that you can use the pieces on either side"	This behavior is evidenced through children's verbalizations only
		Checking Construction: The child checks at his/her own construction	This behavior might be accompanied by verbalizations such as "Let me have a look…"	Characterized by a clear pause and glance directed at the track made so far
		Checking Plan: The child checks at the plan before continuing building the track	This behavior might be accompanied by verbalizations such as "Let me see…"	Checking behavior is characterized by a clear pause and glance directed at model
		Evaluation: Assessment of task difficulty, own competence, and quality of construction.	"This is tricky" "I can't take it apart"	The child smile after finishing the track
CONTROL		**Planning:** Verbalizations that precede the actual behavior and indicate future actions	"I'm going to do the straight bits first"	This behavior is evidenced through children's verbalizations only
		Seeking: The child seeks materials before and during the task or seeks the correct position of a particular piece before placing it	"Curvy bits, curvy bits…" (while looking for them)	The child looks around at different pieces, selects one and places it straight away

	Sorting: The child sorts, organizes, groups materials or arranges the space/own construction before or during the activity	"I will put this (the plan) on the side"	The child compares the length of two pieces The child groups all similar pieces together
LACK MON/CONT	**Brute Force:** When a piece won't fit, the child tries to force it	This behavior is observed through the child's actions	The child uses both hands to push a piece down
	Focus Joining: Focus on joining the track up rather than copying the shape in the model	This behavior is observed through the child's actions	The child focuses exclusively on joining the track, failing to consider previous errors
	Finishing Error: The child claims he is finished when there is a major discrepancy between the track and the plan	"I'm done!" "Finished"	This behavior is evidenced through children's verbalizations only
	Goal Neglect: The child shows awareness of error but does not act accordingly	"This one is bigger than the other" (but does not fix it)	This behavior is evidenced through children's verbalizations only
	Off-Task: The child gets distracted or engages in irrelevant conversation	"Do you know Ms. Smith, my mom's friend?"	Child gets distracted by looking at the window
	Repetition: The child repeats an incorrect placement or piece selection	This behavior is observed through the child's actions	The child takes a long curve, tries and it doesn't fit, removes the piece and then immediately selects the same type of piece again

From Whitebread, Pino-Pasternak, Marulis, Okkinga, & Vuillier, in preparation

Appendix 3.H. Adapted ChAT (Children Articulating Thinking) Metacognitive Behavior Coding Scheme

	Description	Example (Verbal)	Example (Non-Verbal)
MONITORING	**Awareness:** Reference to previous knowledge or current understanding about the task.	"It is good that you can use the pieces on either side"	This behavior is evidenced through children's verbalizations only.
	Checking Construction: The child checks at his/her own construction.	This behavior might be accompanied by verbalizations such as "Let me have a look…"	Characterized by a clear pause and glance directed at the puzzle made so far.
	Checking Plan: The child checks at the plan (model card) before continuing building the puzzle.	This behavior might be accompanied by verbalizations such as "Let me see…"	Checking behavior is characterized by a clear pause and glance directed at model.
	Evaluation: Assessment of task difficulty, own competence, and quality of construction.	"This is tricky." "I don't know how to make this one." "I did it!"	The child smiles after finishing the puzzle.
CONTROL	**Planning:** Verbalizations that precede the actual behavior and indicate future actions.	"I'm going to do the small (or top) pieces first."	This behavior is evidenced through children's verbalizations only.
	Seeking: The child seeks materials before/ during the task or seeks the correct position of a particular piece before placing it.	"Yellow piece, yellow piece …" (while looking for the yellow Wedgit block).	The child looks around at different pieces, selects one and places it straight away.
	Sorting: The child sorts, organizes, groups materials or arranges the space/own construction before or during the activity.	"I will put this (the plan) on the side."	The child compares the shape/color of two pieces. The child groups all similar pieces together.

LACK MON/CONT	**Brute Force:** When a piece won't fit, the child tries to force it.	This behavior is observed through the child's actions.	The child uses both hands to push a piece down.
	Focus Joining: Focus on joining the puzzle pieces together up rather than copying the shape in the model.	This behavior is observed through the child's actions.	The child focuses exclusively on joining the pieces together, failing to consider previous errors (i.e., building a tower rather than the same tower on the plan/ model card)
	Finishing Error: The child claims to be finished when there is a major discrepancy between the puzzle he/she built and the plan (model puzzle).	"I'm done!" "Finished."	This behavior is evidenced through children's verbalizations only.
	Goal Neglect: The child shows awareness of error but does not act accordingly.	"This one is bigger (or a different color) than the one on the card" (but does not fix it).	This behavior is evidenced through children's verbalizations only.
	Repetition: The child repeats an incorrect placement or piece selection.	This behavior is observed through the child's actions.	The child takes a green Wedgit block, tries and it doesn't fit, removes it and immediately selects the same block again.

Adapted from Whitebread, Pino-Pasternak, Marulis, Okkinga, & Vuillier, in preparation (whose coding scheme was adapted from Bryce & Whitebread, 2012 and Whitebread et al., 2009)

Appendix 3.I: The Head-Toes-Knees-Shoulders (HTKS) measure of Executive Function

Head-Toes-Knees-Shoulders (HTKS)

General Guidelines

- **Administration:**
  - There are specific instructions to the assessor that are in *italics* and should NOT be read to the child.
  - Dialogue to be read to the child is generally located within a ⬚ Text box ⬚ and in bold font, read the dialogue aloud **verbatim**. Do not make any changes or additions to the dialogue (the only exception to this is during the practice section where assessors are prompted to provide positive feedback for correct responses.)
  - Never give feedback during the testing section (only during introduction and practice).
  - Be careful not to cue the child during the testing section. After reading aloud the instruction, look directly at the child's eyes. Do not look at his/her head, toes, knees, or shoulders.
  - Demonstrate the correct response when you see: ⬚ (during the introduction and practice sections.)
  - Do not repeat a test trial, unless the child indicates that they did not hear the instructions.
  - Do not penalize a child for *thinking* about where to place his/her hands. So long as the child does not move towards an incorrect body part before touching the correct part, then the child should receive the full 2 points.
  - Administer the task in an upbeat and positive tone. Children enjoy playing this game!
- **Testing Environment**
  - If possible, find a testing location that is quiet and in an isolated area. Ideally, no other children should be in the same room as the child being tested.
  - If parents request to sit-in during the testing section – ask parents to sit/stand quietly behind the child and out of the child's sight.
  - Have the child stand approximately 3 feet away from you. Administer the task seated or standing, but make sure that you are facing the child.
  - It is not necessary to force the child to remain in the same spot during the test, so long as the child is paying attention to you and to the task.

Scoring Guidelines

SCORE	RULE	EXAMPLE
0	Child touches the wrong body part and does not self-correct	The assessor says, "Touch your knees." The child quickly reaches up to touch her shoulders but then reverses and touches her knees, holding her hands on her knees.
1	Child makes any discernable motion toward an incorrect response but then changes his/her mind and makes the correct response	The assessor says, "Touch your shoulders." The child briefly jerks his hands upwards but then just as quickly puts his hands down and bends to touch his knees.
2	Child produces the correct (opposite) response immediately.	The assessor says, "Touch your toes." The child looks down at her toes but does not bend towards her toes. After a pause, she places both hands on her head.

HTKS Administration FAQ

1. <u>Are you allowed to repeat a trial if you miss a child's response?</u> We do repeat a command if there's too much noise (e.g., we're in a corner of the classroom) and it's obvious the child didn hear us, or they act like they didn't hear what we said. This doesn't happen very often and it h made no difference in the results we have found. On the rare occasions that we have missed a answer we do ask the child to show us again.

2. <u>Are you allowed to repeat a trial if the child misses what you say and asks you to repeat the trial?</u> Yes, we repeat a command if they don't hear it.

3. <u>Do you wait between instructions before moving on to the next prompt (e.g., touch your head</u> Yes, we wait for the response before moving on to the next prompt.

4. <u>What code do you use if the child does not move at all or refuses to participate for the test trials?</u> If after we repeat a command, they still don't do anything, we mark it as wrong and continue through the task.

5. <u>How would you code a child's response if he or she just moves his or her hands back and forth continuously from their head to their toes?</u> We wait until they finish, and keep giving the task (even if they get the items wrong). After all, being able to listen, pay attention and remember the instructions is required for the task.

6. <u>If the child asks if they are doing ok or giving the right responses during the test trials, are you allowed to say something neutral like "You're giving a lot of good answers?" Or should you say nothing at all?</u> If a child asks how they are doing, we say something like "you're really good at these games."

Examples and Scoring Suggestions

*For the following examples, assume that the child has his hands on his head at the start of the trial:

COMMAND	CHILD RESPONSE	SCORE
Touch your Toes	Child keeps hands on head	2
Touch your Toes	Child briefly raises hands upward off of head – and makes no downward motion towards toes – and then replaces hands on head	2
Touch your Toes	Child removes hands from head and briefly moves hands in downward motion before returning hands to head	1
Touch your Head	Child keeps hands on head	0
Touch your Head	Child removes hands from head and touches toes	2
Touch your Head	Child removes hands from head but starts to move hands back towards head, but then touches toes	1

HEAD-TOES-KNEES-SHOULDERS (HTKS)

Parts I, II, and III
FORM A - Extended

Child name	_____
Birthdate	_____
ID #	_____
Gender	_____
Examiner name	_____
Today's date	_____

Directions: After establishing positive rapport with the child, say or read the directions in **bold type** aloud. Words in CAPITAL LETTERS should be emphasized. Administer the task seated or standing; the child should stand, about 3 feet from you, during the task. *Administer Part II* if child responds correctly (include self-corrects) to 5 or more items on Part I of the task, *or* if child is in kindergarten or beyond. *Administer Part III* if child responds correctly (include self-corrects) to 5 or more items on Part II of the task, *or* if child is in first grade or beyond.

The person symbol indicates that you should perform the motion to demonstrate the correct movement to the child. If the child produces the correct (opposite) response immediately, score the item "2". If they self-correct to the correct response, score the item "1". If they do not touch the correct part of their body at all or touch the named part, score the item "0".

A self-correct occurs if the child makes any discernible motion toward an incorrect response, but then changes his/her mind and makes the correct response. Pausing to think, not moving, and then responding correctly does not count as a self-correction – it would be scored as correct.

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> **Now we're going to play a game. The game has two parts. First, copy what I do. Touch your head.**

Touch your head; wait for the child to touch his/her head.

> **Good! Now touch your toes.**

Touch your toes; wait for the child to touch his/her toes.
Repeat the two commands with motions again, or until the child imitates you correctly.

PART I: PRACTICE

> **Now we're going to be a little silly and do the OPPOSITE of what I say. When I say touch your HEAD, INSTEAD of touching your head, you touch your TOES. When I say touch your TOES, you touch your HEAD. So you're doing something DIFFERENT from what I say.**

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

***If the child responds incorrectly** at any point during the practice portion, provide additional explanations up to 3 times before beginning the test portion:

> Remember, when I say to touch your _____, you touch your _____, so you are doing something DIFFERENT from what I say. Let's try another one.

→ Number of additional explanations given: 0   1   2   3

A1. What do you do if I say "touch your head"?	0 (other than toes)	1	2 (toes)
A2. What do you do if I say "touch your toes"?	0 (other than head)	1	2 (head)

If the child responds verbally: "can you show me? "

> **Ok, let's practice a few more.**

B1. Touch your head	0 (other than toes)	1	2 (toes)
B2. Touch your toes	0 (other than head)	1	2 (head)
B3. Touch your head	0 (other than toes)	1	2 (toes)
B4. Touch your toes	0 (other than head)	1	2 (head)

Proceed to Part I test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.

We will keep playing this game, and you keep doing the OPPOSITE of what I say.

		Incorrect	Self-Correct	Correct
1.	Touch your head	0 (other than toes)	1	2 (toes)
2.	Touch your toes	0 (other than head)	1	2 (head)
3.	Touch your toes	0 (other than head)	1	2 (head)
4.	Touch your head	0 (other than toes)	1	2 (toes)
5.	Touch your toes	0 (other than head)	1	2 (head)
6.	Touch your head	0 (other than toes)	1	2 (toes)
7.	Touch your head	0 (other than toes)	1	2 (toes)
8.	Touch your toes	0 (other than head)	1	2 (head)
9.	Touch your head	0 (other than toes)	1	2 (toes)
10.	Touch your toes	0 (other than head)	1	2 (head)

TOTAL (Self-Correct + Correct) ⟶ ☐

**If the child responds correctly (include self-corrects) to 5 or more items on Part I of the task, or if child is in kindergarten or beyond, continue to Part II.

*If the child should **not** continue to Part II:*   Thank you for playing this game with me today!

PART II: INTRODUCTION

> Ok, now that you've got that part, we're going to add a part. Now, you're going to touch your shoulders and your knees. First, touch your shoulders.

Touch your shoulders; wait for the child to touch his/her shoulders.

> Now, touch your knees.

Touch your knees; wait for the child to touch his/her knees.
Repeat the two commands with motions again, or until the child imitates you correctly.

PART II PRACTICE:

> Ok, now we're going to be silly again. You keep doing the opposite of what I say like before. But this time, touch your knees and shoulders. When I say to touch your KNEES, you touch your SHOULDERS, and when I say to touch your SHOULDERS, you touch your KNEES.

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

If the child responds incorrectly at any point during the practice portion, provide additional explanations up to 2 times before beginning the test portion:

> Remember, when I say to touch your _____, instead of touching your knees, you touch your _____. Do the OPPOSITE of what I say.

Number of additional explanations given: 0   1   2

C1. What do you do if I say "touch your knees"?	0 (other than shoulders)	1	2 (shoulders)

If the child responds verbally: "can you show me? "

D1. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
D2. Touch your shoulders	0 (other than knees)	1	2 (knees)
D3. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
D4. Touch your shoulders	0 (other than knees)	1	2 (knees)

Proceed to Part II test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.

Now that you know all the parts, we're going to put them together. You're going to keep doing the opposite of what I say to do, but you won't know what I'm going to say.

There are four things I could say.
If I say touch your HEAD, you touch your TOES.
If I say touch your TOES, you touch your HEAD.
If I say touch your KNEES, you touch your SHOULDERS.
If I say touch your SHOULDERS, you touch your KNEES.

Are you ready? Let's try it.

	Incorrect	Self-Correct	Correct
11. Touch your head	0 (other than toes)	1	2 (toes)
12. Touch your toes	0 (other than head)	1	2 (head)
13. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
14. Touch your toes	0 (other than head)	1	2 (head
15. Touch your shoulders	0 (other than knees)	1	2 (knees)
16. Touch your head	0 (other than toes)	1	2 (toes)
17. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
18. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
19. Touch your shoulders	0 (other than knees)	1	2 (knees)
20. Touch your toes	0 (other than head)	1	2 (head)

PART II TESTING:

TOTAL (Self-Correct + Correct) ⟶ ☐

**If the child responds correctly (include self-corrects) to 5 or more items on Part II of the task, or if child is in first grade or beyond, continue to Part III.*

Thank you for playing this game with me today!

If the child should not continue to Part III:

PART III INTRODUCTION

> **You are doing so well we just have one more part! Now we are going to change the rules of the game.**
>
> **When I say to touch your HEAD, you touch your KNEES.**
> **When I say touch your KNEES, you touch your HEAD.**
> **When I say touch your SHOULDERS, you touch your TOES.**
> **And when I say touch your TOES, you touch your SHOULDERS.**
>
> **Ok? Let's practice!**

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

**If the child responds incorrectly at any point during the practice portion, provide additional explanations up to 2 times before beginning the test portion:

> Remember, we changed the rules. "Touch your head" means touch your KNEES – head goes with knees now. "Touch your shoulders" means touch your TOES – shoulders goes with toes.
>
> ⟶ Number of additional explanations given: 0   1   2

PART III PRACTICE:

E1. What do you do if I say "touch your head"?	0 (other than knees)	1	2 knees)
E2. What do you do if I say "touch your shoulders"?	0 (other than toes)	1	2 (toes)

If the child responds verbally: "can you show me? "

F1. Touch your head	0 (other than knees)	1	2 (knees)
F2. Touch your shoulders	0 (other than toes)	1	2 (toes)
F3. Touch your toes	0 (other than shoulders)	1	2 (shoulders)
F4. Touch your knees	0 (other than head)	1	2 (head)

> **You're doing great! Let's do a few more.**

Proceed to Part III test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.

PART III TESTING:

	Incorrect	Self-Correct	Correct
21. Touch your shoulders	0 (other than toes)	1	2 (toes)
22. Touch your head	0 (other than knees)	1	2 (knees)
23. Touch your knees	0 (other than head)	1	2 (head)
24. Touch your toes	0 (other than shoulders)	1	2 (shoulders)
25. Touch your toes	0 (other than shoulders)	1	2 (shoulders)
26. Touch your knees	0 (other than head)	1	2 (head)
27. Touch your shoulders	0 (other than toes)	1	2 (toes)
28. Touch your head	0 (other than knees)	1	2 (knees)
29. Touch your head	0 (other than knees)	1	2 (knees)
30. Touch your shoulders	0 (other than toes)	1	2 (toes)

After the child completes the task, say: **Thank you for playing this game with me today!**

Appendix 3.J: The Expressive Vocabulary Test (EVT) measure of Expressive Language

Expressive Vocabulary Test

Point to the picture of the three green leaves and say:

"What do you see?"

Prompt: If the examinee's response is "plant", say:

"No, it is part of a plant, but what is it?"

Point to the picture of the steps and say:

"Steps. Tell me another word for Steps."

Prompt: If the examinee's response is "upstairs", say:

"Yes, the steps go upstairs, but what it is another word for this (point to the picture)"?

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CHAPTER IV

A Dynamic Assessment (DA) Intervention for Facilitating Metacognitive Processing in Preschoolers

Abstract

This study focused on examining whether a Dynamic Assessment (DA) intervention would enhance the metacognitive skills of preschool-aged children and whether their metacognitive skills would predict their cognitive and pre-academic skills. Eighty-three diverse preschoolers (M_{age}=53.47 months) were randomly assigned to an intervention or comparison group to assess the facilitation of metacognitive processes. Children's cognitive and metacognitive skills were assessed before and after participating in a DA intervention (or repeated exposure). Children in the DA obtained significant gains on both cognitive and metacognitive skills whereas children in the comparison condition did not. Mediated/explicit instruction (within the DA) seemed to be most effective at facilitating metacognitive processes. Children's metacognitive skills were positively related to cognitive development and pre-academic functioning in language arts, mathematics, problem solving, and memory. Individual differences in metacognitive skills predicted children's pre-academic functioning in language arts and mathematics. Children at risk for learning difficulties who had higher metacognitive skills also had higher cognitive and pre-academic skills indicating that metacognition may serve as a protective factor.

Keywords: Metacognition, Metamemory Knowledge, Dynamic Assessment, Early Childhood, SES Achievement Gap

A Dynamic Assessment (DA) Intervention for Facilitating Metacognitive Processing in Preschoolers

Importance of Metacognition to Learning

Since its inception as a theoretical and empirical concept (Flavell, 1976), metacognition (Mc; cognition about cognition) has been conceptually tied to learning and cognition. In fact, the need to search for such a construct was due in large part to "learning failures". In the seminal paper in which Flavell introduced the term "metacognition" (Flavell, 1976), he described the need for this new construct and area of research based on recent studies of problem-solving performances of children. He highlighted problem-solving as being the "central problem in learning and development, namely, how and under what conditions the individual assembles, coordinates, or integrates his already existing knowledge and skills into new functional organizations", Flavell 1976, p. 231. However, he also pointed to the puzzling limited success of children's problem-solving and speculated that this new and important concept was—at least in part—related to this:

> Resnick and Glaser's research provides us with some striking examples of children failing to solve problems for which they possess the necessary solution procedures. They ought to solve these problems, we think, and yet they do not. Why not? My own guesses on the matter originate in the expected place, namely, the area in which I have done most of my recent research and thinking. This area is the development of *metacognition* (Flavell, 1976, p. 232).

Flavell continued to highlight the centrality of Mc to problem-solving, learning and cognition as he developed this new area of research further (Flavell 1979). Moreover, other prominent researchers endorsed the importance of this new field of research for learning and development and agreed that Mc was "at the very roots of the learning process," (Brown 1987, p. 66). Furthermore, researchers underscored the importance of Mc for addressing mechanisms of

change, development, and cognitive progress. For example, addressing children's metacognitive processes during problem-solving would address "*when* to store information and *how*, *where*, and *when* to retrieve it… The "*how*" includes a variety of storage and retrieval strategies. The "*where*" refers to a variety of storage and retrieval resources (the child's head, the heads of others, and numerous nonhuman resources). The "*when*" has already been alluded to, and may be pertinent to Resnick and Glaser's findings. It refers to the child's growing sense that such and such situations call for active, deliberate attempts to learn and store, and that so and so situations call for active, deliberate attempts to retrieve and apply what is in store" (Flavell, 1976, p. 233).

There have been many different conceptualizations of Mc from its original "thinking about thinking" conceptualization (Flavell, 1976) to "knowledge and regulation of cognition (Brown 1987) to a more nuanced "knowledge of: person (self); task; strategies (Flavell, 1979) to the more recent "control and monitoring of cognitive processes" (Nelson & Narens 1990). Generally, researchers agree that Mc can be conceptualized as the knowledge, regulation, and monitoring of cognitive processes, which is the way it is being used in this study.

In the 1920s to early 1930s, well before the official appearance of the Mc construct, Vygotsky (1978, 1986) discussed—at great length—the importance of self-regulatory processes (such as the metacognitive skills Flavell later described) to development and learning. He consistently referred to the facilitative nature of these processes for moving to higher mental functioning: "Intellectualization of a function and voluntary control of it are just two moments of one and the same process of the formation of higher mental functions," Vygotsky, 1986, p. 167). He made a clear distinction between the "lower" mental functions (such as perception, memory, and, attention) and "higher" (or "cultural" as he viewed them) mental functions which "appear gradually in a course of radical transformation of the lower functions" (Vygotsky, 1986, p. xi).

Vygotsky proposed that this "transformation" occurred through psychological tools such as language, (including: private / inner speech or expressive / communicative language.

Empirical Evidence

In addition to the robust theoretical and conceptual links between Mc and learning, there is substantial evidence implicating strong associations between Mc and greater levels (and depth) of learning and academic achievement across grade levels and even when controlling for other cognitive and self-regulated learning (SRL)[1] factors (e.g., August, Flavell & Clift, 1984; Borkowski, Carr, & Pressley, 1987; Bransford, Brown & Cocking, 2000; Carr, Kurtz, Schneider, Turner & Borkowski, 1989; Garner, 1990). Moreover, though Mc is related to intelligence (Borkowski et al., 1987; Sternberg, 1984, 1985) it has been shown to outweigh intelligence in predicting learning performance (Demetriou, Gustafsson, Efklides, & Platsidou, 1992; Elshout, 1987; Sternberg, 1985; Veenman & Beishuizen, 2004; Veenman, & Spaans, 2005). Further, the predictive strength of Mc is consistent across domains (e.g., Problem-solving: Davidson & Sternberg, 1998; Inductive reasoning: Prins, Veenman, & Elshout, 2006; Mathematics: Desoete, Roeyers, & Huylebroeck, 2006, Schoenfeld, 1992; Science: Georghiades, 2004, White & Frederiksen, 1998; Writing: Harris, Graham, Brindle, & Sandmel, 2009; and Reading comprehension: Palincsar & Brown, 1984, Pressley, 2002). Findings have also indicated that Mc was especially important for learning tasks within students' zones of proximal development (ZPD; Vygotsky, 1978); when tasks were at the boundaries of their knowledge and abilities (Prins et al., 2006). Importantly concerning the current study, Mc has more recently been shown

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[1] The positive influence of Mc is not limited to academic learning. Mc has also been shown to have important associations to other positive life outcomes (e.g., relieving depression and other disorders such as Obsessive Compulsive Disorder, anxiety, and generally to making better life choices and decisions) (e.g., Fisher, 2009; 2011; Wells, 2008) but the focus of this study is on examining associations between Mc and cognitive development/academic learning

to influence even preschool-aged children's cognitive ability and academic achievement (Shamir, Mevarech, & Gida, 2009; Whitebread, Bingham, Grau, Pasternak, & Sangster, 2007; Whitebread et al., 2009). Moreover, there is preliminary evidence that—neurologically, as well as behaviorally—Mc is associated with indicators of enhanced learning (i.e., error detection and correction responses related to progress monitoring) in preschool and primary school-aged children (Marulis, Kim, Grammer, Carrasco, Morrison, & Gehring, 2013; Rueda, Pozuelos, Paz-Alonso, Combita-Merchan, & Abundis, 2011).

Several meta-analytic reviews found robust evidence of the unique importance of Mc to learning and academic achievement across domains (Dignath, Buettner, & Langfeldt, 2008; Donker, Boer, Kostons, Dignath van Ewijk, & Van der Werf, 2014; Hattie, Biggs, & Purdie, 1996; Wang, Haertel, & Walberg, 1990). However, these studies focused on children in primary school and beyond, thus there remains limited information on: what different ways of measuring Mc can reveal, the associations between Mc and cognitive/academic success, and ways it is best facilitated, in younger children. This is what the current study was designed to address.

Nevertheless, metacognitive processes appear to be a fruitful avenue through which to intervene for enhanced learning and development. Providing potentially converging indications, Jacob & Parkinson (in preparation) conducted a meta-analysis to examine the effectiveness of executive function (EF) preschool interventions. They found that, overall, there was no effect of these well-designed interventions. One speculation as to why these interventions did not produce effects despite their proper designs and implementation was that none of the interventions included "metacognitive bridges" that helped the children learn *how* and *when* to apply the EF skills and strategies they learned in the interventions to the "real life" learning situations, similar to Resnick and Glaser's research discussed in Flavell, 1976. Researchers continue to describe Mc

as a way for learners to acquire control over their own thinking and learning and, particularly when they are struggling or having problem-solving or cognitive failures and difficulties they such as described in Resnick and Glaser's studies, and possibly the EF interventions described and analyzed in Jacob and Parkinson's (in preparation) meta-analysis (Efklides & Sideridis, 2009). This issue of application is at the forefront of several disciplines and has been called many things including: learning, transfer, strategy development, metastrategic knowledge, and conditional metacognition. Across the various conceptualizations, most searchers and educational practitioners view application as the highest aspiration of learning and development. An analogy to Mc as a catalyst can be drawn where Mc is seen as the fuel for fire. One needs content knowledge (i.e., oxygen in the analogy) and strategy knowledge (i.e., heat in the analogy) to learn, but in order to perform well and deeply understand a leaning task, one must know *when* and *how* to apply/regulate knowledge/strategies; in other words, be *metacognitive* (i.e., fuel in the analogy). The fuel is essential for a robust fire[2].

Intervening in the preschool years has been shown to be both more effective (e.g., Heckman & Masterov, 2007) and sustaining (e.g., Camilli, Vargas, Ryan, & Barnett, 2010; Li, Farkas, Duncan, & Burchinal, 2011) than intervening in kindergarten or later. Consequently, the current study was designed to investigate the effectiveness of a scaffolded intervention targeting preschool-aged children's metacognitive knowledge about a card recall task and associations to cognitive development and pre-academic functioning. Importantly, the intervention in this study was designed as a Dynamic Assessment (DA) intervention, and as such, mechanisms of change would more easily be detected compared to previous studies that have primarily relied on

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[2] This is not an exhaustive analogy, rather a cartoon as there are other important "ingredients" to learning such as motivation and emotional regulation, but I will argue that Mc (i.e., the fuel) is always an essential ingredient.

correlational analyses or standardized intervention.

Across many cultures, children between approximately 4-7 years undergo important developmental changes (Rimm-Kaufman & Pianta, 2000), which has historically been referred to as the "5-7 shift" (White, 1965). In particular, this developmental time is a sensitive period for learning related skills and SRL skills such as Mc and individual differences can be seen prior to formal schooling (Bronson, 2000). Consequently, this developmental period is ideal for intervening on these processes. Furthermore, because early cognitive skills have largely been underestimated due to the non-developmentally appropriate ways they were measured (for a review of this underestimation, see Gelman & Baillargeon, 1983), which is particularly pervasive in metacognition; many researchers persist in maintaining the later emergence of 7-8 years for metacognitive processes (Flavell, 1979; Kreutzer, Leonard, & Flavell, 1975; Veenman et al., 2006). However, recent studies have shown robust evidence of Mc in preschool-aged children (Marulis et al., 2013, submitted; Shamir et al., 2009; Whitebread et al., 2005, 2007, 2009, in preparation). Due to this recent and growing body of evidence regarding the earlier emergence of metacognitive processes, it is important to examine this age group closely for evidence of Mc, its malleability, and associations and predictions to cognition and pre-academic achievement.

Understanding how students develop critical skills that allow them to deliberately use specific mechanisms and supportive metaskills to control direct and plan their cognition and behavior has several implications for improving student academic achievement, beginning with school adjustment (e.g., Morrison, Ponitz, & McClelland, 2010). The transition to formal instruction (instruction designed to raise a child's skill level) typically occurs in kindergarten. It is at this point that children begin to experience a variety of classroom requirements that call for the use of specific cognitive skills. For example, children need to recruit Mc to apply

appropriate strategies to various learning tasks across domains (Rimm-Kaufman, Curby, Grimm,

Nathanson, & Brock, 2009).

Metacognition as a Protective Factor: Socioeconomic Status (SES) Achievement Gap

Importantly, Mc may serve as a protective, or resilience, factor for children at risk for

learning difficulties related to their low socioeconomic status (SES). Risk has been

conceptualized as "an elevated probability of a negative or undesirable outcome in the future",

Masten & Gewirtz, 2006, p. 24. Related to development and learning, this typically means poor

developmental outcomes such as delayed speech production, and low academic achievement.

Risk factors for learning and development typically include low- socioeconomic status (SES),

minority status, and maternal depressive symptoms. These risk factors, especially SES, have

consistently been associated with academic achievement and the achievement gap between low-

SES and middle-SES children. Meta-analyses (Marulis & Neuman, 2010; 2013; Sirin, 2005;

White, 1982) have found low family SES to be the risk factor most associated with learning

difficulties. Furthermore, the achievement gap related to SES is .5 *SD* (Borman & Dowling,

2010; Perry & McConney, 2010) and these effects can be detected as early as 9 months of age

(Halle, Forry, Hair, Perper, Wandner, Wessel, & Vick, 2009). Children from low-SES families

tend to have lower SRL (including metacognitive) skills (Matthews, Kizzie, Rowley, & Cortina,

2010; National Center for Education Statistics, 2001; Sektnan, McClelland, Acock, & Morrison,

2010).

Encouragingly, however, there are individuals who achieve positive outcomes despite

these risk factors and have often been termed "resilient" in the literature. Related to this,

researchers study these individuals for the "protective factors", or environmental and individual

factors that "protect, buffer, or mediate risk in an individual, and promote resilience, which in turn promotes positive outcomes", Raskind, 2014, p. 1. Importantly in regards to the current study, higher metacognitive skills, despite risk factors such as SES, have been associated with greater learning and academic achievement (Matthews et al., 2010; Sektnan et al., 2010), indicating that these skills may serve as resilience or protective factors that could potentially narrow the SES achievement gap increasing equity. Moreover, some of these findings related to lower achievement and metacognitive skills in children from low-SES families may be due in large part to fewer mediated learning experiences (MLE; Feuerstein, Rand, & Hoffman, 1979) that will be discussed in greater detailed below. Feuerstein and his colleagues (1979) argued that cognitive development was often masked in children from low-SES families due to limited exposure to MLE opportunities rather than the typical arguments related to low-SES environments (e.g., conditions of poverty, neurological impairment, emotional disturbances). Thus, this study was designed to address the SES achievement gap and the possibility that boosting children's metacognitive experiences and supports during the MLE may increase their learning potential and performance (thus Mc may act as a protective or mediating factor).

Theoretical Grounding

The overarching theoretical framework for the current study incorporates both the information-processing theory of cognitive development—within which constructs like metamemory, Mc, and metacognitive strategies originated (e.g., beginning with research on cognitive processing and memory; Miller, 1956)—and sociocultural theory (Vygotsky, 1978) which has a tradition of literature that focuses mostly on what is conceptualized as self-regulatory processes (including metacognitive aspects. Similar to Whitebread and colleagues (2009), this study is guided by an integration of these (traditionally disparate) theoretical lines.

Within the information-processing perspective, development is viewed mostly through the lens of maturational changes in children's minds and brains (e.g., executive functioning or memory components that develop in line with the developing prefrontal cortex). These changes (i.e., development) are influenced by the way an individual process incoming information and, as children mature (and their brains/mind become more mature and developed), their ability to cognitively process becomes more advanced. Traditionally, a model of the mind from an information-processing perspective is analogous to that of a computer, though the evidence supporting this straightforward comparison is limited. Reliance solely on this perspective and its tenets, along with the issues inherent in the way Mc has traditionally been measured in young children, may be related to the pervasive view (with ample—though not comprehensive—supporting evidence) that Mc does not develop until middle childhood (approximately age 7-8). This work and theoretical grounding provides one of the frames for my series of dissertation studies informing my theoretical perspective, approach, and interpretation.

Within the sociocultural framework is the idea that children's learning and development is enhanced through social interaction with more developed members of their culture (e.g., adults and "more capable peers"). Children are thought to develop from an external to an internalized focus mediated through this social interaction. A concept central to this perspective is the Zone of Proximal Development (ZPD) or "*the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers*" (Vygotsky 1978, p. 86). Thus, mediated participation (e.g., scaffolded or supportive instruction) and interactions with adults or more able peers is reputed to can have a large impact on children's cognitive development that subsequently affects their long-term academic achievement (and

much research including Vygotsky's own and that of his followers and beyond has supported this

principle). These interactions often result in qualitative changes or "revolutionary

breakthroughs" (Vygotsky, 1984, p. 249) in learning that are crucial to higher levels of

development. Proposed mechanisms underlying these changes include a scaffolding transition in

which the adult (or more capable peer) takes on the bulk of the metacognitive and self-regulatory

processing (e.g., monitoring and regulating of cognition) but makes it explicit to the child/novice

and gradually relinquishes these processes (with support and guidance) to the child so that the

child begins to internalize the metacognitive and self-regulatory processes and apply them to

learning contexts and tasks (Brown 1987; Palincsar & Brown, 1984). Parents and teachers who

provide facilitative early experiences for young children can positively affect the developmental

trajectory of young children's self-regulatory processes (Grolnick & Farkas, 2002). Furthermore,

the Ecological Systems and sociocultural theory (Bronfenbrenner, 1979; Vygotsky, 1978) as well

as a recent meta-analysis (Karreman, van Tuijl, van Aken & Dekovic´, 2006) point to the

importance of socialization on children's social and cognitive development; children are thought

to develop from an external to an internalized locus of control through social interaction.

Research suggests that both parents (e.g., Fivush, 1992) and teachers (e.g., Brophy, 2004) can

play an important role in socializing their children in a way that will facilitate their cognitive

development (including self-regulation and academic performance). Thus, such influential adults

may be mechanism for increasing children's academic outcomes.

Another prominent researcher, Reuven Feuerstein, has developed a parallel yet

converging theory of development with similar underlying beliefs and mechanistic explanations.

Feuerstein's key theory (the Structural Cognitive Modifiability with a focus on Mediated

Learning Experience) centers on the idea that cognitive development is dependent on the

"quality of the mediated learning that the child experiences" (Feuerstein et al., 1979, p. 102).

Inherent in both Vygotsky and Feuerstein's theories and beliefs is the fundamental assumption that cognitive development and capabilities/competences are dynamic and malleable rather than static or fixed. Relatedly, both researchers emphasize the importance of qualitative (conceptual) changes to reaching higher levels of cognitive functioning, development and learning.

Feuerstein empirically supported many of Vygotsky's arguments by showing that mediated instruction—or "mediated learning experiences"—provided to young children (particularly those at risk for learning difficulties such as those living in poverty or children who had been labeled "mentally retarded"), greatly enhanced their cognitive development and learning. He showed that specific adult-mediated interactions helped children develop higher mental functions (that, in turn, fostered higher cognitive processing and progress) (Poehner, 2005). Feuerstein subsequently developed an educational program called the "Instrumental Enrichment Program" that has robust empirical support for its benefits in enhancing the cognitive functions requisite for academic learning and achievement. Similar to the concept of the ZPD, Feuerstein's work focuses on the idea that social interactions mediate development and learning and, that in order to appropriately and comprehensively assess a child's level of development or cognitive functioning, both her or his independent and mediated performance should be examined. In fact, an examination of the effects of the Instrumental Enrichment Program (i.e., proving a rich mediated learning experience for children at-risk) indicates that children's learning with adult-mediated support is more predictive of their knowledge/understanding/achievement than assessments of their independent performances (Poehner, 2005).

Much empirical work supports the idea underpinning the sociocultural/cognitive modifiability theories that adult-mediated interactions and instruction—when strategic and based on theories of cognitive change—is robustly effective across domains not only in increasing metacognitive and self-regulatory processes but also transfer to the performance task and beyond (e.g., Brown, Pressley, Van Meter & Schuder, 1996; Fuchs, Compton, Fuchs, Bouton, & Caffrey, 2011; Fuchs, Fuchs, Compton, Bouton, Caffrey, & Hill, 2007; Perels, Merget-Kullmann, Wende, Schmitz, & Buchbinder, 2009; Whitebread, Pino Pasternak, Marulis, Okkinga, & Vuillier, in preparation). There is also evidence that similar results occur within peer-mediated contexts (when peers are trained in group regulatory and explanatory dialogue) (e.g., Palincsar & Brown, 1984; Shamir et al., 2009; Whitebread et al., in preparation).

An integration of the information

-processing and sociocultural/cognitive modifiability theories will guide this study (cumulating in a DA intervention) in the following ways. The information-processing theory posits that information is organized and processed in specific ways by minds/brains. Accordingly, the way young children processed instructional information regarding metacognitive processes and strategies was investigated, as well as how presenting/mediating this information in various ways was associated with subsequent development and learning (Haywood & Lidz, 2007). The sociocultural/cognitive modifiability theoretical perspective suggests that the types of interactive environments children encounter can have a large impact on their cognitive development, subsequently affecting their learning and academic achievement. And, furthermore, that mediated-learning experiences are not only supportive of conceptual change and development, but indicative of a child's developmental capacities and understanding (aligned with the ZPD).

Importantly, for this study, an integration of these theoretical perspectives is well-suited to addressing the overarching aim of investigating why some children are more responsive to education, experience, instruction and intervention than others (or, conversely, why some educational contexts, pedagogical orientations, types of experiences, instruction and intervention enhance the responsiveness of young children) and what is particularly important to enable and encourage children to be successful academically.

Stemming from an integration of the information-processing theory and sociocultural/cognitive modifiability theories, this study comprised multiple methods culminating in DA. DA involves a pre-test—socially-mediated intervention—post-test format in which assessment and instruction are conducted simultaneously to examine how adult-mediated interaction affects learners' capabilities and competences (Haywood & Lidz, 2007). Unlike traditional assessment, DA aligns with Vygotsky's conceptualization of the ZPD and Feuerstein's Cognitive Modifiability, a more comprehensive indicator of children's cognitive abilities and levels of development. Specifically, DA allows researchers to see into the "processes that lead to the person's development and change" (Kozulin, 2012, p. xxii), and "focuses on a person's learning potential and the modifiability of his or her cognitive functions" (Kozulin, 2012, p. xvi). Researchers have found that DA provides information (unlike traditional "static" assessment) about the processes learners undergo while they are solving problems (Hasson & Joffe, 2007) and that (unlike traditional "static" assessment) DAs can predict learners' future development and learning (Jonsson, Mattheos, Svingby and Attstrom, 2007).

Furthermore, DA has been shown to uniquely predict young children's learning as well. Researchers found that a DA uniquely predicted first grade student's responsiveness to reading instruction (or Responsiveness to Intervention, RTI; Fuchs et al., 2011). For example, Fuchs and

colleagues found that the use of DA (see Fuchs et al., 2007 for a detailed description and protocol of the DA procedure) contributed unique variance (beyond established predictors of reading development such as letter and sound naming, elision, oral vocabulary, listening comprehension, and word attack, as well as other predictive measures such as sustaining attention and repressing impulsive behavior) to word identification and reading comprehension skills at the end of first grade.

Mediated Learning Experiences

Mediated Learning Experiences (MLE) highlight interactions between teachers and learners and what learners are able to learn from these experiences that are facilitated by teachers. During a MLE, the facilitator draws the learners' attention specifically to aspects of the learning experience that she or he deems most helpful for the learner to move her or him to the "next level of learning,", or for learning new applications of a learning task (Feuerstein, Rand, Hoffman, & Miller, 1980). The MLEs are similar to Vygotsky's (1978) notion of the ZPD, where "actualization of cognitive development depends on the individual's experience in social interaction with a more competent or capable person", Seabi, Cockcroft, & Fridjhon, 2009, p. 164. MLEs are continually being scaffolded by the facilitator and learner; the learner provides feedback by responding to the instruction and the facilitator responds by adjusting the mediation accordingly during the assessment and so on. MLEs can be naturally occurring experiences, such as parental interactions with their children, as well as intentional learning experiences in school. MLEs are one example of a DA type of instructional assessment. The ones used in this study is similar to the MLE, though more structured and based in empirical work and task analyses as described.

Graduated Prompt Method (GPM)

Similarly, the graduated prompt method (GPM; Campione & Brown, 1987) is a method for assessing and instructed students that aligns with Vygotsky's ZPD concept (1978). However, the GPM is more scripted than the MLE method where there are predetermined cues and prompts scripted that are pre-tested in a hierarchical order, with the examiner/facilitator providing increasing levels of support (e.g., see Haywood & Lidz, 2007). The DA used in the current study is an adapted GPM. There was a predetermined structured hierarchical script that was used with every child and increasing levels/types of supports were used. However, the instructional supports were specifically developed based on a task analysis (i.e., regarding meta-memory) of what was needed to succeed on the task (card recall) based on previous empirical studies. Consequently, the DA intervention in this study was a combination of a GPM DA and a more standard intervention based on empirically-driven principles.

DA: Metacognitive Mediated Instruction

The three types of mediated instructional support in the current DA were chosen based on a task analysis regarding conceptual change, and more specifically, cognitive requisites for the card recall task used in this study, which indicated that, in young children, the most likely candidates for enhancing metacognitive and cognitive (i.e., metamemory and memory) performance were: 1. Elicitation of self-explanation (e.g., Crowley & Siegler, 1999; Feuerstein et al., 1980; Siegler & Lin, 2009; Wellman & Lagattuta, 2004), 2. Prompts/hints (e.g., Black & Rollins, 1982; Feuerstein et al., 1980; Haywood & Lidz, 2007) and 3. Explicit instruction (e.g., Bjorklund, & Harnishfeger, 1987; Fabricius & Hagen, 1984; Grammer, Coffman, & Ornstein, 2013; Marulis & Neuman, 2010, 2013).

Memory-related strategies

Moreover, to develop the instructional supports for the DA intervention, a task analysis and literature review was conducted. Studies have shown that though there are naturally occurring developmental changes in children's metamemory, mnemonic or memory-related strategies (Schneider & Pressley, 1997), social interactions with peers and adults plays an important role in the development of these skills (Moely et al., 1992; Coffman, Ornstein, McCall, & Curran, 2008; Reese, Haden, & Fivush, 1993). In particular, these studies have found evidence that teacher's metacognitive and strategy-related language in the context of instruction (Coffman et al., 2008) was associated with children's independent abilities to recall information and successfully use mnemonic strategies. Again, this aligns with Vygotsky's work suggesting that cognitive processes are enhanced through social interactions.

Around preschool, children are beginning to be more strategic and developing a greater ability for memory. In one study 4-year-old children were more purposeful about remembering objects that they were told they needed to remember compared to objects with which they were told to play (Baker-Ward, Ornstein, & Holden, 1984). Also, 2-year olds have used simple strategies when asked to remember the location of objects (DeLoache, Cassidy, & Brown, 1985).

There is robust evidence indicating that children can successfully be trained to learn to use the memory strategies of rehearsal, organizational, and elaboration, and subsequently, that they benefit from using these strategies. Nevertheless, young children typically do not transfer these strategies to other contexts (Grammer, Coffman, & Ornstein, 2013). Thus, an intervention such as the one in this study that incorporated metacognitive processing that teach children *how* and *when* to use strategies and *why* they are important may have the potential to help children learn not only to gain skills but to generalize them.

The Current Study

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The main focus of the current study was to investigate the effectiveness of a DA intervention for facilitating metacognitive processes in preschool-aged children. Related to this was the focus on examining whether individual differences in executive functioning and expressive language skills, and family background differences (i.e., children in the tuition-based preschools compared to children in the Great Start Readiness Program [GSRP] need-based classrooms) were associated with metacognitive processing. Finally, this study was designed to address whether metacognitive processes were associated with and predictive of cognitive and pre-academic skills. Specifically, three research questions were addressed.

Research Questions and Hypotheses

The first research question was: How malleable are children's metacognitive processes? Specifically, how effective is a DA intervention in facilitating metacognitive processes in preschool-aged children? And, what does DA reveal about mechanisms that facilitate metacognitive development in preschool-aged children? It was hypothesized that the children's metacognitive processes would be malleable during this preschool period when similar SRL and EF skills have been shown to be flexible and modifiable through well-designed interventions (e.g., Barnett, Jung, Yarosz, Thomas, Hornbeck, Stechuk, & Burns, 2008; Diamond, Barnett, Thomas, & Munro, 2007; Perels et al., 2009). Though there are limited studies that have examined Mc in preschool-aged children, recent studies have found that metacognitive processes are emerging at this age (Marulis et al., submitted; Shamir et al., 2009; Whitebread et al., 2007, 2009). Consequently, conducting a DA—designed to facilitate these processes—during the preschool years was predicted to be a powerful way to intervene and explore the ways that mediated instruction promoted development of metacognitive processes. Though DAs typically

do not focus on metacognitive processes explicitly as their outcome measures, targeting instead specific content area such as reading development (Fuchs et al., 2011; Fuchs et al., 2007) or sequential pattern completion (Haywood & Lidz, 2007), metacognitive functions are the processes being targeted by mechanisms of the DA itself. Accordingly, it "can be worthwhile to explore how well these functions can be facilitated within the context of DA", Haywood & Lidz, 2007, p. 91. For example, in the sequential pattern completion DA (Haywood & Lidz, 2007), children are supported in making patterns with shapes (i.e., yellow triangle, blue triangle, yellow triangle, ____). The DA focuses on patterns and what they are: "A pattern tell us when something happens again and again. Patterns helps us figure out what comes next", Haywood & Lidz, 2007, p. 170. Thus, the mediation targets pattern making skills. However, within this, much of dialogue focuses on enhancing metacognitive processes related to pattern completion skills, e.g., "Why did you pick that one? Why was that the best one?" Haywood & Lidz, 2007, p. 170, after a child chooses a correct shape. Also, one of the emphases during the pattern completion DA task is to teach and support the child to ask her or himself "What comes next", which is a self-questioning metacognitive technique to use while problem-solving.

One related study (Lange & Pierce, 1992) successfully trained 4-5 year olds to use using memory strategies. Lange and Pierce (1992) provided the children with a "brief period of metacognitive instruction about why the strategy is effective and how, when and where to use it," Lange & Pierce, 1992, p. 460. They found that the children's memory strategies (specifically, taxonomic sorting) significantly increased and maintained several days later. Given that the DA is a brief 5- minute metacognitive instruction training (and includes mediated support backed by theoretical and empirical grounding) and the children in the current study are the same age as those in Lange & Pierce (1992), the results were expected to be similar.

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The second research question was whether individual differences in executive functioning (Head Toes Knees Shoulders; HTKS) or expressive language (Expressive Vocabulary Test; EVT) would predict metacognitive performance in preschoolers. Though Mc and executive function (EF) are conceptually related, there is limited research that integrates the two constructs (e.g., Fernandez-Duque, Baird, & Posner, 2000) and none with preschool-aged children, which is a gap in the current literature (Marulis, Baker, Basilio, & Whitebread, in preparation). Nevertheless, theories of both Mc and EF propose that these constructs operate by modulating lower level processes (that, without a higher-order cognition or "meta" skill 'executive' would be tied to external stimuli) and adding greater flexibility to cognition. Also, both involve monitoring and regulating input needed for voluntary, goal-directed action; for example, in a school setting, asking a teacher for help when needed, which involves being attentive to one's thinking and aware of one's abilities in relation to the task at hand and then inhibiting other behaviors and thoughts in order to enact a remedial strategy. It follows that Mc and EF would be interdependent across development. For example, if a child is aware that a task is far above her or his ability (e.g., has accurate metacognitive knowledge about herself or himself and the task), she or he would be more likely to attend to her or his progress more closely and put forth more effortful inhibitory control on this challenging task. However, it is also clear that these could operate distinctly; this child could be fully metacognitively aware but unable to exert the appropriate effort/attention or inhibit classroom distractors.[3] There is empirical evidence that Mc and EF are associated in primary-school-aged children (Roebers, Cimeli, Röthlisberger & Neuenschwander, 2012; Roebers & Spiess, 2013; Whitebread, 1999).

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[3] Other skills such motivation could play a strong part in this scenario as well of course. For example, the child may have the metacognitive knowledge and EF ability but be unwilling/uninterested to exert the needed effort or seek help. However, for the purposes of this study, I am focusing on Mc and EF within the SRL construct.

However, it is an open empirical question as to how Mc and EF are related in preschoolers and whether/how much they work together to influence various aspects of cognition and pre-academic achievement. It was hypothesized that these skills would be related in the preschool-aged children and that the EF measure would predict the metacognitive processing skills of the preschoolers.

Expressive vocabulary (i.e., the size of a child's vocabulary that he or she is able to articulate) has also been shown to be associated with metacognitive development (Lockl & Schneider, 2006; Lockl & Schneider, 2007). Expressive language tasks typically involve asking children to describe, label, or provide another name for a picture that is shown to them. Therefore, It was hypothesized that the preschoolers' scores on the EVT would be associated with and predict their scores on the metacognitive tasks (i.e., the McK questions and the McK strategies).

The third research questions were: How are preschoolers' metacognitive skills related to cognitive development and pre-academic functioning? Do metacognitive skills serve as a protective factor for young children at risk for learning difficulties?

As discussed earlier, associations between Mc and cognitive skills have been well established (e.g., Borkowski, Carr, & Pressley, 1987; Bransford, Brown & Cocking, 2000; Desoete, Roeyers, & Huylebroeck, 2006; Georghiades, 2004; Rueda et al., 2011; White & Frederiksen, 1998), including recent evidence from studies with preschool-aged children (Marulis et al., 2013, submitted; Shamir et al., 2009; Whitebread, Bingham, Grau, Pasternak, & Sangster, 2007; Whitebread et al., 2009), and meta-reviews (Dignath et al., 2008; Wang et al., 1990). Hence, the hypothesis for this study was that associations would be present between Mc

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and cognition (on a card recall task) and pre-academic functioning as well. In addition, It was hypothesized that the children's metacognitive skills would uniquely predict both their cognitive and pre-academic (language arts and mathematics) skills.

Research indicates that children with high self-regulatory skills perform better cognitively and academically than children with low self-regulation *regardless* of the presence of risk factors such as minority status, low maternal education, single-parent family, English language learner (ELL), low income, and longer periods of high maternal depressive symptoms (Matthews, Kizzie, Rowley, & Cortina, 2010; Sektnan et al., 2010). Therefore, SRL skills have been linked with high academic achievement for children in the face of various environmental factors shown to typically negatively impact academic achievement, suggesting these skills may serve as potential protective and facilitative factors. Thus, it was hypothesized that, in this study, the children in the GSRP classroom who had high metacognitive functioning would also have high cognitive and pre-academic scores (higher than their peers who scored lower on the metacognitive tasks).

Method

Participants

Participants were 83 children (42.74-68.60 months, M_{age}=53.47 months SD=4.53; 41% female) from seven preschool classrooms in Southeastern Michigan. Four teachers—each with a dedicated paraprofessional—taught the preschool classes as follows; One teacher taught a PreK academy for 4-5 year olds, which was an all-day program held every week day. However, not every child attended every week day; some children attended Mondays, Wednesdays, and Fridays only for example. Another teacher taught a typical half-day (tuition-based) preschool

class in which children attended different days/times based on age. This program included a 3 to young-4 year old group which attended preschool on Monday and Wednesday mornings, a 4 year old group which attended preschool on Monday and Wednesday afternoons, and a 4.5-late 5 year old group which attended preschool on Tuesday, Thursday and Friday morning to early afternoons. The other two teachers taught a Great Start Readiness Program (GSRP), which is federally funded program similar to the Head Start program. Eligibility for this program is determined by age (children must be 4 years old and would not turn 5 before November 1st of the year of entrance), by income, and or other difficult family situations. The GSRP classrooms were half-day programs that were held Mondays through Thursdays in the mornings and afternoons.

Across the seven classrooms, there were 108 children who were eligible for my study based on age (between 3-5 years old). I participated in the PreK academy, preschool, and GSRP, parent orientations, including a presentation of what my study would entail, how I would partner with the school and district and the potential benefits of the research. After the presentations, I asked parents to fill in the consent forms (indicating whether they were or were not interested in having their children participate in my study). Over 90% of the parents (99/108) returned the consent forms indicating they were interested in having their children participate in my study. Prior to beginning my assessments, I spent two weeks in the children's classrooms to build a rapport and get to know the children and their teachers. During this time, it became apparent that another 15 children would not be eligible to participate—despite their parental permission— because they were English Language Learners (ELL) still learning basic English words. Furthermore, one child did not want to participate even with much encouragement from her teacher and me. Thus, the final sample was 83 children. There was no missing data or attrition

over the month of this study. The final sample was 46% White, 27% Black, 8% Asian, 6% Bi-racial, 11% Chaldean, and 2% Hispanic.

Assignment to Conditions

Because the principal aim of this study was to examine whether and how the DA facilitated metacognitive processing, the majority of the sample was assigned to the intervention group. However—to address practice/test-retest effects (Hausknecht, Halpert, Di Paolo, & Moriarty Gerrard, 2007) in other words, to be able to make a stronger claim that any result was due to the intervention—a modest comparison group (25% of the sample) was included; using stratified randomization (across the GSRP and Tuition classrooms), 62 children were assigned to the intervention condition and 21 to the comparison group.

Data Collection Procedure

All children were individually assessed in two 15-20 minute sessions. The first session was the card recall DA intervention for the Experimental group/repeated exposure for the Comparison group (COMP). Additionally, all children were assessed using McK Questions related to the card recall task. Specifically, the first session was designed as a test—mediated intervention or repeated exposure—re-test DA. The following steps were undertaken:

1. **Pretest**: The card recall task with McK questions (see Appendix 4.A).
2. **DA/COMP:** The 62 children in the intervention condition then participated in a DA mediated intervention with the card recall. The 21 children in the comparison condition participated in a repeated exposure card recall task (same as the pre-test but for 5 rather than 2 minutes) (using a different set of—conceptually and perceptually similar—cards[4]). Briefly, the DA (which will be described in detail below) entailed:

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[4] See Appendix 4.B for the entire set of 27 cards (3 sets of 9)

a. The first type of support consisted of asking children for **self-explanations**. For example asking: "What types of things could help you remember more cards?; "What kinds of things have helped you remember things before?"

b. The second type provided **prompts/hints**. For example, saying: "Other children have said that sorting the cards by the type of picture helped them remember the cards better. Do you think that would be helpful?"

c. The third type was **explicit** instruction on using strategies. For example, telling the children: "Try sorting the cards by the type of picture; that will help you remember them."[5]

3. **Post-test:** The original card recall task with McK questions (same as the pre-test with a different but conceptually and perceptually similar set of cards.

The second session focused on executive functioning, expressive vocabulary, and pre-academic functioning assessment measures. The executive functioning and expressive vocabulary measures were designed to be covariates and potential moderators in these analyses while the pre-academic functioning measures were designed to function as outcome measures to which the metacognitive measures would be used to predict. Specifically, executive functioning was measured using the Head, Toes, Knees, Shoulders (HTKS) task and expressive vocabulary using the Expressive Vocabulary Test (EVT) to be described in detail below. As described earlier, executive function and expressive language skills are often related to metacognitive processes in children.

Measures.

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[5] The specific types of instructional support were adapted from the DA protocols used by Haywood and Lidz (2007) with preschool-aged children and based on empirical work by studies such as Fabricius & Hagen (1984) related to causal attribution of a strategy. For example, I included "Try sorting the cards by the type of picture; that will help you remember them" in the DA as a causal attribution in the explicit instruction portion of the DA support. Often young children how limited implementation of learned strategies even when they have been able to state and demonstrate knowledge of the effectiveness of the strategy (e.g. Salatas & Flavell, 1976). Nevertheless, when making explicit attributions (or connections between metacognitive knowledge and metacognitive skills such as monitoring) children are more likely to continue the use of successful strategies or even successfully transfer the use of strategies (e.g., Fabricius & Hagen, 1984). This empirically-driven principle was incorporated into the more traditional (Haywood & Lidz, 2007) DA intervention.

Cognitive task: Card recall task. To appropriately assess Mc with young children, it is important to have a contextualized cognitive task about which to be metacognitive (see Marulis, Palincsar, Berhenke, & Whitebread, submitted for more details). An individually-administered memory card recall task was used for this purpose. This card recall memory task was adapted from Shamir et al., 2009 and Haywood & Lidz, 2007, both of whom used similar tasks with preschool-aged children. The card recall task was used as a pre-test, a DA or COMP (repeated exposure comparison task), and a post-test. In each of the three instances, a set of nine cards was used, each with three sets of three superordinate categories (e.g., three toys, three vehicles, and three pieces of clothing). Thus, there were 27 cards total. The cards were counterbalanced across versions A and B; see Appendix 4.A and 4.B. The superordinate categories were chosen based on the items used in Rosch and Mervis' experiments (1975) and Rosch (1975) for being the most familiar to young children.

Specifically, for the pre- and post-tests, each child was shown each of the nine picture cards in a randomized (mixed or non-grouped) order and asked what each card depicted (i.e.,: "Tell me what this is a picture of"). If the child did not know or named the picture incorrectly, she or he was told the correct name. If the child named something that was close and was correct within the category (e.g., labeling "peas" beans, which is still a vegetable), she or he was not corrected and the same term was used with the child throughout the task. After all of the named cards were placed on the table in front of the child, she or he was told that she or he would need to remember the names of the cards and that the cards would be hidden in a few minutes[6]. After two minutes (with no instructions or assistance), the cards were collected and the child was asked

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[6] See Appendix 4.C for detailed instructions

to recall the picture cards. She or he was given one point per card accurately remembered (0-9 points possible; see Appendix 4.C). Specifically, the following steps were undertaken for the pre-, comparison repeated exposure, and post-tests (the DA intervention will be described in detail in a subsequent section):

1. Pre-test
   a. Card recall and McK questions: Each child will be given nine named cards (Set A[7]) and told that they will need to remember the cards by name (adapted from Shamir et al., 2009). The child will first be asked to name each object, then given two minutes (without instructions or assistance) with the cards after which time the cards will be collected and the child will be asked to recall the names of the pictures on the cards (One point will be given per card accurately recalled). Next, each child will be asked what they did to remember the cards and responses will be scored for metacognitive knowledge (similar to the McKI). Further, performances will be assessed for metacognitive behaviors displayed during the task. For example, cards sorted into three categorical piles would be considered a metacognitive strategy (i.e., strategy that reflects awareness of what may improve recall performance).
      i. Do: Place Set A in front of the child in a randomized (mixed or non-grouped) order.
      ii. Say: (adapted from Haywood & Lidz, 2007): **For the intervention group:** *"Now, we are going to work together on a picture game. I am going to ask you to play the game all by yourself first and then I get to be teacher and we'll work together on it. Then I will ask you to do it all by yourself again. Okay? Are you ready to play?"* **For the comparison group:** *"Now, you are going to work on a picture game. I am going to ask you to play the game by yourself three times. Okay? Are you ready to play?* [Wait for child to assent; prompt/encourage if needed]. *"Okay, let's start. Here are some pictures. First, tell me the name of each picture"* [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. *"Now, we're going to play a hide and remember game. In a few minutes, I'm going to hide these pictures, and then you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures". Great! Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the*

[7] See Appendix 4.B

pictures? Why?" If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you were looking up* [or whatever the child is doing], "*what were you doing when you did that*?"

1. COMP: Repeated Exposure (Comparison group only)
    a. Card recall/ McK questions (same procedure as pre-test using Set B[8])
        i. Do: Place Set B in front of the child in a randomized (mixed or non-grouped) order.
        [Identical to the card recall/ McK questions pre-test, each child will be given nine cards and told that they will need to remember the cards by name. The only difference between this administration and the pre- and post-test administration is that the children will be given 5 instead of 2 minutes to be comparable to the DA mediated intervention]
        ii. Say: (adapted from Haywood & Lidz, 2007): "*Here are some new pictures. Please tell me the names of these pictures*" [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. Say: "*Like before, I'll hide these cards again and you will need to remember and tell me the names of the pictures that were here. This time in 5 minutes. Okay?*
        iii. Provide 5 minutes to be comparable to the DA mediated discussion before removing/hiding the cards, then ask the child to recall the pictures and record her/his score.
        [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] "*Okay, time is up. Now, tell me the names of the pictures". Great! Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you were looking up* [or whatever the child is doing], "*what were you doing when you did that*?"
2. Post-test
    a. Card recall/ McK questions (same procedure as pre-test using Set C[9])
        i. Do: Place Set C in front of the child in a randomized (mixed or non-grouped) order.
        ii. Say: "*Here are some new pictures. Please tell me the names of these pictures*" (Once again helping if she/he is unable to accurately name the pictures). Then

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[8] See Appendix 4.B

[9] See Appendix 4.B

say: "*In a few minutes, I'll hide these again and you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures". Great! Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you were looking up* [or whatever the child is doing], "*what were you doing when you did that*?"

Metacognitive knowledge questions (McK Questions). Next, to assess children's metacognitive knowledge about the card recall task, each child was asked what she or he did to recall the cards and whether what she or he did to remember the cards helped (see Appendix 4.A for entire protocol). These questions were adapted from Shamir and colleagues (2009) task and extended. Responses were be scored on a scale of 0-2—as was the Metacognitive Knowledge Interview (McKI; see Chapter II, Marulis et al., submitted)—based on the level of Mc present.

Moreover, performances were coded for metacognitive knowledge strategies displayed during the task (adapted from Haywood & Lidz, 2007). Children received 1 point for each type of metacognitive knowledge strategy they used (while indicating knowledge of the helpfulness of that strategy for the card recall task) without assistance. The strategies that were included were: separating the cards into categories, repeating the card names/rehearsing, talking about details/elaborating, spontaneously recalling cards by category, using visualization of location as a clue and other. For example, repeating the names of the cards on their own, and saying "Oh, that's going to help me remember them!" An example that was coded as an "other" strategy was sounding out words and sorting by words that started with the same sound (rather than categorically) and saying: "Saying these sounds helps me think about the cards! I'm going to

remember all of them now!" For all strategies except for "spontaneously recalls items by category/family", the child's response was coded dichotomously. Each child was given 1 point- when she or he displayed strategy (no matter how many times) or no points if she or he did not display the strategy during the card recall task. For "spontaneously recalls items by category/family", each child was given 1 point if the following conditions were met: The child recalled two or three pictures in the same category/family (e.g., Pets/Animals: dog, cat, rabbit) in the same phrase (without any pauses) or the child recalled all three pictures in the same category/ family with pauses in between (but no extra pictures in between) or the child named the category/family, e.g., "Pets" and paused in between naming the actual two or three pictures. The child received no points if she or he did not recall the pictures in categories/families at all (or did not mention that recalling them in groups helped her or him remember) or recalled two pictures in the same category/ family with pauses in between. For the "separated into categories" code, each child received 1 point if she or he separated two or three cards into a category/family away from other cards and said that this would help her or him remember the cards or separated three cards into a category/family within a full group or cards saying this would help her or him remember. For example, if a child sorted the dog, cat, and rabbit into one pile and said "I will remember more pictures if I put them together like this. They're all animals!" These types of behaviors were considered displaying metacognitive strategies (i.e., strategies that reflected awareness of what would improve recall performance). Two researchers independently coded 30% of the sample for the McK questions and strategies. Agreement between coders was high for both the questions (intraclass correlation coefficient [ICC] =.89) and strategies (ICC =.95). See Appendix 4.D.

Pre-academic performance. The Woodcock-Johnson III tests of Letter-Word

Identification (LW) and Applied Problems (AP) (Woodcock, McGrew, & Mather, 2001) were

used to assess children's pre-academic performance (pre-academic achievement) in language arts

and mathematics (see Appendix 4.E). The LW tested children's identification skills through

identification of increasingly difficult isolated letters and words while the AP test measured

children's ability to analyze and solve practical problems in mathematics with increasing

difficulty. Both tests had high levels of internal consistency (α = .94-.98).

Head-Toes-Knees-Shoulders (HTKS). The HTKS assessment task (Ponitz, McClelland,

Connor, Jewkes, Farris, & Morrison, 2008; Ponitz, McClelland, Matthews, & Morrison, 2009) is

an established and validated behavioral self-regulation instrument that is administered to

individual children to measures executive function skills (see Appendix 4.F). This measure taps

into the executive function skills that are believed to underlie self-regulation and are necessary

for self-regulated learning. Using the HTKS task, children were asked to remember behavioral

commands (e.g., "touch your toes") and respond with an action that is in conflict with these

commands (e.g., child must touch their head when they hear the command "touch your toes"). In

this way, children needed to recruit their working memory regarding the commands and response

inhibition in order to inhibit their dominant response to follow the command. Furthermore, as the

task get increasingly difficult, children needed to recruit cognitive flexibility (i.e., the commands

switch at the end so that when asked to "touch your toes", the child must touch their shoulders

instead of their head). Children received 2 points for correct responses (i.e., touching their head

when asked to touch their toes); incorrect responses earn 0 points, and 1 point is given if children

self-correct their response. Scores range from 0 to 40 on the HTKS, with higher scores

indicating higher levels of behavioral regulation. Recent work has established strong reliability

and validity on the HTKS task (McClelland et al., 2008; Ponitz et al., 2008). McClelland et al. (2008) reported inter-rater reliability for the Head-to-Toes short version of this measure to be 0.95, and Ponitz et al. (2009) report 75% consistency across examiners in scoring the HTKS. In addition, construct validity was established with parent ratings of attentional focusing and inhibitory control, two cognitive components believed to be tapped by HTKS. Ponitz et al. (2009) reported that children with higher scores on the HTKS in fall of kindergarten received higher ratings on attentional focusing, and inhibitory control. In addition, children rated higher in the spring by their kindergarten teachers on the behavioral regulation scale of the Child Behavior Rating Scale earned higher HTKS scores in the spring.

Expressive Vocabulary Test (EVT). The EVT (Williams, 1997) is a standardized norm-referenced (conormed with the Peabody Picture Vocabulary Test-III; PPVT-III; Dunn & Dunn, 1997) test of expressive vocabulary for children through adults (ages 2.5-90). The EVT is indivivdually administered and takes approximately 5-10 minutes for preschool-aged children. The EVT has two sections: labeling and synonyms. Using the EVT, the experimenter asked the children to look at pictures (see Appendix 4.G) and provide a one-word response describing what was in the picture. In the next section, children were asked for synonyms. They were told a one-word name for a picture and were asked to provide another one-word word for the same picture (see Appendix 4.G).

Importantly for this study, EF and Mc skills tend to be intertwined early in development and are difficult to parse. Moreover, they both play important roles to cognitive development and academic functioning. Thus, EF variables were included in the regression models predicting metacognitive, cognitive, and pre-academic skills. In addition, expressive language is a strong predictor of metacognitive skills, particularly declarative/articulated metacognition (e.g., Lockl

& Schneider, 2006, 2007). Thus, it was essential to include an expressive language measure as a covariate in the current analyses. The EVT was chosen for this purpose as it is appropriate and normed for use with preschool aged children and includes both labeling and synonym segments providing a comprehensive depiction of young children expressive vocabulary. In addition, to address the last research question, the HTKS and EVT were included as potential moderators to examine the potential variance within children's response to the DA.

Dynamic Assessment Intervention during the Card Recall Task

DA procedure. As described earlier, the general procedure for the DA intervention followed a card recall—mediated DA card recall post-test design with McK questions posed to the children after the card recall task (see the previous section on the card recall task for the pre- and post-test procedures that occurred before and after the DA intervention). The entire intervention spanned 5 minutes and involved the following specific directions:

1. Do: Place Set B in front of the child
2. Say: (adapted from Haywood & Lidz, 2007): "*Now it's my turn to be teacher. We're going to talk about how to remember what we see. Here are some new pictures. Please tell me the names of these pictures*" [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. Say: "*Like before, you're going to have to remember the names of these pictures after a few minutes. Okay? So, we should do something to help remember the pictures. Okay?*
3. After child assents, start the first type of DA mediated-instruction**: *Self-explanation Questioning*—**intended to elicit self-explanations regarding strategy usage—with the child: *I wonder what you could do that would help you remember the names of the pictures better. What do you think?"* [Wait and respond to child's response. If she/he does not offer a strategy or says "I don't know", prompt with: "*If you want to remember all of these pictures, how can you do that?* Then*, "What kinds of things have helped you remember things before? How do you think that helped? I wonder*

what would be most helpful. What do you think?" Continue using these questions that elicit self-explanations until the child offers (or starts to enact) a strategy. If needed, use practical encouraging prompts such as: *"Just give your best answer" What's one thing you can think of that would help you remember the pictures?"* The strategy offered or enacted by the child may or may not be a strategy known to be effective for recall (i.e., one with empirical support from memory research with young children such as 1. Rehearsal 2. Categorical grouping 3. Visual imagery 4. Creating stories/elaboration - these are in developmental order). As the child talks about/enacts the strategy, say: "*Hmmm, I wonder if that will help you remember. Let's try/keeping trying*" and ask the child to demonstrate the strategy with the cards if she/he hasn't already; as the child demonstrates, ask *"Is that helping you to remember? Why?"* If child discontinues the strategy, say: "*Can you remind me what you are doing to help you remember the pictures? Do you think it is helping?* If child continues with strategy, ask specific questions about it. For example, if they are using rehearsal say: "*Oh, you're saying the names of the pictures over and over again to yourself. Is that helping you remember?" Why?"*). If child is doing a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seems to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you're looking up* [or whatever the child is doing], "*what are you doing when you're doing that.* If the child is still struggling and not implementing a strategy, go to the next type of mediation.

4. The next type of DA mediated-instruction is **Prompts/hints**. Say: "*Other children your age have told me that looking at the pictures and saying the names over and over again to themselves has helped them remember. How would that work? How could you try that?* If child spontaneously starts to rehearse, allow and encourage that strategy and use other hints. If child does not, continue to prompt that rehearsing helps (e.g., "*Many other children just like you have said it works; it has also helped me before! How do you think it could work for these pictures? What about these?").* If child discontinues the strategy, say: *Remember that other children have said that saying the names over and over again to themselves has helped them remember the pictures. They said it really helps*"). *Another thing that helps people remember*

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pictures is thinking about how the pictures could go together helped them remember the names better. "How would that work?"... How could these pictures go together?" If child spontaneously starts to categorically sort, allow and encourage that strategy and use other hints for more accurate/efficient sorting. If child does not, continue to prompt that sorting by categories/groups helps (e.g., "*Many other children just like you have said it works; it has also helped me before! How do you think these two pictures go together?... And what about these pictures?").* If child discontinues the strategy, say: "*Remember that other children have said that thinking about how the pictures go together helped them remember them. They said it really helps*"). If child is doing a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seems to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you're looking up* [or whatever the child is doing], "*what are you doing when you're doing that.* If the child is still struggling and not implementing a strategy, go to the next type of mediation.

5. The third type of DA mediated-instruction is ***Explicit Instruction.*** Say: "*When I want to remember many pictures like this, I look at them and say their names over and over again to myself and say something about them like this* (demonstrate: e.g., "*School bus, school bus, school bus. Okay, that will help me remember the yellow school bus. Blue dress, blue dress, blue dress. Okay, I think I will remember that pretty blue dress with a pink bow now.)* Allow time for the child to start the strategy but if she/he does not spontaneously, say: *"Now you try it. Start with this picture. Okay, that'll help you remember because you are practicing the name and helping your brain remember it! Now try it for these pictures."* Again allow time for the child to start the strategy but if she/he does not spontaneously, say: *"Let's try like this"* and start to rehearse another set of pictures having him/her repeat afterward (e.g., "*Big truck, big truck, big truck." Okay, now I will remember the big red truck.*). Then go back to *"Now you try it."* If child discontinues the strategy, say: *"Remember, looking at the pictures and saying their names over and over again will help you remember the pictures…because it is practicing and helping the name stay in your brain so that you will remember it later." You can also make groups with pictures that are alike to help you remember them like this: These go together because they are alike* (e.g., tools).

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Allow time for the child to start the strategy but if she/he does not spontaneously, say: *"We can make groups with these pictures. Let's make groups with pictures that are alike/that go together. That will help you remember the pictures."* Again allow time for the child to start the strategy but if she/he does not spontaneously, say: *"Let's try like this"* and start to make a categorical group, e.g., by putting the shirt and pants together; hand the child the dress and ask her/him to place in the correct group. Provide as much help as necessary for at least one full group of categorically-sorted pictures. For example, if the child is not accurately sorting, point to one of the groups (e.g., Clothing) and say: "*Why did I put these in one group?... Tell me about the things in our groups…These are all _____".* Wait for the child to respond. If she/he does not give the correct answer, provide prompts (e.g., *"these are things we wear",* then identify the group,: *"this is a group of Clothing; each picture is a piece of clothing we wear"*). Once the child has successfully sorted the cards into a categorical group, say: "*Good, it helps when we make groups of like pictures. That way you only have to remember a few groups of pictures instead of 9 separate pictures!"* If child discontinues the strategy, say: *"Remember, putting the pictures into groups that are alike will help you remember the pictures…because there are less things to remember"*.

6. Provide 5 minutes to allow for mediated discussion before removing/hiding the cards. [Once child assents/is ready, set the timer for 5 minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures".* *Great! Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: "*I noticed you were looking up* [or whatever the child is doing], "*what were you doing when you did that*?"

Analytic plan

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The data analysis for this study will include group comparisons (repeated measures analysis of variances ANOVAs; (covariates: expressive language/EVT and executive function/HTKS) of: pre- and post-test card recall and associated Mc scores (the McK questions and McK strategies) to examine the malleability of children metacognitive (and cognitive) processes. In addition, a grounded analysis of the video records of children's behavior during the DA and card recall tasks was undertaken to explore how the different types of supports were associated with children's verbal and non-verbal responses. For example, note will be made of which type of support, if any, was associated with changes in responses or metacognitive behaviors for each child and then compare my notes across children for emerging patterns. This qualitative analysis will be integrated with the pre- and post-test and repeated measure comparisons to examine whether the grounded analysis aids in my interpretations of the quantitative results. Repeated-measures ANOVA and qualitative descriptive analyses examining patterns will be used to analyze this data.

All results will be interpreted through an integration of information-processing theory and sociocultural cognitive modifiability theories of cognitive development, with particular emphasis on the ZPD, in which children's abilities will be examined in terms of both their independent and mediated performances, and the ways in which children's metacognitive processing is affected by mediated information. Specifically, analyses will address whether mediated instruction will not only be associated with enhanced performance on a cognitive (i.e., card recall) task and metacognitive (i.e., accurately reporting strategies used and rating performance and behavioral Mc such as monitoring during the card recall task) task conducted during the DA, but also whether basic cognitive skills such as EF and expressive vocabulary will affect children's metacognitive processing.

Results

Descriptive Results

The descriptive results for the sample split by GSRP and Tuition-based preschool classrooms on the Mc, EF, and cognitive (expressive vocabulary and card recall) assessment tools can be seen in Tables 4.1 and 4.2. In general, these tools have both revealed more metacognitive capabilities in these preschool-aged children than previous studies, particularly involving interviewing children (the metacognitive questions regarding the card recall task), would indicate, with the exception of the recent studies that have been reviewed here. In addition, as can be seen in Table 4.1, not surprisingly, the children in the GSRP (low-SES) class obtained lower scores across all measures than the children in the Tuition-based preschool classes. Furthermore, as can be seen in the correlation table, Table 4.2, the executive function and expressive language scores were largely associated with the metacognitive processes as hypothesized. Though Table 4.2 presents results for the sample as a whole the correlations hold for both the GSRP and Tuiton-based classrooms with several exceptions. The McK questions for the children in the GSRP classrooms were significantly correlated with their Applied problems scores (r=.33, p=.03) at pre-test whereas they were not for the children in the Tuition-based classrooms (r=.12, p=.18). Interestingly (though not related to the research question on whether metacognitive processes would function as protective or mediating factors for young children at risk for learning difficulties), the pre-academic functioning scores (letter word identification and applied problems) for the children in the GSRP classrooms were not significantly related (r=.27, p=.09) whereas the scores for the children in the Tuition-based classrooms showed a high to moderate association as is common with these types of standardized academic achievement tests (r=.59, p<.001). Similarly, the executive functioning and expressive vocabulary scores for the

children in the GSRP classrooms showed no association (r=.10, p=.54) whereas the scores for

the children in the Tuition-based classrooms showed a low but significant association (r=.31,

p=.04). Because the children in the GSRP classroom who had higher metacognitive processing

also had higher cognitive and pre-academic scores, it may be that these underlying skills were

serving as resilience factors across content areas even though the children's cognitive and pre-

academic functioning was not consistent (i.e., the children who scored high on pre-academic

functioning in mathematics were not necessarily the same children who scored high on pre-

academic functioning in language arts in the GSRP classrooms).

Table 4.1.

Children's Scores on the Measurement Tools (all children; n=83)

Assessment	GSRP *M*(*SD*); Range	Tuition *M*(*SD*); Range
Card Recall	**Pre:** 4.36(2.08); 0-8 **DA/COMP:** 6.26(2.60); 0-9 **Post:** 4.90(2.35); 0-9	**Pre:** 4.54(2.03); 0-7 **DA/COMP:** 6.20(2.72); 0-9 **Post:** 5.15(2.53); 0-9
McK Questions	**Pre:** 1.62(1.17); 0-4 **DA/COMP:** 2.12(1.90); 0-7 **Post:** 1.81(1.47); 0-6	**Pre:** 2.02(1.66); 0-5 **DA/COMP:** 2.43(2.08); 0-8 **Post:** 2.05(1.79)0-6
McK Strategies	**Pre:** 0.69(.75); 0-2 **DA/COMP:** 2.67(1.49); 0-6 **Post:**	**Pre:** 0.88(0.81); 0-3 **DA/COMP:** 2.56(1.45); 0-5 **Post:**

|	1.64(1.06); 0-4	1.90(1.32); 0-4
HTKS	9.62(10.84)0-41	12.07(13.28); 0-42
EVT	99.48(10.54); 79-130	100.02(12.76); 39-121
LW	102.71(15.18); 72-135	114.73(17.45); 72-155
AP	99.60(13.05); 68-125	103.39(15.16); 59-137

Table 4.2.

Correlations between the children's Mc, EF, expressive language, cognitive and pre-academic assessment scores controlling for age.
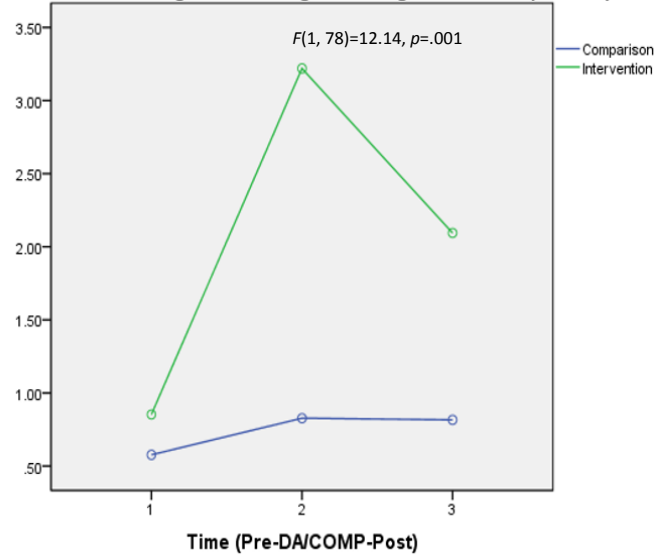
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. McK Questions_Pre	-	.51***	.42***	.18	.28*	.14	.40***	.32**	.28*	.36**	.31**	.22*	.32**
2. McK Questions_DA/COMP		-	.63***	.28*	.47***	.28*	.51**	.46****	.49***	.42***	.31**	.26*	.36**
3. McK Questions _Post			-	.25*	.34**	.29**	.26*	.28*	.51***	.43**	.27*	.33**	.38***
4. McK Strategies_Pre				-	.45***	.36**	.36**	.42**	.45***	.19	.16	.05	.17
5. McK Strategies_ DA/COMP					-	.61***	.29**	.66***	.62***	.21	.36**	.05	.16
6. McK Strategies_Post						-	.38**	.56***	.55***	.19	.24*	.09	.16
7. Card Recall_Pre							-	.58***	.43***	.22*	.27*	.13	.38**
8. Card Recall_ DA/COMP								-	.63***	.25*	.37**	.13	.33**
9. Card Recall_Post									-	.31**	.46***	.20	.33**
10. HTKS (Executive function)										-	.32**	.26*	.45***
11. EVT (Expressive Vocabulary)											-	.38***	.42***
12. Letter Word Identification												-	.47***
13. Applied Problems													-

*p < .05, ** p < .01 *** p < .001

Metacognitive Questions on the Card Recall (out of 6)

$F(1, 78)=4.67, p=.03$

Comparison
Intervention

Time (Pre-DA/COMP-Post)
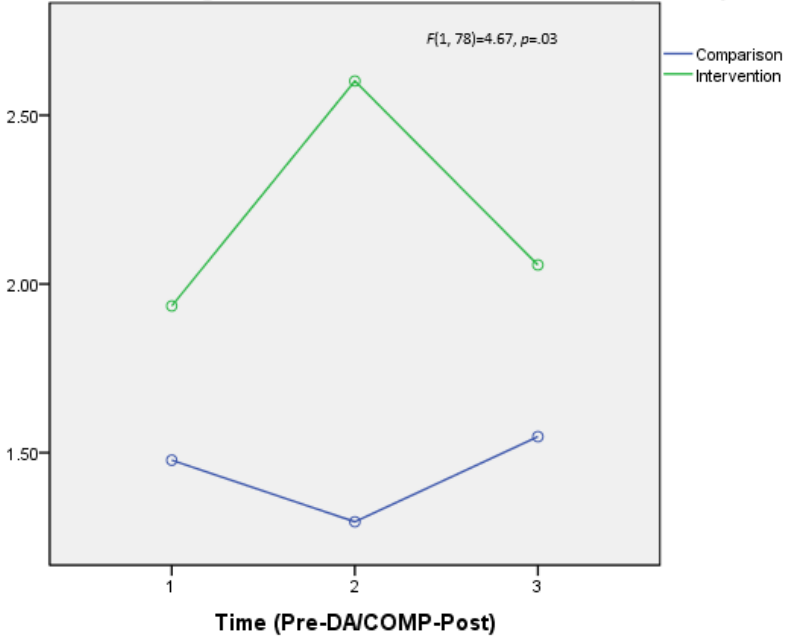
Metacognitive Strategies During Card Recall (out of 6)

$F(1, 78)=12.14, p=.001$

Comparison
Intervention

Time (Pre-DA/COMP-Post)

Controls: Age, HTKS, EVT

Card Recall Task (out of 9)

$F(1, 78)=12.37, p=.001$

Comparison
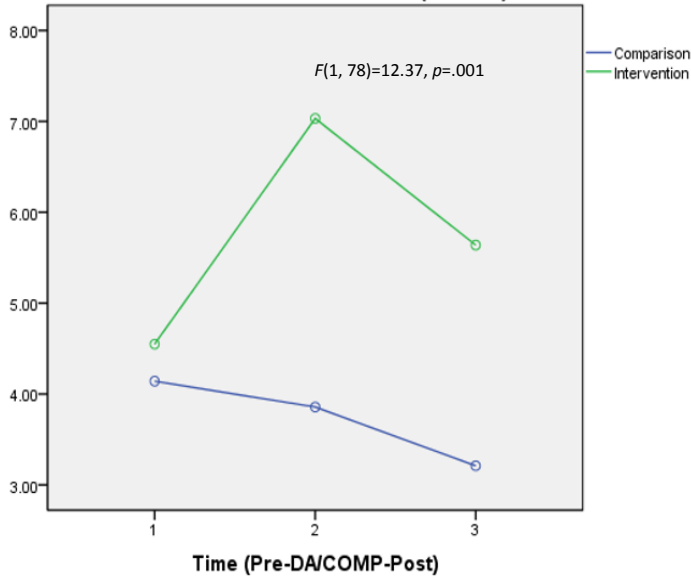Intervention

Time (Pre-DA/COMP-Post)

Figure 4.1. Comparison and Intervention group scores on the metacognitive and cognitive tasks from at all time points (pre- to DA/COMP to post-test).

To address the first research question regarding the malleability of children's metacognitive processes; specifically related to the effectiveness of a DA intervention in facilitating metacognitive processes in preschool-aged children, a series of mixed-effect model analysis of variances (ANOVAs) were undertaken using IBM SPSS Statistics 20.0 controlling for age, expressive vocabulary (i.e., the EVT) and executive function (i.e., the HTKS) where time was the within-subject repeated measures variable and condition was the between-subject. The outcome measures in these ANOVAS were 1. The metacognitive strategies used during the card recall task (e.g., sorting the cards into categorical groups; using rehearsal; visualizing the location of cards, etc., and saying that this strategy would aid in remembering the cards), 2. The card recall task itself (the cognitive measure) and 3. The McK questions asked about the card recall task immediately afterward. Across all three outcomes, the children in the intervention group showed significant growth from pre- to DA to post-test (see Figure 4.1) compared to the comparison group (with the exceptions that the children in the intervention group did not gain significantly from the pre-test or DA to the post-test on the metacognitive questions related to the card recall task). Moreover, there was a similar pattern of results across the three measures where the children improved greatly from pre-test to the DA intervention (peaking during the DA intervention when they were receiving mediated support) and decreasing at post-test (not significantly except for the metacognitive questions where they returned to only slightly higher than their pre-test scores).

Regarding the second part of the first research question, what does DA reveal about mechanisms that facilitate metacognitive development in preschool-aged children, as can be seen in Table 4.3, certain McK strategies were facilitated more so than others. For example, categorizing increased from 3.2% of children using the metacognitive strategy (i.e., using a

categorizing strategy and indicating that it would be helpful to their learning, such as "I put all of the fruit together, now I will remember them!") to 90.3% of children using categorization during the DA intervention. Some strategies maintained this increase to post-test when the children were not receiving support. For example, the use of the McK strategy talk/elaboration showed a large increase from pre-test to DA from 17.7% to 50%, and only decreased slightly to 46.8% at post-test. This strategy involved talking and/or elaborating about the pictures on the cards, such as making up a story about the cards or singing a song about them. For example, saying: "I know, I'll make up a story about the pictures! That will help me remember a lot of them… Okay… My Dad has a red truck (a picture card) and he is going to wear his jeans (a picture card) and shirt (a picture card), put his hammer (a picture card) in the back and bring our dog (a picture card), and go to work." Also, using the McK strategy recalling in groups in which children named the picture cards they remembered in groups, for example saying "I remember… the Pets! The dog, cat…and rabbit! It helps to remember them when you think about them altogether, like in a group". At pre-test, 37% of the children used this strategy. During the DA, this increased to 88%, and only decreased slightly at post-test to 72.6%. The use of rehearsal (i.e., repeating the name of the picture cards over and over) and saying that this was helpful to remembering the pictures showed a similar pattern as well (see Table 4.3). Thus, it appears that the DA differentially facilitated metacognitive strategies.

Table 4.3.

Metacognitive knowledge (McK) strategies most facilitated during the DA intervention in percentages of children using each strategy at each time point.

McK Strategies	Pre-test	DA	Post-test
Categorize *("Putting these animals together will help me remember them!")*	3.2	90.3	32.3
Rehearsal	24.2	71.0	54.8
Talk/Elaborate	17.7	50.0	46.8
Recall in groups	37.1	88.0	72.6
Visualize	3.2	9.7	3.2
Other	1.6	16.1	8.1

Furthermore, the type of support during the DA seemed to be differentially associated with metacognitive strategy use (see Table 4.4). During the 5 minutes of the DA intervention, there were three different types of instructional support: Self-explanation, Prompts/hints, and Explicit instruction. Children used the greatest average number of total metacognitive strategies (*M*=12.50, *SD*=8.66) during the explicit instruction support compared to using an average of only 3.74 (*SD*=4.45) metacognitive strategies during the Prompts/hints instructional support and an average of 1.50 (*SD*=3.08) metacognitive strategies during the Explicit instruction instructional support. Thus, similar to two meta-analyses examining the most effective interventions for vocabulary acquisition (Marulis & Neuman 2010, 2013) in preschoolers,

explicit instruction was also the most effective method for facilitating metacognitive processes.

However, it may be that the Self-explanation and Prompts/hints support were similarly

facilitative but the explicit behaviors did not appear as greatly until the last Explicit support.

Integrating a neurological technique such as EEG (Electroencephalography) to measure ERPs

(Event-related potentials) may provide additional information to help parse this analysis.

Table 4.4.
Frequency of McK used during the instruction types of the DA intervention.

Instruction Type	Self-explanation	Prompts/hints	Explicit/mediated
5 minutes	What could you do to help you remember?	Other children said sorting into groups of pictures that go together helped them remember.	Sorting into groups of pictures that go together makes it easier to remember the cards. How would that work?
M(SD) McK strategies; *n*=62	**1.50 (3.08)**	**3.74 (4.45)**	**12.50 (8.66)**

The second research question concerned whether there were associations between

executive functioning, expressive language, and Mc in this sample of preschoolers. As can be

seen in Table 4.2, both executive functioning (i.e., the HTKS task) and expressive language (i.e.,

the EVT) were significantly related to most of the metacognitive and cognitive processes in the

preschoolers; the correlations were low to low-medium in magnitude (*r*s=.22-46). Not

surprisingly, the EVT had the most and strongest associations to the metacognitive processes (all

correlations to metacognitive processes were significant with the exception of that to the McK

strategies at pre-test).

To specifically address whether individual differences in executive functioning and expressive language would predict metacognitive performance, a backwards stepwise regression model was undertaken including the following predictors: age, gender, SES, EVT (expressive vocabulary), HTKS (executive function) first predicting children's scores on the metacognitive knowledge questions post-test (related to the card recall task). For both the McK questions related to the card recall task and the McK strategies (i.e., total metacognitive strategies used during the card recall task), the best fitting models were ones that included all entered variables (age, gender, SES, EVT, and HTKS). Because this indicates that these models contained only variables that uniquely contributed to predicting learning, these results suggest that the HTKS and EVT did not uniquely predict metacognitive development. For the McK strategies, this model fit was $R^2=.33$, $p=.03$; for the McK questions, the model fit was $R^2=.49$, $p<.001$.

To address the third and final research question on how preschoolers' metacognitive skills related to cognitive development and pre-academic functioning and whether metacognitive skills served as protective, resilience, factors for young children at risk for learning difficulties, Pearson correlations between the metacognitive measures and cognitive and pre-academic measures were first conducted (controlling for age, EVT, and HTKS). As can be seen in Table 4.5, the children's metacognitive scores were significantly correlated with their cognitive abilities (i.e., their metamemory knowledge scores were correlated with their memory tasks scores at pre-, DA/COMP and post-test). Additionally, as can be seen in Table 4.2 (the correlational table), children's metacognitive processes were significantly associated with their pre-academic achievement across language arts and mathematics.

Table 4.5.

Correlations between McK questions and cards remembered on the memory task.

Card Recall Task			
McK Questions	**Pre-test**	**DA/COMP**	**Post-test**
	.32, p=.003	*.31, p=.001*	*.42, p<.001*

Regarding the predictive strength of the metacognitive processes, the metacognitive knowledge questions uniquely predicted both the children's Letter Word Identification and Applied Problems pre-academic funcitoning beyond the other variables included in the model (see Table 4.6).

Table 4.6.

Metacognitive, cognitive, and demographic variables predicting pre-academic functioning.

Letter Word Identification (Pre-academic Language Arts Skills)	$R^2 = 51$	$F(3, 79) = 8.09$***
	β	p
McK Questions	.37	.001
Age	.24	.02
Expressive Vocabulary	.19	.07

Applied Problems (Pre-academic Mathematics Skills)	$R^2 = .64$	$F(5, 77) = 10.44$***
	β	p
McK Questions	.30	.007
Age	.27	.01
Expressive Vocabulary	.25	.009
HTKS (executive function)	.28	.013

Note: *** $p < .001$

Lastly, to address the last part of the final research question about Mc serving as a protective factor for young children traditionally at risk for learning difficulties (i.e., promoting

their learning and greater academic achievement despite risk factors that typically are associated with negative learning and academic outcomes), when controlling for SES, the McK questions were still the best predictor for Applied Problems, but expressive vocabulary was the best predictor for Letter Word Identification. Furthermore, the GSRP and Tuition-based classes had differential associations between the metacognitive processes and the cognitive and pre-academic skills, providing further indication that Mc may—at least partially—serve as a protective factor for the children in the GSRP classes, at least specific to problem-solving mathematics. For example, the relation between the McK questions and the Applied Problems for the children in the GSRP preschool classes was .46, $p=.02$ whereas it was .27, $p=.07$ for the children in the Tuition-based preschool classes. In contrast, the relation between the McK questions and the HTKS executive function task was .53, $p<.001$ for the children in the Tuition-based preschool classes, while it was .12, $p=.47$ for the children in the GSRP preschool classes suggesting that, for the children from the higher SES families, metacognitive processes are more strongly linked to executive functioning processes and may not be recruited as much for pre-academic functioning. It may also be that these pre-academic assessments were not as challenging for the children in the Tuition-based preschool classes (as can be seen by their significantly higher scores, see Table 4.1) and thus they did not need to recruit metacognitive knowledge.

Discussion

The socially-mediated DA intervention conducted in this study comprised a brief—five minute—metacognitive instructional training support related to skills needed to succeed on a card recall task for 3-5 year old children. The children who received this DA intervention obtained significant gains on metacognitive strategies and metacognitive knowledge questions as

well as the card recall task itself. To be more specific, the DA and the questions posed to the children afterward targeted children's metamemory, though memory, as Flavell has described it, is "in good part just applied cognition" (Flavell 1971, p. 273). Thus, children were able to apply the metacognitive skills that were facilitated—and I would add, co-constructed—during the mediated DA to the cognitive task (i.e., improvement on the card recall memory task). These children—unlike those in the Resnick and Glaser's studies as described by Flavell (1976)—were able to succeed on this problem solving task, particularly immediately after the DA metacognitive support, but even at post-test when they did not receive support during the card recall task (thus received no support or interaction around doing something to remember the cards), the children in the DA intervention group maintained a significant gain in cards remembered on the card recall task (in addition to the metacognitive knowledge strategies and questions). The findings from this study support Flavell's assertion (1976) that accompanied his inauguration of the term "metacognition"; namely that the reason children were failing to solve problems (for which they knew the solutions), in studies such as those of Resnick and Glaser was due to limited *metacognitive* processing. These limited metacognitive processes were likely due to the limited experiences (such as MLEs) that the children were exposed to where they were supported in acquiring metacognitive skills and strategies or had experiences where metacognitive skills and strategies were modeled. Furthermore, they may not have experienced situations in which metacognitive skills needed to be (or were encouraged to be) recruited. As seen in the current study, a brief 5 minute DA intervention was associated with considerable increases in children's metacognitive skills and strategies, suggesting that these types of MLE opportunities were novel to and facilitative for the children.

Similarly, I propose that the mechanisms underlying the children's growth and success in the current study are metacognitive processes, experiences, and supports. During the DA, children were facilitated in understanding *when, how,* and *where* and to apply the strategies they were receiving mediated instruction in. For example, if the child was not accurately sorting the picture cards during the DA mediated card recall task, the experimenter would point to one of the groups she had previously made (e.g., Clothing) and say: "*Why did I put these in one group? Tell me about the things in our groups…These are all ___ ".* Then the experimenter would wait for the child to respond. If she or he did not provide appropriate responses, the experimenter would provide prompts (e.g., "*these are things we wear", then identify the group: "This is a group of Clothing; each picture is a piece of clothing we wear").* Once the child had successfully sorted the cards into a categorical group, say: *"Good, it helps when we make groups of like pictures. That way you only have to remember a few groups of pictures instead of 9 separate pictures."* If child discontinued the strategy, say: *"Remember, putting the pictures into groups that are alike will help you remember the pictures…because there are less things to remember. When you have to remember things, you can make it easier by making groups like this."*

The results show that the children in the DA intervention group made significant gains from the pre-test to the DA as well as the DA to the post-test and the traditional pre-test to post-test. By examining both the children's independent and mediated performance in this way, a more nuanced picture emerged showing that a greater gain is made between the pre-test to the DA than the pre-test to the post-test (i.e., indicating that the mediated support provided by the DA was additionally beneficial to the children's metacognitive and cognitive processing). This would have been obscured if only the children's scores on the pre- and post-tests had been examined as is traditionally done in intervention studies. By examining both children's independent (i.e., the pre- and post-test scores) and mediated (i.e., the DA scores) performance

(grounded in the sociocultural theory of cognitive development, underscoring the ZPD a more comprehensive picture of the preschoolers' capabilities on their own and with different types of support was revealed. Similar pattern of results were found across outcomes where the children's scores greatly increased during the DA (i.e., mediated performances) and decreased at post-test, but still maintained significantly and substantial gains overall between pre- to post-test. Based on deep theoretical framework—the sociocultural, including the ZPD, and cognitive modifiability theories—and empirical research, children's mediated performance is more predictive of their knowledge/understanding/achievement than assessments of their independent performances (Poehner, 2005).

Also, by closely examining changes in the children's behavior from the pre- to the DA/COMP to the post-test of the card recall task, the second part of the first research question regarding the types of mechanistic information that a DA intervention could reveal about the facilitation of metacognitive development in preschoolers was able to be addressed. The DA revealed that not all McK strategies were facilitated equally (though this may also be—at least in part—related to development, see Ornstein, Haden, & San Souci, 2010). Children substantially maintained a gain from DA to post-test on three McK strategies in particular (rehearsal, talking/elaborating, and recalling [picture cards in groups]). One McK strategy (categorizing) showed the largest gain though children's scores also showed a considerable drop between the DA and post-test for this strategy. The DA targeted all McK strategies (the least focus being on visualization as this is a later developing skill), which is reflected in the general increase in all of the strategies. Furthermore, the cards themselves were selected (see Appendix 4.B) based on category families. While this was not explicitly made any more prominent to the children than the other McK strategies barring visualization, it may have been inherently salient due to the

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familiarity of the pictures and categories (e.g., Pets/Animals: dog, cat, rabbit). However, the categorization McK strategy did not maintain as well as the other strategies once the children were performing independently at post-test. It may be that this is more of a shared (or co-constructed) strategy. For example, some children talked about the similarity between the card recall game in this study and the children's game "Memory." They wanted to make groups of cards together to play in a way that was somewhat parallel to Memory (though they were continually reminded of the specific procedures of this game and that—and how—it was different from Memory). However, some children continued to make piles of alike cards during the DA in which they would hand me a card that "went with" a card that was close to me and so on. Therefore, it may have been less of a solitary strategy from their viewpoint. In future studies, this could be parsed by being more explicit about categorizing on their own and/or including a peer condition in which the children perform the card recall task with another child to examine individual vs. interactive strategies.

Furthermore, it was somewhat surprising that the Explicit DA instruction resulted in the greatest average number of McK strategies being employed (12.50 during the 5 minute card recall task). The mean McK strategies were far lower for the self-explanation and prompts/hints DA instruction (1.50 and 3.74 respectively). This could be because the explicit instruction was the last type of support and thus the children had had more experience and more mediated instruction at this point in the DA, but there was a much greater peak in scores between the self-explanation and prompts/hints (from 1.50 to 3.74) than between the prompts/hints and self-explanation (from 3.74 to 12.50), therefore, this likely was only a partial explanation. Theories and previous research have suggested that self-explanation (Siegler, & Lin, 2009; Wellman & Lagattuta, 2004) and prompts/ hints (Feuerstein et al., 1980; Haywood & Lidz, 2007) could be

similarly facilitative of children's regulatory processes, though that was not borne out in the current study. Some of this research (or the research review) pertained to older children, but some focused on preschool-aged children. Thus, these results may be specific to the facilitation of *metacognitive* processes. These results are similar to two recent meta-analyses that examined the effectiveness of interventions on preschoolers' word learning Marulis & Neuman, 2010; 2013). In both meta-analyses (Marulis & Neuman, 2013 focused on preschoolers at risk for learning difficulties), explicit instruction; that is, instruction that emphasized strategies for directly teaching vocabulary (e.g., detailed word definitions and examples were given before, during, or after a storybook reading with a follow-up discussion designed to review these words) was found to be most effective type of instruction for preschoolers' vocabulary learning (whether or not they were at risk for learning difficulties). Similar results between a more discrete skill such as vocabulary learning and metacognitive processes—a seemingly more socially mediated (e.g., see Brinck & Liljenfors, 2013) skill—were surprising. Self-explanations and prompts/hints would be expected to be similarly facilitating for Mc. However, the entire DA intervention was socially mediated so it may simply be that self-explanations and prompts/hints were not powerful enough to foster the children's metacognitive processes, particularly in such a short time for this young age group. The preschoolers may have needed more explicit instructions and mediation due, in part, to their age and limited experience with metacognitive tasks and applying McK strategies to cognitive tasks.

Moreover, based on the successful work by Feuerstein et al. (1980) that used cognitively-based mediated techniques and self-questioning, specifically a process called *guided discovery* where an adult would lead a child to discover the solution to a problem, greater McK strategies

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resulting from the self-explanations and prompts/hints DA instruction that was similar to the guided discovery used by Feuerstein et al., 1980 may have been hypothesized

However, Fabricius and Hagen (1984), found that *only* when young children (first and second grade students) verbally attributed the increase in their memory performance to a sorting strategy, did they subsequently continue to use that strategy (and chose *not* to use other previously-used strategies such as rehearsal). The children who did not make this causal attribution explicitly did not subsequently make a more efficient choice of strategies in the next memory task sessions. This use of an explicit verbalized causal attribution was similar to the explicit instruction portion of the DA intervention in this study, suggesting that memory strategies—and becoming metacognitive about the use of them—may require explicitness. As mentioned earlier, this should be investigated further with a between-subjects condition and possibly the addition of a neurological method.

Although, as hypothesized, the children's metacognitive processes were associated with both their executive functioning (HTKS) and expressive language (EVT) ranging from low to low-medium (rs=.22-46) and both were included in the final model that best predicted metacognitive scores, neither the HTKS nor the EVT uniquely predicted the children's metacognitive performance. As discussed previously, the associations between these related skills have rarely been explored in preschoolers (or children in general) and thus, this is an area in great need of additional investigation. Theories (e.g., Fernandez-Duque et al., 2000; Goldberg, 2004; Lyons & Zelazo, 2011; Zelazo & Müller, 2002) suggest that EF and Mc function similarly and the studies that have investigated these constructs in children indicate that they are related in important and interacting ways over development (Bryce, 2007; Bryce & Whitebread, 2008;

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Whitebread, 1999). In addition, expressive language has also been shown to be related to metacognitive processes in young children (Lockl & Schneider, 2006; Lockl & Schneider, 2007) but it is unclear whether expressive language precedes metacognitive development, vice versa, or whether they interact in early development. Though the scores on the EVT were associated with, and were included in the best fitting model that predicted the children's metacognitive scores, it was somewhat surprising that they did not uniquely predict any of the children's metacognitive performance given the language heavy nature of the metacognitive tasks in this study.

Accordingly, exploring how early EF, Mc and language are developing, interacting, and impacting learning is a crucial area to investigate in young children. Nevertheless, this remains an area that has been largely uncharted. This was not a main aim of the current study, and thus was not investigated in depth. However, I have planned future longitudinal investigations to comprehensively study the development of early EF, Mc, language, and associations to cognitive and academic functioning in preschoolers.

The culminating research questions that this study was designed to address centered on whether preschoolers' metacognitive would be associated with cognitive and pre-academic functioning, particularly for young children at risk for learning difficulties. As reviewed earlier, there is robust evidence that Mc is not only associated with cognitive and academic skills but uniquely predicts these skills beyond intelligence scores (e.g., Veenman, & Beishuizen, 2004; Veenman & Spaans, 2005; Veenman et al., 2004). However, this evidence is primarily focused on children in middle primary grades and adolescents. The current study provides solid evidence that these associations are also present for young children, prior to beginning formal schooling (and thus without this "training"). In addition, these associations were only slightly—and not significantly—lower at pre-test than at the DA intervention or post-test. Therefore, these

associations do not seem to be dependent upon intervention (though would likely be strengthened by it). Moreover, the McK questions posed to the children directly after the card recall task were the best predictors of the children's scores on both the letter word identification and applied problems measures of pre-academic functioning (similar to the Metacognitive Knowledge Interview—McKI—in Study 1; Marulis et al., submitted) when entered in a model with the other SRL, cognitive, and demographic variables. This was also true for the children from the GSRP classrooms (from low-SES families, many of whom also have other risk factors such as minority status, low maternal education, single-parent family, English language learner (ELL), and longer periods of high maternal depressive symptoms) who obtained similar correlations between many of the cognitive and pre-academic variables and their metacognitive functioning as the children from the Tuition-based classrooms. This finding indicates that, like previous research focused on other SRL skills (Matthews et al., 2010; Sektnan et al., 2010), Mc has the potential to serve as a protective factor for children at risk for learning difficulties as it is linked with higher cognitive and pre-academic functioning in the face of various environmental factors shown to typically negatively impact academic achievement. This is encouraging for addressing the achievement gap related to SES, however because this gap is .5 *SD* (Borman & Dowling, 2010; Perry & McConney, 2010) and begins to emerge before children reach their first birthday (Halle et al., 2009), children at risk for learning difficulties will need powerful intervention related to metacognitive processes (aligned with content knowledge and other SRL variables) to work toward narrowing this gap. This is an area that is in need of systematic research programs and intervention work. Moreover, because the DA intervention was successful with the preschoolers, including the children from the GSRP classrooms, targeting these metacognitive skills and strategies through intervention appears to be a fruitful way to boost the

learning and academic achievement of young children, particularly those traditionally at risk for

learning difficulties. As Vygotsky and Feuerstein maintained, metacognitive regulatory skills in

the children in the current study seemed to act as supportive factors enhancing children's

cognitive development and learning and helping them to advance to higher levels of functioning.

Moreover, as Feuerstein and his colleagues (1979, 1980) emphasized—and supported with

empirical evidence—children deemed "at risk for learning difficulties", for example, children

from low-SES families, tend to have lower levels of learning and academic achievement due to

fewer learning-related experiences (such as MLE opportunities) than their higher-SES peers. The

current study was designed to investigate this line of reasoning related to examining

metacognitive processes as possible protective, mediating, factors for children at risk for learning

difficulties. The results are in line with the claims made by Feuerstein et al., 1979, 1980. The

children in the GSRP classrooms' metacognitive experiences, supports, and processes were

boosted during the DA, which—at least partially—increased their learning performance

indicating that Mc may act as a protective or mediating factor for children at risk for learning

difficulties. It is, thus, an important factor on which to intervene—provide MLE—for all

children, particularly those at risk of struggling with learning or low academic outcomes.

Limitations and Recommendations for Future Research

Before concluding, there are several limitations of the current study to be addressed, as

well as recommendations for future research to be made.

First, the metacognitive processes (McK questions and McK strategies; see Appendix 4.A

and D) were scored using a coding scheme that was developed by the first author. Though a

similar coding scheme for the McK questions was comprehensively assessed in a previous study

(Marulis et al., submitted; Marulis et al., 2013), it has not yet been tested using a

psychometrically-robust approach. For example, a factor analysis has not yet been conducted and there is not yet reliability or validity information available for this coding scheme because this was not a longitudinal study. However, a second researcher coded 30% of the children's responses and behaviors and a high level of agreement was reached. Furthermore, the questions and the scoring system was designed to be parallel to the McKI, which has been used in a large pilot study and two additional studies with consistent and reliable results (Marulis et al., submitted; Marulis et al., 2013). In addition, it is unclear what the floor and ceiling effects would be with these types of assessments, but with this age group (3-5 year olds), the coding schemes were appropriate and there were few children who received minimum (0) or maximum scores.

Second, the DA intervention was brief as it was intended to be an exploratory study rather than a full intervention. Therefore, though the intervention was designed based both on DA principles (e.g., Haywood & Lidz, 2007) and those of SRL intervention for preschool-aged children (e.g., Dignath et al., 2008; Donker et al., 2014), this was not intended to be a full scale intervention study. Related to this, I was unable to counterbalance the types of instructional support (i.e., self-explanation; prompts/hints; explicit instruction) of the DA to examine effects more precisely. This also meant that I was unable to parse effects of the explicit instruction in facilitating children's metacognitive processes from the other types of DA supports and the cumulative effects of the three types of DA support. However, as discussed previously, there was a considerable increase in scores between the prompts/hints and explicit instruction whereas there was only a small increase in scores between the self-explanation and prompts/hints instruction. Therefore, it is likely that the explicit instruction, in part, was associated with greater metacognitive processing in the preschoolers. In future research, these should be disentangled

with a proper intervention study, and a between-subjects condition to directly compare the types of DA support. The addition of a neurological measure (e.g., EEG) to investigate internal processing during the DA support that may be taking place prior to explicit behaviors would also be beneficial.

Relatedly, there was a small comparison group, and thus unequal sample sizes between the two groups. This was a purposeful design choice as the main aim of this study was to investigate the effects of a DA intervention and what it would reveal about young children's metacognitive processing. Consequently, when the final sample (after the removal of children who were unable to understand or speak any or very limited amounts of English) was 83, 75% was reserved for the intervention group in order to have a large group to study in depth. This resulted in 62 children for the intervention group and 21 children for the comparison group which, while small, was still an appropriate sample size for analysis.   In the current study, effects were detected between the groups, but there may have been some obscuring of nuanced effects. Taking a simple correlational example, the card recall scores were significantly—but differentially—related at all time points for the intervention group. The correlation between pre- and post-test was .44, while the correlation between pre-test and DA was .58, and the correlation between DA and post-test was .67, all ps <.001. If one were to simply consider the relation between pre- and post-test, the association between children's scores at the different time points would appear smaller than they actually may be based on both independent *and* mediated performance. This should be investigated in future research with comparable group sizes.

Third, though information provided by DA studies is valuable in the ways that have been outlined, the information is not normative and inferences for instruction are limited to the type

built into the DA. Consequently, generalizability will be limited. Future studies should examine effects of broader instruction developed from the mechanistic information obtained in this study.

Lastly, I was unable to obtain specific family SES data from a large portions of the families in the study. Therefore, for the demographic variables, class level SES was used based on whether the children were enrolled in the GSRP classes or the Tuition-based classes. Thus, even though effects were obtained in the expected direction (i.e., the children in the GSRP had lower metacognitive, cognitive, and pre-academic scores than the children in the Tuition-based classes), the variable used was not specific to each child's family. Consequently, the effects were not examined precisely, which is important to pursue in future research to examine whether Mc would serve as a protective factor for children from families with specific risk factors. However, though these analyses were based on a broad class variable, this was a close proxy due to the specific preschool program eligibility clause (i.e., in order to be eligible to enroll in the GSRP program, a federally funded program, the families had to meet federal poverty income levels based on their household size).

Conclusion and Implications

The findings from this study indicate that—as hypothesized—the preschool children's metacognitive processes were considerably (though variably) malleable and that using a systematic DA intervention to foster these processes was effective both proximally (the specific skills that were trained—i.e., the metacognitive strategies—were facilitated) and distally (skills that were not specifically trained—i.e., the card recall memory skills themselves—were facilitated). As suggested by Haywood and Lidz (2007), it was a worthwhile endeavor to focus this DA specifically on metacognitive processes as its outcome measure. Similar to the way DAs

with preschoolers targeting cognitive and pre-academic domains in preparation for preschool have been successful in facilitating these skills (Bensoussan, 2002; Haywood & Lidz, 2007; Malowitsky, 2001), this DA successfully facilitated metacognitive processes in preschoolers.

Explicit mediated instruction was the most effective in facilitating metacognitive processes in young children (at least after having experienced Self-explanation and Prompts/hints DA instruction) and specific McK strategies were most facilitated (rehearsal, recall clustering, talking/elaborating and categorizing though this was not maintained as well from the DA to post-test as the others). Children's executive functioning and expressive vocabulary were related to their metacognitive processes but, though they were included in a best fitting model predicting these skills, were not unique predictors. And, lastly, children's metacognitive processes were not only related to cognitive and pre-academic skills but their children's responses to the McK questions were the best predictors of both the language arts and mathematics pre-academic skills. This was particularly true for children at risk for learning difficulties.

Accordingly, studying preschoolers' metacognitive processes and relations to development and learning is particularly fruitful as this is when it is most likely to affect subsequent developmental, cognitive, and academic trajectories (Camilli et al., 2010; Heckman & Masterov, 2007), particularly for children living in poverty (Barnett, 2011). Examining developing metacognitive skills and ways they are best supported early in a child's developmental and educational trajectory (i.e., just before or at the transition to schooling) has strong implications for early childhood policy, particularly related to commitments to equitable access to educational and social opportunities: helping all children reach their highest learning and academic potentials.

Appendices

Appendix 4.A. Card Recall Task and Metacognitive Knowledge (McK) Questions.

ID

Memory and Metamemory: Card Recall task PERFORMANCE
Conceptualizing and Assessing Metacognitive Development in Young Children

VERSION B

At pretest, after two minutes, say: *"Okay, time is up. Now, tell me the names of the pictures"*. Check the pictures correctly recalled. Record any different (incorrect) responses and total points under "Pretest" (1 point per correct response). Follow the same procedure for DA and posttest. Write comments about child's behavior (verbal/non-verbal) in the Notes section.

One point for each item recalled. Record order in which child recalls.	Pretest	DA	Posttest
1. Jack-in-the-Box___ Block ___ Teddy bear ___ Different responses:			
2. Football ___ Basketball ___ Baseball ___ Different responses:			
3. Apple ___ Banana ___ Orange ___ Different responses:			
1. Dog ___ Cat ___ Rabbit ___ Different responses:			
2. Chair ___ Table ___ Couch ___ Different responses:			
3. Peas ___ Corn ___ Carrot ___ Different responses:			
1. Pants ___ Shirt ___ Dress ___ Different responses:			
2. Saw___ Hammer___ Screwdriver ___ Different responses:			
3. Car ___ Bus ___ Truck ___ Different responses:			
TOTAL POINTS	/9	/9	/9

Notes:_____

_____

Name:_____Date:_____ID:_____Teacher:_____

Metacognition Knowledge Questions
Use this protocol after children have completed the Card Recall task (Pre-; DA; and Posttest)

CARD RECALL TASK_*PRE*

Once the Card Recall **_PRETEST_** task is complete, tell child: "Thank you for working on this card game! I would like to talk to you about the card game you just did and about your thinking. My job is to learn about how kids learn and think and I have a few questions for you, Okay?" Once child assents, say: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer." (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. "Now, please tell me what you did to remember the cards." [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards].

   _____

   _____.

2. Do you think that helped you remember the pictures? Why?" _____

   _____

   _____.

3. Gogi would like to learn about this game too. Would you teach him/her what you did to remember the cards? [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Can you tell Gogi about how that helped you remember the cards?*

   _____

   _____.

1

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CARD RECALL TASK_*DA*

Once the Card Recall ***DA*** task is complete, tell child: "Thank you for working on this card game again! I would like to talk to you about the card game again, Okay?" Once child assents, say: "Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer." (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. "Now, please tell me what you did to remember the cards." [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards].

   _____

   _____.

2. Do you think that helped you remember the pictures? Why?" _____

   _____

   _____.

3. Gogi would like to learn about this game too. Would you teach him/her what you did to remember the cards? [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Can you tell Gogi about how that helped you remember the cards?*

   _____

   _____.

4. *If* child remembered more this time (more than at pretest), say: "You remembered more this time than before! Why do you think that is?"

   _____

   _____.

2

CARD RECALL TASK_*POST*

Once the Card Recall ***POSTETEST*** task is complete, tell child: "**Thank you for working on this card game again! I would like to talk to you about the card game again, Okay?**" Once child assents, say: "**Thank you. Remember, there are no right or wrong answers; I only want to know what you think. Just give *your* best answer.**" (If they don't agree, try to prod them by saying that 'I really need your help and want to learn about how kids think'.)

1. "**Now, please tell me what you did to remember the cards.**" [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards].

    _____

    _____.

2. **Do you think that helped you remember the pictures? Why?**" _____

    _____

    _____.

3. **Gogi would like to learn about this game too. Would you teach him/her what you did to remember the cards?** [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Can you tell Gogi about how that helped you remember the cards?*

    _____

    _____.

4. *If* child remembered more this time (more than at pretest), say: "**You remembered more this time than before! Why do you think that is?**"

    _____

    _____.

"**Thank you for sharing your ideas and how you think with me and Gogi!**"

3

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Appendix 4.B. Card Recall Task_27 Cards (9 per assessment session; in categorical groups).

1-Dog.jpg	2-Cat.jpg	3-Rabbit.jpg	4-Apple.jpg	5-Banana.jpg	6-Orange.jpg
7-Peas.jpg	8-Carrot.jpg	9-Corn.jpg	10-Saw.jpg	11-Hammer.jpg	12-Screwdriver.jpg
13-Car.jpg	14-Bus.jpg	15-Truck.jpg	16-Block.jpg	17-JackInTheBox.jpg	18-TeddyBear.jpg
19-Football.jpg	20-Basketball.jpg	21-Baseball.jpg	22-Ch		24-Table.jpg
25-Pants.jpg	26-Shirt.jpg	27-Dress.jpg			
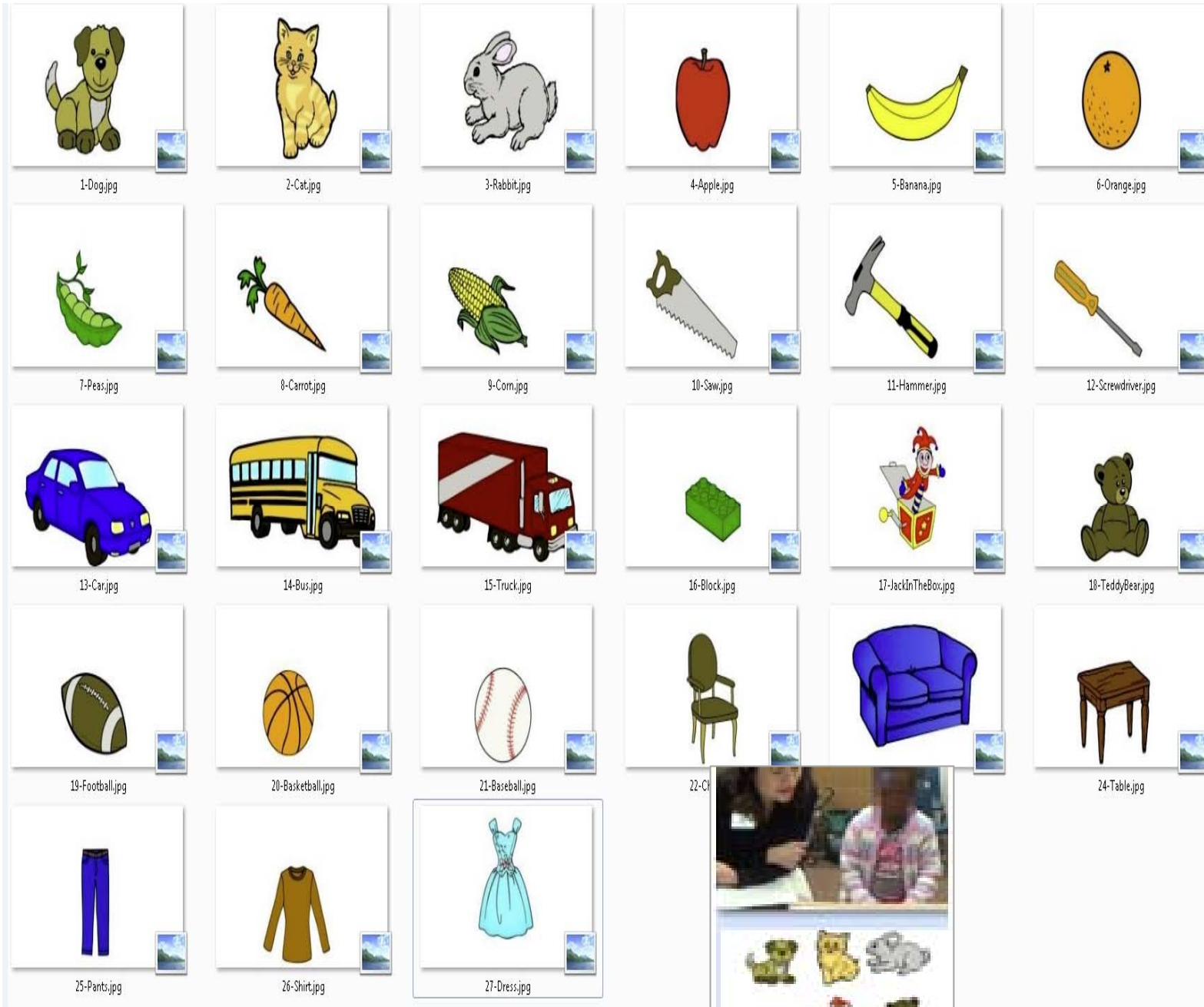
Card Recall Task: Categories VERSION A

I. For the Card Recall task, **27** unique cards in total will be used as follows:
   1. **PRE-TEST:** Card set **A** (3 categories/3 cards each; 9 total cards)
   2. **DA:** Card set **B** (3 categories/3 cards each; 9 total cards)
   3. **POST-TEST:** Card set **C** (3 categories/3 cards each; 9 total cards)

1. Pre-test SET A:
   i. Animal: Dog, Cat, Rabbit
   ii. Furniture: Chair, Table, Couch
   iii. Vegetable: Peas, Corn, Carrot

2. DA SET B:
   i. Clothing: Pants, Shirt, Dress
   ii. Tool: Saw, Hammer, Screwdriver
   iii. Vehicle: Car (automobile), Bus, Truck

3. Post-test SET C:
   i. Toys: Jack-in-the-box, Block, Teddy bear
   ii. Sport: Football, Basketball, Baseball
   iii. Fruit: Apple, Banana, Orange

I.   For the Card Recall task, **27** unique cards in total will be used as follows:
1. **PRE-TEST:** Card set **A** (3 categories/3 cards each; 9 total cards)
2. **DA:** Card set **B** (3 categories/3 cards each; 9 total cards)
3. **POST-TEST:** Card set **C** (3 categories/3 cards each; 9 total cards)

1. Pre-test SET A:
   i.   Toys: Jack-in-the-box, Block, Teddy bear
   ii. Sport: Football, Basketball, Baseball
   iii. Fruit: Apple, Banana, Orange

2. DA SET B:
   i.   Animal: Dog, Cat, Rabbit
   ii. Furniture: Chair, Table, Couch
   iii. Vegetable: Peas, Corn, Carrot

3. Post-test SET C:
   i.   Clothing: Pants, Shirt, Dress
   ii. Tool: Saw, Hammer, Screwdriver
   iii. Vehicle: Car (automobile), Bus, Truck

Appendix 4.C. Full Card Recall (pre- and post-test) and Mediated DA intervention or Comparison group (COMP) Protocol

Session 1/2: Card recall pre-test—mediated DA—Card recall post-test

I.   **Pre-test**

1) Do: Place <u>Set A</u> in front of the child in a randomized (mixed or non-grouped) order.
2) Say: (adapted from Haywood & Lidz, 2007): *"We are going to work together on a picture game now. I am going to ask you to play the game all by yourself first and then I get to be teacher and we'll work together on it. Then I will ask you to do it all by yourself again. Okay? Are you ready to play?*

"Okay, let's start. Here are some pictures. First, tell me the name of each picture" [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. *"Now, we're going to play a hide and remember game. In a few minutes, I'm going to hide these pictures, and then you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures"*. Great! *Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: *"I noticed you were looking up* [or whatever the child is doing], *"what were you doing when you did that?"*

II.   **DA Intervention (1. Self-explanation 2. Hints/Prompts 3. Explicit instruction)**

1) Do: Place <u>Set B</u> in front of the child in a randomized (mixed or non-grouped) order.
2) Say: (adapted from Haywood & Lidz, 2007): *"Now it's my turn to be teacher. We're going to talk about how to remember what we see. Here are some new pictures. Please tell me the names of these pictures"* [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. Say: *"Like before, you're going to have to remember the names of these pictures after a few minutes. Okay? So, we should do something to help remember the pictures. Okay?*

After child assents, start the first level of DA mediated-instruction **Questioning**—intended to elicit self-explanation regarding strategy usage—with the child: *"I wonder what you could do that would help you remember the names of the pictures better. What do you think?"* [Wait and respond to child's response. If she/he does not offer a strategy or says "I don't know", prompt with: "If you want to remember all of these pictures, how can you do that?, then, *"What kinds of things have helped you remember things before? How do you think that helped? I wonder what would be most helpful. What do you think?"* Continue using these questions that elicit self-explanations until the child offers (or starts to enact) a strategy. If needed, use practical encouraging prompts such as: *"Just give your best answer" What's one thing you can think of that would help you remember the pictures?"* As the child talks about/enacts the strategy, say: *"Hmmm, I wonder if that will help you remember. Let's try/keeping trying"* and ask the child to demonstrate the strategy with the cards if she/he hasn't already; as the child demonstrates, ask *"Is that helping you to remember? Why?"*
If child discontinues the strategy, say: *"Can you remind me what you are doing to help you remember the pictures? Do you think it is helping?"* If child continues with strategy, ask specific questions about it. For example, if they are using rehearsal say: *"Oh, you're saying the names of the pictures over and over again to yourself. Is that helping you remember?" Why?"*). If child is doing a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seems to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: *"I noticed you're looking up* [or whatever the child is doing], *"what are you doing when you're doing that?"* If the child is still struggling/not implementing a strategy, go to next level of DA.

The next level of DA mediated-instruction is **Prompts/hints**. Say: *"Other children your age have told me that looking at the pictures and saying the names over and over again to themselves has helped them remember. How would that work? How could you try that?"* If child spontaneously starts to rehearse, allow and encourage that strategy and use other hints. If child does not, continue to prompt that rehearsing helps (e.g., *"Many other children just like you have said it works; it has also helped me before! How do you think it could work for these pictures? What about these?"*). If child discontinues the strategy, say: *"Remember that other children have said that saying the names over and over again to themselves has helped them remember the pictures."*

"Another thing that helps people remember pictures is thinking about how the pictures could go together helped them remember the names better. "How would that work?" How could these pictures go together?" If child spontaneously starts to categorically sort, allow and encourage that strategy and use other hints for more accurate/efficient sorting. If child does not, continue to prompt that sorting by categories/groups helps (e.g., *"Many other children just like you have said it works; it has also helped me before! How do you think these two pictures go together? And what about these pictures?").* If child discontinues the strategy, say: *"Remember that other children have said that thinking about how the pictures go together really helped them remember them").*

If child is doing a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seems to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: *"I noticed you're looking up* [or whatever the child is doing]*; "what are you doing when you're doing that?"*

If the child is still struggling and not implementing a strategy, go to the next level of mediation.

The third level of DA mediated-instruction is **Explicit Instruction**. Say: *"When I want to remember many pictures like this, I look at them and say their names over and over again to myself and say something about them like this.* Demonstrate: e.g., *"School bus, school bus, school bus. Okay, that will help me remember the yellow school bus. Blue dress, blue dress, blue dress. Okay, I think I will remember that pretty blue dress with a pink bow now."* Allow time for the child to start the strategy but if she/he does not spontaneously, say: *"Now you try it. Start with this picture. Okay, that'll help you remember because you are practicing the name and helping your brain remember it! Now try it for these pictures".* Again allow time for the child to start the strategy but if she/he does not spontaneously, say: *"Let's try like this" and start to rehearse another set of pictures having him/her repeat afterward (e.g., "Big truck, big truck, big truck". Okay, now I will remember the big red truck".).* Then go back to *"Now you try it."* If child discontinues the strategy, say: *"Remember, looking at the pictures and saying their names over and over again will help you remember the pictures…because it is practicing and helping the name stay in your brain so that you will remember it later".*

"You can also make groups with pictures that are alike to help you remember them like this: These go together because they are alike" (e.g., tools). Allow time for child to start the strategy but if she/he does not spontaneously, say: *"We can make groups with these pictures. Let's make groups with pictures that are alike/that go together. That will help you remember the pictures."* Again allow time for child to start the strategy but if she/he does not, say: *"Let's try like this"* and start to make a categorical group, e.g., by putting the shirt and pants together; hand the child the dress and ask her/him to place in the correct group. Provide as much help as necessary for at least one full group of categorically-sorted pictures. For example, if the child is not accurately sorting, point to one of the groups (e.g., Clothing) and say: *"Why did I put these in one group? Tell me about the things in our groups…These are all _ ".* Wait for the child to respond. If she/he does not give the correct answer, provide prompts (e.g., *"these are things we wear", then identify the group: "this is a group of Clothing; each picture is a piece of clothing we wear").* Once the child has successfully sorted the cards into a categorical group, say: *"Good, it helps when we make groups of like pictures. That way you only have to remember a few groups of pictures instead of 9 separate pictures!"* If child discontinues the strategy, say: *"Remember, putting the pictures into groups that are alike will help you remember the pictures…because there are less things to remember".*

Provide 4 minutes to allow for mediated discussion before removing/hiding the cards (give 2 minutes), then ask the child to recall the pictures and record her/his score.: *"Okay, now it's time to see how well you can remember the pictures. Now I will hide these and you tell me which ones you remember in a few minutes".*

III.   Post-test
1) Do: Place <u>Set C</u> in front of the child in a randomized (mixed or non-grouped) order.
2) Say: *"Here are some new pictures. Please tell me the names of these pictures"* (Once again helping if she/he is unable to accurately name the pictures). Then say: *"In a few minutes, I'll hide these again and you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures".* Great! *Now, please tell me what you did to remember the cards.* [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior, say: *"I noticed you were looking up* [or whatever the child is doing], *"what were you doing when you did that?"*

Session 1/2: Card recall pre-test—mediated DA—Card recall post-test_COMP

I. Pre-test

1) Do: Place **Set A** in front of the child in a randomized (mixed or non-grouped) order.
2) Say: (adapted from Haywood & Lidz, 2007): *"Now, you are going to work on a picture game. Okay? Are you ready to play?* [Wait for child to assent; prompt/encourage if needed].

"Okay, let's start. Here are some pictures. First, tell me the name of each picture" [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. *"Now, we're going to play a hide and remember game. In a few minutes, I'm going to hide these pictures, and then you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures".* Great! Now, please tell me what you did to remember the cards. [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior (e.g., mental rehearsal silently or visualizing- e.g., he or she seemed to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: *"I noticed you were looking up [or whatever the child is doing], "what were you doing when you did that?"*

II. Comparison (comparable to DA Intervention)

1) Do: Place **Set B** in front of the child in a randomized (mixed or non-grouped) order.
2) Say: (adapted from Haywood & Lidz, 2007): *"Now here are some new pictures. Please tell me the names of these pictures"* [Wait to see if the child knows the name of each picture; if not, provide it and ask the child to repeat it]. Say: *"Like before, you're going to have to remember the names of these pictures after a few minutes. Okay? So, you should do something to help remember the pictures.*

Provide 4 minutes to allow for mediated discussion before removing/hiding the cards (give 2 minutes), then ask the child to recall the pictures and record her/his score: *"Okay, now it's time to see how well you can remember the pictures. Now I will hide these and you tell me which ones you remember in a few minutes".*

III. Post-test

1) Do: Place **Set C** in front of the child in a randomized (mixed or non-grouped) order.
2) Say: *"Here are some new pictures. Please tell me the names of these pictures"* (Once again helping if she/he is unable to accurately name the pictures). Then say: *"In a few minutes, I'll hide these again and you will need to remember and tell me the names of the pictures that were here. Okay?* [Once child assents/is ready, set the timer for two minutes; after it beeps, collect/hide the cards and continue] *"Okay, time is up. Now, tell me the names of the pictures".* Great! Now, please tell me what you did to remember the cards. [If the child says "nothing" or "I don't know" prompt them to think again or tell what they did before I collected the cards]. *Do you think that helped you remember the pictures? Why?"* If child did a non-verbal behavior, say: *"I noticed you were looking up [or whatever the child is doing], "what were you doing when you did that?"*

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Appendix 4.D. Metacognitive Knowledge (McK) Strategies displayed and coded during the card recall task.

Memory and Metamemory: Card Recall task PERFORMANCE
Conceptualizing and Assessing Metacognitive Development in Young Children

Children's verbal and non-verbal behaviors will be scored/coded during the task and afterward (when watching the video for confirmation). Please use the following table to record scores.

Strategy Score: One point each.	Pre Test	DA	Post Test
1. Separates into categories/families [categorization]			
2. Repeats name(s) [rehearsal]			
3. Talks about detail(s)/Creates story or song [elaboration]			
4. Spontaneously recalls items by category/family			
5. Uses visualization of location as a clue			
6. Other strategies:			
TOTAL POINTS (# strategies used)			

Note: If child is doing a non-verbal behavior during the DA (e.g., mental rehearsal silently or visualizing- e.g., he or she seems to be doing something cognitive/thinking but it is non-verbal and thus difficult to discern), say: *"I noticed you're looking up* [or whatever the child is doing], *what are you doing when you're doing that?"* If the child did this during the pre- or posttest, ask the same question afterward: *""I noticed that you were looking up* [or whatever the child did], *when you were trying to remember the pictures; what were you doing when you're doing that?"* Record the non-verbal strategy the child said she/he was doing under "Other strategies" with NV next to it to indicate that it was a non-verbal behavior. If the child names something that is not a specific strategy, e.g., *"remember the pictures"* or *"thinking about the pictures"*, prompt for more information by saying: *"Good, can you tell me more about that?* [E.g.,: *"What did you do to remember the pictures?"* Or *"What do you mean by 'thinking about the pictures'/What did you do when you were thinking about the pictures?"*]. If, after prompting, the child names a specific strategy, record and score as one point. If she or he still does not provide a specific strategy, record what she/he said but do not give a point for this.

Appendix 4.E. Woodcock-Johnson III tests of Letter-Word Identification and Applied Problems.

Test 1 Letter-Word Identification

ID

Basal: 6 lowest correct
Ceiling: 6 highest incorrect

Score 1, 0

1 ____ L	
2 ____ A	
3 ____ W	
4 ____ S	
5 ____ i	
6 ____ y	
7 ____ R	
8 ____ N	
9 ____ k	
10 ____ red	
11 ____ p	
12 ____ Q	
13 ____ b	
14 ____ U	
15 ____ see	
16 ____ the	
17 ____ is	
18 ____ and	
19 ____ go	
20 ____ will	
21 ____ not	
22 ____ but	
23 ____ from	
24 ____ had	
25 ____ keep	
26 ____ said	
27 ____ with	
28 ____ light	
29 ____ their	
30 ____ which	
31 ____ would	
32 ____ use	
33 ____ together	
34 ____ young	
35 ____ point	
36 ____ piece	
37 ____ built	
38 ____ however	
39 ____ enough	
40 ____ practice	
41 ____ bought	
42 ____ interested	
43 ____ knowledge	
44 ____ diagram	
45 ____ investigate	
46 ____ process	
47 ____ thermostat	
48 ____ authority	
49 ____ audience	
50 ____ impatient	
51 ____ fiercely	
52 ____ courageous	
53 ____ astronomer	
54 ____ leagues	
55 ____ deliberately	
56 ____ essential	

57 ____ acrylic
58 ____ chromosome
59 ____ apostrophe
60 ____ precipitate
61 ____ apparatus
62 ____ reminiscent
63 ____ italicized
64 ____ psychosis

65 ____ debris
66 ____ paraphernalia
67 ____ municipality
68 ____ melodious
69 ____ subsidiary
70 ____ euphemism

71 ____ trichinosis
72 ____ facetious
73 ____ phonemic
74 ____ ignominious
75 ____ tricot
76 ____ gouache

[ ] Number Correct (0–76)

Test 1 Letter-Word Identification
Scoring Table
Encircle row for the Number Correct.

Number Correct	AE (Est)*	GE (Est)*
0	<2-0	<K.0
1	2-5	<K.0
2	3-5	<K.0
3	3-11	<K.0
4	4-4	<K.0
5	4-7	<K.0
6	4-10	<K.0
7	5-0	K.0
8	5-2	K.1
9	5-4	K.2
10	5-6	K.3
11	5-7	K.4
12	5-9	K.5
13	5-10	K.6
14	6-0	K.7
15	6-1	K.8
16	6-2	K.8
17	6-3	K.9
18	6-4	1.0
19	6-5	1.1
20	6-6	1.2
21	6-7	1.2
22	6-8	1.3
23	6-9	1.4
24	6-10	1.5
25	6-11	1.6
26	7-0	1.6
27	7-1	1.7
28	7-1	1.8
29	7-2	1.9
30	7-3	1.9
31	7-4	2.0
32	7-5	2.1
33	7-6	2.2
34	7-7	2.3
35	7-8	2.3
36	7-9	2.4
37	7-10	2.5
38	7-11	2.6
39	8-0	2.7
40	8-1	2.8
41	8-3	3.0
42	8-4	3.1
43	8-6	3.2
44	8-7	3.3
45	8-9	3.5
46	8-11	3.6
47	9-1	3.7
48	9-3	3.9
49	9-5	4.1
50	9-8	4.3
51	9-11	4.5
52	10-2	4.7
53	10-6	4.9
54	10-9	5.2
55	11-1	5.5
56	11-5	5.8
57	11-9	6.1
58	12-1	6.4
59	12-6	6.8
60	12-10	7.2
61	13-2	7.6
62	13-7	8.0
63	14-0	8.5
64	14-6	9.1
65	15-0	9.7
66	15-7	10.4
67	16-3	11.3
68	17-1	12.4
69	18-1	13.8
70	19	15.0
71	19	16.8
72	20	>18.0
>72	>22	>18.0

*AE and GE are estimates of the precise values provided by the software scoring program.

2 Form B

Test 10 Applied Problems 📖

Basal: 6 lowest correct
Ceiling: 6 highest incorrect

Score 1, 0

1 _____ 1 finger
2 _____ 2 fingers

3 _____ 1
4 _____ 2
5 _____ 1

6 _____ 2 *and* 3
7 _____ 2
8 _____ 3

9 _____ 1 *and* 3
10 _____ 2
11 _____ 2

12 _____ 5
13 _____ 5
14 _____ 4

15 _____ 3
16 _____ 4
17 _____ 4
18 _____ 7
19 _____ 7

20 _____ 1
21 _____ pencil and candy
22 _____ 7
23 _____ 7:50
24 _____ 5

25 _____ 12 cents
26 _____ 2
27 _____ 9:30
28 _____ 12 dollars
29 _____ 22 cents

30 _____ 5
31 _____ 70 cents
32 _____ $1.30
33 _____ $5.75
34 _____ 5

35 _____ 10
36 _____ 8
37 _____ 5
38 _____ 42 dollars
39 _____ 11:30

40 _____ 9
41 _____ $1,440
42 _____ 30 dollars
43 _____ 370
44 _____ 8

45 _____ $6.75
46 _____ $\frac{1}{2}$
47 _____ 25
48 _____ 4 and −2
49 _____ $\frac{3}{4}$

50 _____ 240 dollars
51 _____ 100 dollars
52 _____ 5
53 _____ 80.5
54 _____ $\frac{5}{6}$

55 _____ 5 and 3
56 _____ 12 minutes
57 _____ 50 centimeters (*centimetres*)
58 _____ between 226 and 226.3 cubic inches (*cubic centimetres*)

59 _____ $11,025
60 _____ 28 centimeters (*centimetres*)
61 _____ y = 4 − 2x
62 _____ .048 inches per minute (*centimetres per minute*)
63 _____ $16\sqrt{3}$ square inches (*square centimetres*)

Number Correct (9–63)

Note: Answers in parenthesis are for use with test pages that utilize the metric system.

Test 10 Applied Problems
Scoring Table
Encircle row for the Number Correct.

Number Correct	AE (Est)*	GE (Est)*
0	<2-0	<K.0
1	<2-0	<K.0
2	2-6	<K.0
3	2-10	<K.0
4	3-2	<K.0
5	3-4	<K.0
6	3-7	<K.0
7	3-9	<K.0
8	4-0	<K.0
9	4-2	<K.0
10	4-5	<K.0
11	4-7	<K.0
12	4-9	<K.0
13	4-11	<K.0
14	5-1	K.1
15	5-3	K.2
16	5-5	K.4
17	5-7	K.5
18	5-9	K.7
19	5-11	K.8
20	6-2	1.0
21	6-4	1.1
22	6-6	1.3
23	6-9	1.5
24	7-0	1.7
25	7-3	1.9
26	7-6	2.1
27	7-9	2.3
28	8-0	2.6
29	8-4	2.8
30	8-8	3.1
31	9-0	3.5
32	9-5	3.8
33	9-9	4.2
34	10-2	4.5
35	10-6	4.9
36	10-10	5.2
37	11-2	5.6
38	11-7	6.0
39	11-11	6.3
40	12-3	6.7
41	12-8	7.2
42	13-0	7.7
43	13-6	8.2
44	13-11	8.9
45	14-5	9.6
46	15-0	10.5
47	15-8	11.8
48	16-6	12.9
49	17-5	13.0
50	18-8	13.2
51	20	13.8
52	23	15.0
>52	>28	>18.0

*AE and GE are estimates of the precise values provided by the software scoring program.

Woodcock Johnson Letter Word Identification

2. Point to the "A."

8   4

A

▲ **Correct:** points to A

R

N

k

keep

said

with

light

their

which

would

use

Woodcock Johnson Applied Problems

: How many birds are there?

When added together, how much money is this?

Paul bought two packages of gum for 50 cents. He had a total of ten sticks of gum. He gave his brother one half of his gum. How many sticks of gum did Paul have left?

3   5

2

Point to the number that tells how many dogs there are

Appendix 4.F: The Head-Toes-Knees-Shoulders (HTKS) measure of Executive Function

Head-Toes-Knees-Shoulders (HTKS)

General Guidelines

- **Administration:**
  - There are specific instructions to the assessor that are in *italics* and should NOT be read to the child.
  - Dialogue to be read to the child is generally located within a [Text box] and in bold font, read the dialogue aloud **verbatim**. Do not make any changes or additions to the dialogue (the only exception to this is during the practice section where assessors are prompted to provide positive feedback for correct responses.)
  - Never give feedback during the testing section (only during introduction and practice).
  - Be careful not to cue the child during the testing section. After reading aloud the instruction, look directly at the child's eyes. Do not look at his/her head, toes, knees, or shoulders.
  - Demonstrate the correct response when you see: (during the introduction and practice sections.)
  - Do not repeat a test trial, unless the child indicates that they did not hear the instructions.
  - Do not penalize a child for *thinking* about where to place his/her hands. So long as the child does not move towards an incorrect body part before touching the correct part, then the child should receive the full 2 points.
  - Administer the task in an upbeat and positive tone. Children enjoy playing this game!
- **Testing Environment**
  - If possible, find a testing location that is quiet and in an isolated area. Ideally, no other children should be in the same room as the child being tested.
  - If parents request to sit-in during the testing section – ask parents to sit/stand quietly behind the child and out of the child's sight.
  - Have the child stand approximately 3 feet away from you. Administer the task seated or standing, but make sure that you are facing the child.
  - It is not necessary to force the child to remain in the same spot during the test, so long as the child is paying attention to you and to the task.

Scoring Guidelines

SCORE	RULE	EXAMPLE
0	Child touches the wrong body part and does not self-correct	The assessor says, "Touch your knees." The child quickly reaches up to touch her shoulders but then reverses and touches her knees, holding her hands on her knees.
1	Child makes any discernable motion toward an incorrect response but then changes his/her mind and makes the correct response	The assessor says, "Touch your shoulders." The child briefly jerks his hands upwards but then just as quickly puts his hands down and bends to touch his knees.
2	Child produces the correct (opposite) response immediately.	The assessor says, "Touch your toes." The child looks down at her toes but does not bend towards her toes. After a pause, she places both hands on her head.

HTKS Administration FAQ

1. Are you allowed to repeat a trial if you miss a child's response? We do repeat a command if there's too much noise (e.g., we're in a corner of the classroom) and it's obvious the child didn hear us, or they act like they didn't hear what we said. This doesn't happen very often and it h made no difference in the results we have found. On the rare occasions that we have missed a answer we do ask the child to show us again.

2. Are you allowed to repeat a trial if the child misses what you say and asks you to repeat the trial? Yes, we repeat a command if they don't hear it.

3. Do you wait between instructions before moving on to the next prompt (e.g., touch your head Yes, we wait for the response before moving on to the next prompt.

4. What code do you use if the child does not move at all or refuses to participate for the test trials? If after we repeat a command, they still don't do anything, we mark it as wrong and continue through the task.

5. How would you code a child's response if he or she just moves his or her hands back and forth continuously from their head to their toes? We wait until they finish, and keep giving the task (even if they get the items wrong). After all, being able to listen, pay attention and remember the instructions is required for the task.

6. If the child asks if they are doing ok or giving the right responses during the test trials, are you allowed to say something neutral like "You're giving a lot of good answers?" Or should you say nothing at all? If a child asks how they are doing, we say something like "you're really good at these games."

Examples and Scoring Suggestions

*For the following examples, assume that the child has his hands on his head at the start of the trial:

COMMAND	CHILD RESPONSE	SCORE
Touch your Toes	Child keeps hands on head	2
Touch your Toes	Child briefly raises hands upward off of head – and makes no downward motion towards toes – and then replaces hands on head	2
Touch your Toes	Child removes hands from head and briefly moves hands in downward motion before returning hands to head	1
Touch your Head	Child keeps hands on head	0
Touch your Head	Child removes hands from head and touches toes	2
Touch your Head	Child removes hands from head but starts to move hands back towards head, but then touches toes	1

HTKS Guidelines – October 2010

HEAD-TOES-KNEES-SHOULDERS (HTKS)

Parts I, II, and III
FORM A - Extended

Child name	_____
Birthdate	_____
ID #	_____
Gender	_____
Examiner name	_____
Today's date	_____

Directions: After establishing positive rapport with the child, say or read the directions in **bold type** aloud. Words in CAPITAL LETTERS should be emphasized. Administer the task seated or standing; the child should stand, about 3 feet from you, during the task. *Administer Part II* if child responds correctly (include self-corrects) to 5 or more items on Part I of the task, *or* if child is in kindergarten or beyond. *Administer Part III* if child responds correctly (include self-corrects) to 5 or more items on Part II of the task, *or* if child is in first grade or beyond.

The person symbol indicates that you should perform the motion to demonstrate the correct movement to the child. If the child produces the correct (opposite) response immediately, score the item "2". If they self-correct to the correct response, score the item "1". If they do not touch the correct part of their body at all or touch the named part, score the item "0".

A self-correct occurs if the child makes any discernible motion toward an incorrect response, but then changes his/her mind and makes the correct response. Pausing to think, not moving, and then responding correctly does not count as a self-correction – it would be scored as correct.

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> **Now we're going to play a game. The game has two parts. First, copy what I do. Touch your head.**

Touch your head; wait for the child to touch his/her head.

> **Good! Now touch your toes.**

Touch your toes; wait for the child to touch his/her toes.
Repeat the two commands with motions again, or until the child imitates you correctly.

PART I: PRACTICE

> **Now we're going to be a little silly and do the OPPOSITE of what I say. When I say touch your HEAD, INSTEAD of touching your head, you touch your TOES. When I say touch your TOES, you touch your HEAD. So you're doing something DIFFERENT from what I say.**

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

**If the child responds incorrectly at any point during the practice portion, provide additional explanations up to 3 times before beginning the test portion:

> Remember, when I say to touch your _____, you touch your _____, so you are doing something DIFFERENT from what I say. Let's try another one.
>
> → Number of additional explanations given: 0 1 2 3

A1. What do you do if I say "touch your head"?	0 (other than toes)	1	2 (toes)
A2. What do you do if I say "touch your toes"?	0 (other than head)	1	2 (head)

If the child responds verbally: "can you show me? "

> **Ok, let's practice a few more.**

B1. Touch your head	0 (other than toes)	1	2 (toes)
B2. Touch your toes	0 (other than head)	1	2 (head)
B3. Touch your head	0 (other than toes)	1	2 (toes)
B4. Touch your toes	0 (other than head)	1	2 (head)

Proceed to Part I test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.

We will keep playing this game, and you keep doing the OPPOSITE of what I say.

		Incorrect	Self-Correct	Correct
1.	Touch your head	0 (other than toes)	1	2 (toes)
2.	Touch your toes	0 (other than head)	1	2 (head)
3.	Touch your toes	0 (other than head)	1	2 (head)
4.	Touch your head	0 (other than toes)	1	2 (toes)
5.	Touch your toes	0 (other than head)	1	2 (head)
6.	Touch your head	0 (other than toes)	1	2 (toes)
7.	Touch your head	0 (other than toes)	1	2 (toes)
8.	Touch your toes	0 (other than head)	1	2 (head)
9.	Touch your head	0 (other than toes)	1	2 (toes)
10.	Touch your toes	0 (other than head)	1	2 (head)

TOTAL (Self-Correct + Correct) ⟶

**If the child responds correctly (include self-corrects) to 5 or more items on Part I of the task, or if child is in kindergarten or beyond, continue to Part II.*

If the child should **not** continue to Part II: Thank you for playing this game with me today!

PART II: INTRODUCTION

> Ok, now that you've got that part, we're going to add a part. Now, you're going to touch your shoulders and your knees. First, touch your shoulders.

Touch your shoulders; wait for the child to touch his/her shoulders.

> Now, touch your knees.

Touch your knees; wait for the child to touch his/her knees.
Repeat the two commands with motions again, or until the child imitates you correctly.

PART II PRACTICE:

> Ok, now we're going to be silly again. You keep doing the opposite of what I say like before. But this time, touch your knees and shoulders. When I say to touch your KNEES, you touch your SHOULDERS, and when I say to touch your SHOULDERS, you touch your KNEES.

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

**If the child responds incorrectly* at any point during the practice portion, provide additional explanations up to 2 times before beginning the test portion:

> Remember, when I say to touch your ____, instead of touching your knees, you touch your ____. Do the OPPOSITE of what I say.

Number of additional explanations given: 0   1   2

C1. What do you do if I say "touch your knees"?	0 (other than shoulders)	1	2 (shoulders)

If the child responds verbally: "can you show me? "

D1. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
D2. Touch your shoulders	0 (other than knees)	1	2 (knees)
D3. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
D4. Touch your shoulders	0 (other than knees)	1	2 (knees)

Proceed to Part II test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.

Now that you know all the parts, we're going to put them together. You're going to keep doing the opposite of what I say to do, but you won't know what I'm going to say.

There are four things I could say.
If I say touch your HEAD, you touch your TOES.
If I say touch your TOES, you touch your HEAD.
If I say touch your KNEES, you touch your SHOULDERS.
If I say touch your SHOULDERS, you touch your KNEES.

Are you ready? Let's try it.

	Incorrect	Self-Correct	Correct
11. Touch your head	0 (other than toes)	1	2 (toes)
12. Touch your toes	0 (other than head)	1	2 (head)
13. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
14. Touch your toes	0 (other than head)	1	2 (head
15. Touch your shoulders	0 (other than knees)	1	2 (knees)
16. Touch your head	0 (other than toes)	1	2 (toes)
17. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
18. Touch your knees	0 (other than shoulders)	1	2 (shoulders)
19. Touch your shoulders	0 (other than knees)	1	2 (knees)
20. Touch your toes	0 (other than head)	1	2 (head)

PART II TESTING:

TOTAL (Self-Correct + Correct) ⟶ ☐

**If the child responds correctly (include self-corrects) to 5 or more items on Part II of the task, or if child is in first grade or beyond, continue to Part III.

Thank you for playing this game with me today!

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*If the child should **not** continue to Part III:*

PART III INTRODUCTION

> **You are doing so well we just have one more part! Now we are going to change the rules of the game.**
>
> **When I say to touch your HEAD, you touch your KNEES.**
> **When I say touch your KNEES, you touch your HEAD.**
> **When I say touch your SHOULDERS, you touch your TOES.**
> **And when I say touch your TOES, you touch your SHOULDERS.**
>
> **Ok? Let's practice!**

If the child responds correctly: Provide positive feedback on each practice item where the child responds correctly.

***If the child responds incorrectly** at any point during the practice portion, provide additional explanations up to 2 times before beginning the test portion:*

> Remember, we changed the rules. "Touch your head" means touch your KNEES – head goes with knees now. "Touch your shoulders" means touch your TOES – shoulders goes with toes.
>
> Number of additional explanations given: 0   1   2

PART III PRACTICE:

E1. What do you do if I say "touch your head"?	0 (other than knees)	1	2 knees)
E2. What do you do if I say "touch your shoulders"?	0 (other than toes)	1	2 (toes)

If the child responds verbally: "can you show me?"

F1. Touch your head	0 (other than knees)	1	2 (knees)
F2. Touch your shoulders	0 (other than toes)	1	2 (toes)
F3. Touch your toes	0 (other than shoulders)	1	2 (shoulders)
F4. Touch your knees	0 (other than head)	1	2 (head)

> **You're doing great! Let's do a few more.**

Proceed to Part III test section. Do not explain any parts of the task again. Do not provide feedback during the test portion.
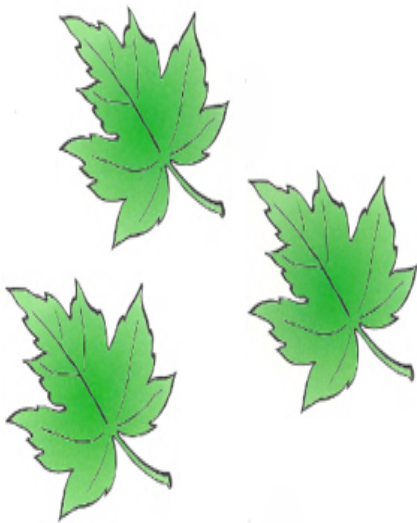
PART III TESTING:

	Incorrect	Self-Correct	Correct
21. **Touch your shoulders**	0 (other than toes)	1	2 (toes)
22. **Touch your head**	0 (other than knees)	1	2 (knees)
23. **Touch your knees**	0 (other than head)	1	2 (head)
24. **Touch your toes**	0 (other than shoulders)	1	2 (shoulders)
25. **Touch your toes**	0 (other than shoulders)	1	2 (shoulders)
26. **Touch your knees**	0 (other than head)	1	2 (head)
27. **Touch your shoulders**	0 (other than toes)	1	2 (toes)
28. **Touch your head**	0 (other than knees)	1	2 (knees)
29. **Touch your head**	0 (other than knees)	1	2 (knees)
30. **Touch your shoulders**	0 (other than toes)	1	2 (toes)

After the child completes the task, say:

> **Thank you for playing this game with me today!**

Appendix 4.G: The Expressive Vocabulary Test (EVT) measure of Expressive Language

Expressive Vocabulary Test

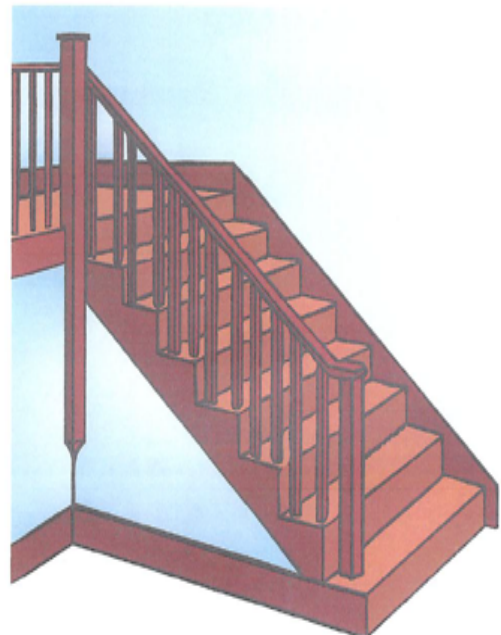Point to the picture of the three green leaves and say:

"What do you see?"

Prompt: If the examinee's response is "plant", say:

"No, it is part of a plant, but what is it?"

Point to the picture of the steps and say:

"Steps. Tell me another word for Steps."

Prompt: If the examinee's response is "upstairs", say:

"Yes, the steps go upstairs, but what it is another word for this (point to the picture)"?

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CHAPTER V

Conclusions, Limitations, and Future Directions

Through this programmatic series of dissertation studies, the emergence of metacognition (Mc)—knowledge, monitoring, and regulation of cognition—has been examined in preschoolers, a critical age for developing important cognitive and self-regulated learning (SRL) skills, when Mc has rarely been studied but also when it is most likely to affect subsequent developmental and academic trajectories. This series of studies has provided evidence that (a) metacognitive processes are more robust in preschoolers than previously asserted (b) early metacognitive declarative knowledge can be feasibly assessed with a developmentally appropriate interview (c) early metacognitive processes are more nuanced than previously thought and, accordingly, should not be grouped—conceptualized and assessed—together under an overarching construct (d) early metacognitive knowledge is malleable and facilitated by Dynamic Assessment (DA) support, particularly explicit mediated instruction (e) early metacognitive knowledge is related to and predictive of cognitive development, other SRL skills—such as executive function (EF)— and pre-academic functioning and (f) early metacognitive knowledge may serve as a protective, resilience factor for young children at risk for learning and later academic difficulties by allowing them to succeed cognitively and academically despite the risks they face (e.g., living in poverty, having parents with low educational levels), thus "protecting" them from risks related to learning and academics, at least partially.

As discussed in the preceding chapters, associations between Mc, development, learning and academic achievement have been well established by extant research. However, much of this evidence is based on inconsistent conceptualizations, operationalizations, and assessments of Mc, leaving this area of research in need of further explication both theoretically and empirically. Moreover, previous research has predominantly focused on older children (middle primary school and above), adolescents and adults, thus having limited ability to address the important developmental period prior to formal schooling (i.e., the preschool years when learning-related skills are developing and considerable individual differences can be seen, e.g., Bronson, 2000). To this end, a main aim of this dissertation was to present a systematic analysis of the key elements of metacognitive development in young children related to its conceptualization and assessment, and to provide the foundation for programmatic research on this topic. Across three research papers presented in Chapters II, III, and IV, the following were discussed: the development of a metacognitive knowledge interview that was designed to address the limited measurement tools available to comprehensively assess metacognitive processes in preschool-aged; the convergent validity between two measures of metacognitive processing to further elucidate the conceptualization and measurement of early metacognitive skills and processes through the comparison of the data revealed by two different measures of metacognition in preschool-aged children; and a DA intervention designed to examine the facilitation of metacognitive processes related to a cognitive task whether children's metacognitive skills would predict their cognitive and pre-academic skills. Within each of these previous chapters directions for future research were discussed; this concluding chapter expands upon these considerations. Specifically, the most important next steps for research on early metacognitive development and learning will be explicated focusing in particular on: (a) the need for further

analysis of the conceptualization and assessment of metacognitive processing in young children to look for convergence divergence within aspects of metacognitive functioning; (b) the need for additional examination of the associations between various aspects of metacognitive functioning and learning/academic achievement in preschool-aged children; (c) instruction, individual factors, contexts, and learning environments, that have the most potential to facilitate metacognitive processes beginning in preschool.

Conceptualization and Assessment of Metacognitive Processing in Young Children

The principal aims of this dissertation thesis were to target the conceptualization and assessment of metacognitive processing, particularly for preschool-aged children, largely absent in the literature, yet crucial for developing educational interventions designed to positively affect developmental and academic trajectories. Explicating the way this important construct is conceptualized, operationalized, assessed, and measured is among the most crucial issues facing SRL and cognitive development researchers and, consequently, was discussed in all three studies presented in Chapters II, III, and IV.

Furthermore, there is a long history—in the area of cognitive development and learning—of young children's skills, abilities, and cognitive processes being underestimated (e.g., for a review of this underestimation, see Gelman & Baillargeon, 1983). Not only does this have implications for developmental trajectories, but also for periods that may be better for intervening. Related to Mc, for example, because many researchers have persisted in the notion that metacognitive processes do not develop until age 7-8 or beyond (e.g., Veenman, Van Hout-Wolters, & Afflerbach, 2006), conducting metacognitive interventions before that age would not make sense. Operating under this paradigm would lead to a loss of (at least) several years when

children could (based on the results of this study and other recent research, e.g., Shamir, Mevarech, & Gida, 2009; Whitebread, Bingham, Grau, Pino-Pasternak, & Sangster, 2007; Whitebread et al., 2009) benefit from such intervention. Moreover, later intervention and instruction could build on the earlier, thus having potentially exponential benefits.

Though this series of linked studies provided clarity around the conceptualization and assessment of early metacognitive development and empirical evidence of metacognitive knowledge (verbal and non-verbal), behavior, skills and strategies in preschoolers that related to and predicated cognitive and pre-academic functioning, there is still much work to be done in this area.

Accordingly, researchers should dedicate more time to examining early metacognitive processes and precisely differentiating them from other (some similarly) developing processes such as EF, theory of mind, self-regulation, co-regulation, motivation, and broadly from cognitive development. In parallel, researchers should be careful about how they measure these processes and analyze the alignment between the way they have conceptualized and assessed early Mc. Clarifying this concept has been called for by prominent researchers (e.g., Brown, 1987; Kuhn & Dean, 2004), and, as discussed in Chapter I, in a recent review of SRL research, it was found that researchers provided explicit definitions least often for the construct of Mc (Dinsmore, Alexander, & Loughlin, 2008) with definitions being provided in only 39 out of 123 studies reviewed (32%). Furthermore, the SRL constructs were frequently interchanged (i.e., the same definition presented for Mc in one paper was presented for self-regulation in another). Regarding alignment between conceptualization and assessment, Dinsmore and his colleagues (2008) found that, for Mc, the alignment was 71%. These authors implored researchers and

educators to be 'vigilant' in their conceptualization and assessment of the interrelated (though

distinct) constructs of SRL, and particularly Mc as they found that to be the most 'fuzzy'/ least

defined construct. It has been 6 years since this plea, and the state of the Mc construct has

improved with more attention toward its clarification and assessment (e.g., Efklides, & Misailidi,

2010); nevertheless, it has remained a construct in need of elucidation related to its

conceptualization and assessment (Brinck, & Liljenfors, 2013; Desoete & Ozsoy, 2009; Donker,

Boer, Kostons, Dignath van Ewijk, & Van der Werf, 2014; Whitebread & Grau, 2012) and

researchers should be precise in the way they conceptualize and assess this important construct

and in the alignment between its conceptualization and assessment.

Correspondingly, in both Chapters I and III, cautions for researchers examining

metacognitive processes were discussed (see Figure 5.1).

Four cautions: (from measurement experts) when studying metacognition:
1. Field needs a plan for comprehensive assessment of the construct
   a. Reliability and validity norms
   b. Plan for translating theory into instruments that can be appropriately evaluated
2. Generate and test models
   a. Translate metacognitive theory into testable models
3. Construct and evaluate instruments that assess specific components of the model
   a. Use multiple measures/using multiple methodologies (convergent validity)
4. Use diverse assessment models
   a. Use multitrait, multimethod (MTMM) approach.
      See Campbell & Fiske, 1959 and Cook & Campbell, 1979.
   b. Incorporate diverse approaches including neurophysiological.

Figure 5.1. Expected cautions from the measurement community regarding effectively

examining metacognition. Adapted from Schraw, 2000, p. 304-308.

In my dissertation studies, I adhered to several of these—at least preliminarily—at the same time as conducting one of the first program of studies to comprehensively examine Mc in preschoolers. However, this was just the beginning steps toward these important goals. As a field, it is critical that we follow these measurement-related cautions when studying Mc so that this area of work can be regarded as highly reputable in addition to the conceptualization, assessment, and resultant findings becoming more consistent across studies.

Associations between Aspects of Metacognitive Functioning and Learning in Preschoolers

Closely related to this is the importance of acknowledging the need to isolate specific aspects of metacognition rather than consider it a 'blanket' construct (Brown, 1987). Recently, researchers have described Mc as "multifaceted" (Efklides, 2008) and "multidimensional" (Lai, 2011) indicating the general awareness that Mc should not be conceptualized (or assessed) as an overarching construct. However, often, this is how it is assessed and conceptualized, which may also be related to some inconsistency in findings across studies. Therefore, it is crucial to not only discuss Mc as a "multifaceted phenomenon" (Efklides, 2008, p. 280) or a "multidimensional set of skills" (Lai, 2011, p. 33), rather to be precise about what this means at the conceptualization *and* measurement level. Efklides (2008) presented a model of the multifaceted, multilevel metacognition phenomenon (see Figure 5.2). She did not conclude with the model, however, but discussed theoretical, measurement, and intervention implications of her proposed model with its complexities and interactive cycles. This promotes the future research that I have described here as well as in the previous chapters that is instrumental to refining the Mc construct and explicating its implications for learning and development.
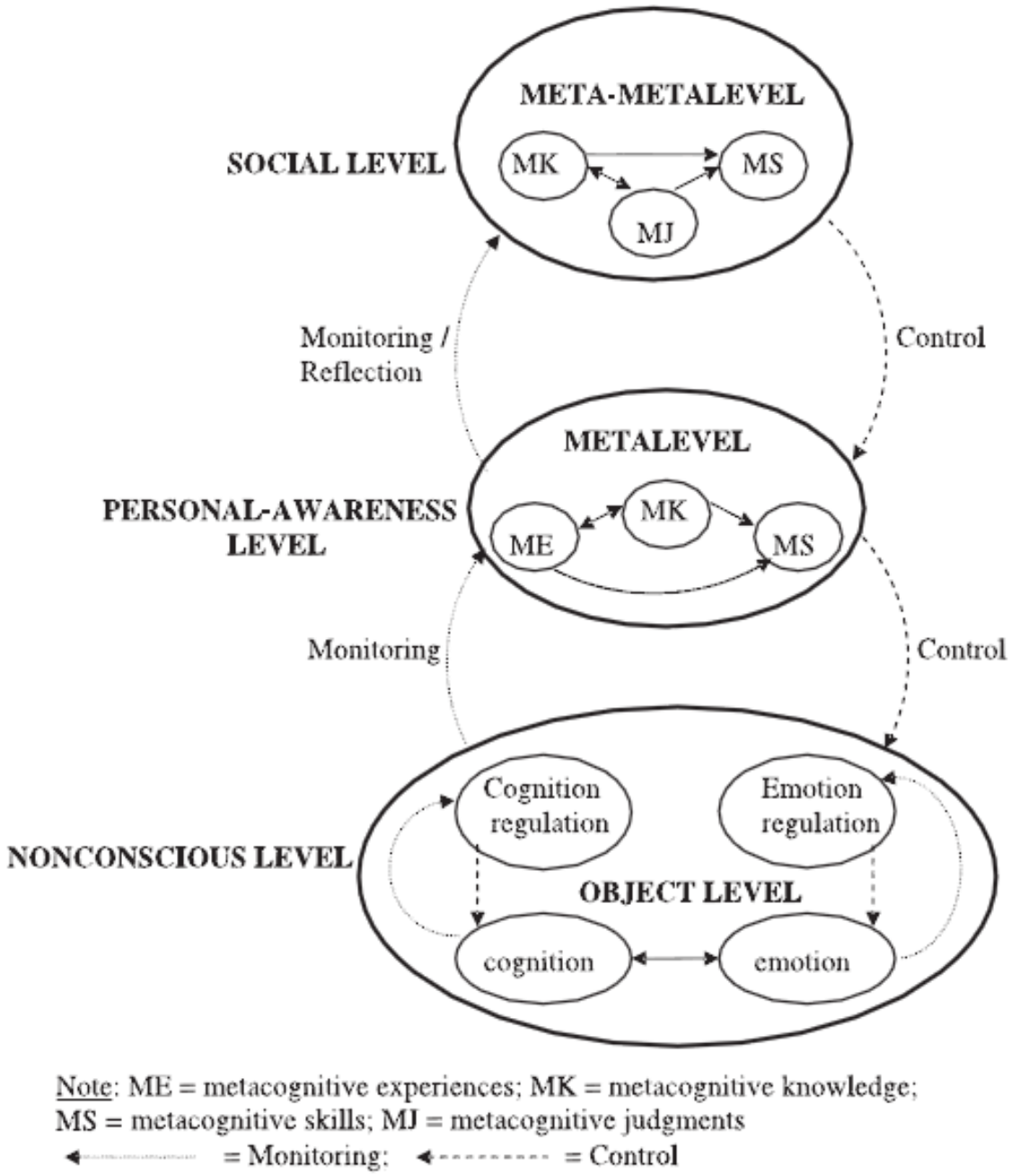
Figure 5.2. Multifaceted and multilevel model of Metacognition.

From Efklides, 2008, p. 283.

As an illustration of assessing specific aspects of the model, Efklides (2008)

recommended expanding beyond the reliance on static self-report measures (that are prospective,

or retrospective) and integrating behavioral and physiological measures along with methods that are able to detect the dynamic nature of metacognitive experiences (ME) during tasks, which can include verbal and nonverbal behaviors, facial expressions, body movements, gazes, etc. that can reveal affective and informational aspects of ME. Another example, would be assessing metacognitive skills (MS), which Efklides (2008) recommended using systematic observations of behavior patterns (indicative of strategy use). She also suggested using measures that are able to detect implicit and explicit metacognition in longitudinal studies targeting the development of metacognitive knowledge (MK) to elucidate the "interaction of the facets of metacognition between them, as well as with cognition and affect, along with growing age, knowledge and/or expertise" (Efklides, 2008, p. 284). Also, she emphasized the importance of neuropsychological measures and neuroimaging techniques for understanding associations between brain functioning and conscious/nonconscious monitoring and control of cognition. Though this is a complex, interacting model, and thus it is likely not possible to test the entire model in one study, it is important for researchers to target parts of the model and carefully consider which methods and measurement tools would be best to test whether this model would fit the data related to children's metacognitive functioning.

An example of this type of model testing (with a simple model) was a factor analysis with high school students conducted two decades ago by Allen and Armour-Thomas (1993). Using principle components analysis, the authors found evidence for Sternberg's six "metacomponent" model of Mc (Sternberg, 1986) that he proposed would permeate most complex problem-solving tasks: (1) deciding upon the nature of the problem; (2) selecting components or steps needed to solve the problem; (3) selecting a strategy for ordering the components of problem solving; (4) selecting a mental representation for information; (5) allocating resources; and (6) solution

monitoring. These components were found to account for 62% of the explained variance (on a self-report measure that asked 126 high school students to rate the extent to which they optimally employed metacomponents of Mc when faced with hypothetical problem-solving situations in diverse contexts). Moreover, these components were found to be interdependent and used by the students across all types of problem-solving situations. Therefore, there has been evidence that Mc should not be treated as a unidimensional construct and should be investigated in a nuanced way for many years. These authors concluded with: "The results of the current study, although clarifying some important issues regarding the construct of metacognition, are by no means definitive. We recognize that the validation of a construct, particularly one as elusive as metacognition, is a lengthy process; the present investigation represents only a first step in this direction. Other measures of metacognition are needed, such as direct observations of students solving real problems, teacher ratings of students' use of metacognitive strategies, as well as performance measures for more comprehensive evidence of the validity of the construct" (Allen & Armour-Thomas, 1993, p. 209). Encouragingly, there have been a multitude of studies conducted since this factor analysis that have employed such measures to provide more comprehensive evidence. However, much of this measurement work has not been done in the same study with the same sample, not allowing for precise construct validity or factor analysis, which is what is greatly needed. The convergent validity study presented in Chapter III begins to address this, and provides evidence that metacognitive processes are nuanced even in preschool-aged children (though less so for children from low-SES families) and that there is some overlap between declarative metacognitive knowledge about a puzzle task and metacognitive behaviors during the same puzzle task, though there remains substantial unique elements left to explore. Nevertheless, as Allen and Armour-Thomas (1993) described, this is "by no means definitive".

Additional metacognitive processes should be examined in the same study with the same

children in a careful convergent validity study such as the one described in Chapter III. In

addition, factor analyses should be conducted on metacognitive processes in the preschool to

early primary grade years the way they have been done with EF (Wiebe, Espy, & Charak, 2008;

Wiebe, Sheffield, Nelson, Clark, Chevalier, & Espy, 2011) to examine whether Mc is more or

less unitary across early development and which aspects of metacognitive processes are more

closely linked over this early period of development. Furthermore, it is important to investigate

whether these links between various aspects (or subcomponents) of Mc change over

development or across individual differences, such as across different populations (e.g., low-SES

vs. mid to high-SES as in Study 2 presented in Chapter III).

Some researchers have investigated specific aspects of Mc in isolation (e.g., Zohar &

Peled, 2008), which is another way to avoid conceptualizing and assessing Mc as a unitary

"blanket" term. Zohar and Peled (2008) examined the effects of an intervention on a Mc

subcomponent they referred to as "metastrategic knowledge (MSK)''. In previously studies, they

argued, MSK was confounded with other Mc subcomponents and thus it was impossible to

isolate the effects of each subcomponent and discern which was (most) important for learning

and academic achievement. The authors acknowledged that: "Although the various components

of metacognition have 'fuzzy borders' and are hard to isolate, we made an effort to focus the

intervention in the present study on MSK as a unique and differentiated component of

metacognition. Our first aim was, therefore, to test the effects of MSK as a distinct instructional

objective" (Zohar & Peled, 2008, p. 340). These researchers found that by explicitly teaching

MSK to 5th graders, they were able to provide considerable and significant gains on reasoning

scores at the strategic and metastrategic level, which were present on both near and far transfer

tasks immediately after instruction and 3 months later (Zohar & Peled, 2008). This study

illustrates another useful way to isolate the aspects of Mc and its effects on children's learning

and academic achievement, though it would be a more robust examination to include other

measures of metacognitive processing in a similar study to examine (a) convergent validity

between the aspects of Mc and (b) associations to learning, transfer and immediate and delayed

performance to examine whether different aspects of Mc provide differential associations or

predictions to learning.

Factors Facilitative of Metacognitive Processes in Preschoolers

Kuhn has suggested that if one is interested in increasing meaning making in any content

area, one should target Mc (Kuhn, 1999). She pointed to its early developmental origins but

countered that *without intervention and facilitation*: "like many other intellectual skills,

metacognitive skills typically do not develop to the level desired" (Deanna Kuhn interview,

Shaughnessy, 2004, p. 274). However, this position indicates that metacognitive processes can

and should be targeted for intervention and facilitation, beginning early in development.

As described in detail in Study 3, presented in Chapter IV, a DA intervention targeting

metacognitive knowledge strategies was successful in facilitating preschoolers' metacognitive

knowledge processes (strategies, declarative knowledge, and behavioral skills). This type of

instructional intervention should be pursued in greater depth and across aspects of metacognitive

processing to examine whether different components of Mc are differentially affected by

intervention. As discussed in detail in Chapter IV, to examine the facilitation of metacognitive

processing more comprehensively, broad longitudinal intervention studies should be designed

based on the information provided in Study 3. However, beyond large interventions and

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instructional techniques, there are facilitative learning environments and contexts, along with individual factors that have great potential to enhance metacognitive processes beginning in preschool.

Individual factors facilitative of metacognitive processes. There are several individual social cognitive processes that have been shown to be facilitative foundations to Mc. Theory of mind (ToM) is one and Private speech (PS) is another. I will briefly summarize these constructs and then discuss, more specifically, the facilitation of Mc.

Theory of mind. ToM is typically conceptualized as an understanding of mental representation (e.g., Flavell & Miller, 1998; Taylor, 1996; Wellman, 2002). More specifically, it refers to the ability to attribute mental states such as beliefs, intents, desires, and knowledge to oneself and others and the ability to understand that the mental states of others may differ from those of oneself (Premack & Woodruff, 1978). Children develop a ToM between approximately 3 to 5 years of age, typically being assessed by the ability to pass a False Belief task wherein one must predict the behavior or mental states of another person who holds a mistaken belief (Amsterlaw & Wellman, 2006). Many researchers view ToM as an important developmental precursor to Mc (e.g., Kuhn, 1999; Pillow, 2008; Veenman et al., 2006) and Flavell has referred to Mc as "applied ToM" (Flavell, 2000) indicating that children with greater ToM will generally be capable of achieving greater levels of metacognitive skills (though, as discussed previously, these should be empirically differentiated). ToM is typically viewed as a social-developmental achievement (in typically developing children), Mc—even while being viewed as a successor to ToM—follows a different path as it typically does not fully develop without facilitation through

explicit instruction, socialization, scaffolded interactions or facilitative environments and situations (e.g., Kuhn, 1999).

   Private speech. PS has been conceptualized as verbalizations that are lower in volume than typical conversations and not explicitly directed toward another person/people (thus not appearing to serve any interpersonal communicative functions (Flavell, Beach, & Chinsky, 1966; Winsler, Fernyhough, McClaren, & Way, 2005). PS has been viewed by researchers beginning with Vygostky (1934/1986) as a precursor to metacognitive behavior, and has been conceptualized as "an instrument of thought" used to verbally mediate cognition and behavior to carry out solutions to problems (Vygotsky, 1986) or as "externalized thought" (e.g., Manning, White, & Daugherty, 1994). This "externalized thought" was thought to become internalized over time and with experience, thus developing into "internalized thought" related to problem-solving, or Mc. Indeed, Manning and her colleagues have proposed that children who seem to simply be talking to themselves may instead be engaging in precursors to metacognitive thinking by planning, monitoring, or regulating their own activities (Manning et al., 1994). Additionally, the association between PS and Mc has been documented empirically. For example, many studies have implicated PS as a metacognitive mediator (e.g., Winsler, Diaz & Montero, 1997; Winsler & Naglieri, 2003). Manning and her colleagues (1994) found converging evidence that kindergarten children who were rated by their teachers as autonomous (a construct similar to SRL), academically advanced, or creative employed more private speech with a 'metacognitive focus' (and less 'lower level' or irrelevant private speech than children not rated in any of these ways).

The development of both ToM and PS seem to be associated with the development of metacognitive processes in young children. Less clear is the direction of these associations or whether ToM or PS may function as mechanisms of change for metacognitive processes in young children. This should be addressed in future research.

Contextual factors facilitative of metacognitive processes. There are several contextual processes and conditions that have been shown to be facilitative of Mc including peer interactions, metacognitive learning opportunities and environments. I will briefly discuss these contexts and how their potential to facilitate Mc in young children.

Peer interactions. Another potential mechanism for change related to the facilitation of Mc that has rarely been investigated (and was not explored in the current series of dissertation studies) is peer interactions. Schraw and Moshman (1995) discussed the potential power of these social interactions for facilitating metacognitive processes among peers of "roughly the same cognitive level in relevant aspects so that none can be considered an expert with cultural knowledge to be passed on to the others" (Schraw & Moshman, 1995, p. 364). This conceptualization is similar to the study conducted by Shamir and colleagues (2009). Shamir et al. (2009) included a peer-assisted learning (PAL) condition so that they could compare this to an individual learning condition (IL) related to metacognitive knowledge in preschoolers. They found that the PAL was significantly more facilitative of Mc than the IL for the 3-5 year old children. Similarly, Whitebread et al., 2007; 2009 found that preschool-aged children displayed more metacognitive behaviors in collaborative group configurations. Other work has found peer interactions and group problem-solving to increase students' learning and performance (e.g., Geil & Moshman, 1994), but Shamir et al., 2009, and Whitebread et al., 2007; 2009 were the first

researchers to show that this was true for preschool-aged children as well. This should be investigated further including the development of collaborative interventions related to metacognitive processes.

Regarding mechanisms of change, Schraw & Moshman (1995) have suggested that results showing greater performance in collaborative groups compared to individual conditions support their proposal that peer interactions are key to facilitating Mc, which consequently, results in enhanced problem-solving.

Metacognitive learning opportunities and environments. Siegler has pointed to the importance of studying learning as it unfolds: "the only way to find out how children learn is to study them closely while they are learning" (Siegler, 2006, p. 469). This type of close investigation typically occurs in classrooms. Researchers who do this type of work have identified learning environmental factors that are reliably associated with greater levels of Mc beginning in preschoolers including allowing children to choose their own goals and levels of challenge and engage in self-evaluation (e.g., Perry, 1998; Winne & Hadwin, 1998), encouraging students *and* teachers to verbalize and discuss their reasoning and problem-solving (e.g., Mercer & Littleton, 2007; Whitebread et al., 2007). Additionally, classroom research has shown that certain types of instructional practices are most effective for facilitating Mc including explicit teaching and modeling of Mc strategies, explicit feedback that links increased performance with specific strategies employed (i.e., enhanced metacognitive awareness), and gradually decreasing the support (i.e., external regulation) provided by the teacher allowing students to internalize their learning processes (e.g., Perels, Merget-Kullmann,Wende, Schmitz, & Buchbinder, 2009; Hattie, Biggs, & Purdie, 1996). Furthermore, contextualized practice of metacognitive and content-specific strategies (e.g., Danoff, Harris, & Graham, 1993), opportunities to collaborate

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with peers and teachers (Whitebread & Coltman, 2007), and a supportive environment where

risk-taking is encouraged and mistakes are considered invaluable learning opportunities (e.g.,

Perry, 1998).

Borkowski, Chan, & Muthukrishna (2000) suggested that metacognitive factors develop

through "high quality, interactive strategy instruction in both home and school" (Borkowski et

al., 2000, p. 5). This facilitative instruction focused on teaching children to use strategies

appropriately, learning about *when* and *how* to optimally use them and *when* and *how* to recruit

specific skills and metaskills. Borkowski and his colleagues (2000) created a model (see Figure

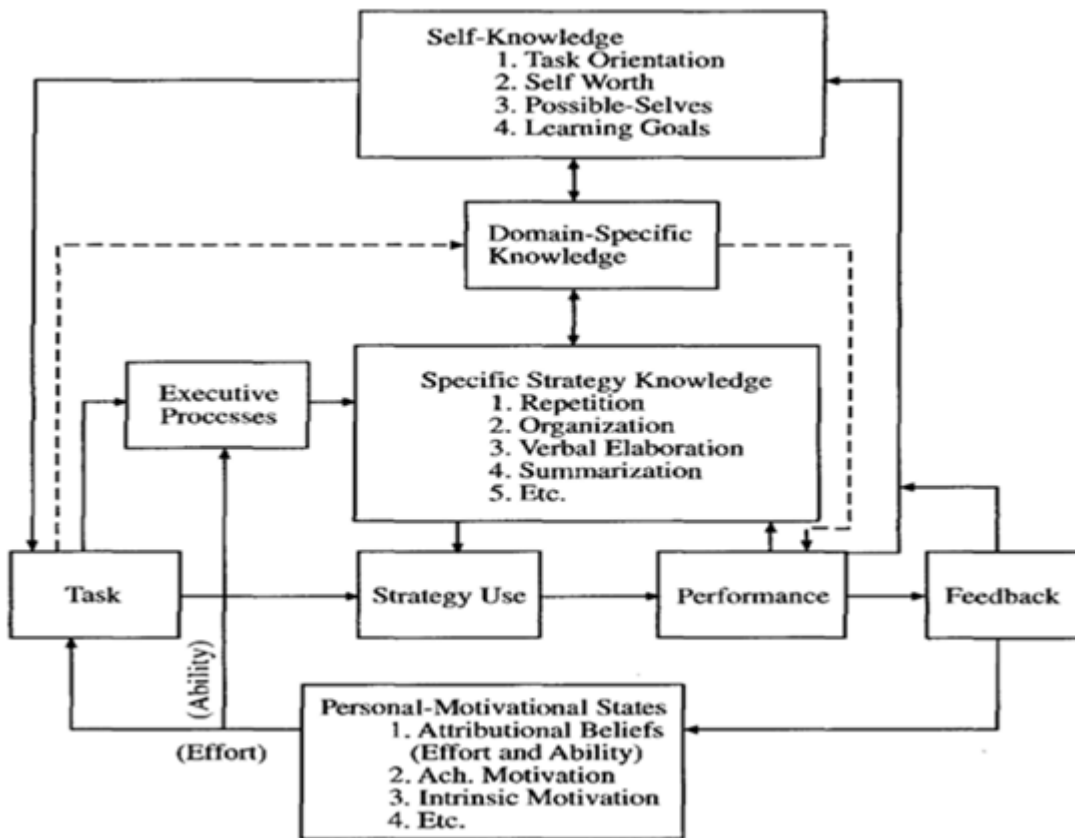5.3) to illustrate this interactive cyclical process.

Figure 5.3. Cognitive, motivational and self-system metacognitive components

From Borkowski, Chan, & Muthukrishna, 2000, p. 10.

Larkin (2000) examined first grade teachers' metacognitive learning opportunities (or the way first grade teachers facilitated metacognitive processes in their first grade science students). She developed and assessed a coding scheme (see Figure 5.4) to investigate the metacognitive learning opportunities across 10 classrooms. She found a positive association between metacognitive learning opportunities provided by teachers and first grade children's Mc and science learning.

Code	Explanation	Example
TS	Refers to self-learning strategies	"What could you do if you've got problems ?"
TK	Questions acquisition of knowledge	"How do you know that ?"
TI	Teacher prompts regarding information provided	"We found the biggest, what else could we do ?"
TE	Teacher aids explanations	"X explained putting the biggest to smallest very well"
TQ	Teacher questions/comments on strategies	"How are you putting them in order"
TP	Teacher asks for predictions of success	"Will this make it easier ?"
TL	Teacher shows expectations of planning	"How are we going to do this, what do we need to think about ?"
TO	Teacher expects checking	"Check what you are counting in"
TC	Teacher refers to own cognitive processes	"I don't understand it either"
TT	Teacher refers to thinking	"Let's put on our thinking caps"
TU	Teacher refers to universals of cognition	"We are learning how to solve problems"

Figure 5.4. Coding scheme assessing metacognitive learning opportunities facilitative of metacognitive behaviors. From Larkin, 2000, p. 8.

Ornstein and his colleagues have also examined associations between classroom contexts and metacognitive development. They (Ornstein, Grammer, Coffman, 2010) found significantly greater Mc, cognitive performance (on a card recall task) and strategy use in first graders who were in a classroom with "high mnemonic" teachers (i.e., teachers who provided a metacognitive framework in the classroom and explicitly prompted strategy development by offering strategies in particular domains and discussing why they would be effective. For example, these teachers used both explicit prompts and suggestions such as: "*Remember when you write, you have to go back and read what you wrote out loud*" and questions designed to elicit self-explanation and metacognitive awareness, such as: "*How did you solve that problem?*") compared to "low mnemonic" teachers. The difference between students in the classrooms with high and low mnemonic teachers remained *three years* later. Importantly, these children maintained their facilitated Mc across three teacher/classroom context transitions.

Kuhn has emphasized the importance of these types of opportunities for the development and enhancement of Mc: "If students participate in discourse in which they are frequently asked, 'How do you know?' or 'What makes you say that?' they become more likely to pose such questions to themselves. Eventually, we hope, they interiorize the structure of argument as a framework for much of their own individual thinking. (D. Kuhn interview: Shaughnessy, 2004, p. 275). In addition, Kuhn has emphasized the importance of teachers addressing *why* certain strategies are more effective and appropriate than others in certain contexts or domains making it more likely that children will internalize and abstract/transfer the information and knowledge they have learned to new situations (Shaughnessy, 2004).

These metacognitive learning opportunities can ideally be made more explicit. I propose that the most effective way to facilitate Mc, particularly in young children, is a combination of metacognitive learning opportunities scaffolded by significant adults and explicit instruction targeting metacognitive processes (such as that used in my DA intervention described in Study 3, presented in Chapter IV).

Researchers, both at the genesis of theorizing about and empirically examining Mc (e.g., Vygotsky, 1978) as well as the contemporary (e.g., Efklides & Misailidi, 2010) have provided support for the view that Mc is best facilitated in both implicit (e.g., socialization, social communication, collaboration and interactions, imitation and modeling) and explicit (e.g., direct informal and formal instruction) ways. In sum, metacognitive instruction, and individual factors (e.g., ToM and PS) along with and contextual factors (e.g., peer assisted interactions, scaffolded classroom environments, metacognitive learning opportunities and dialogue) may act as bootstrapping mechanisms for children, helping them to become more conscious and metacognitive in their knowledge and comprehension of their own thoughts and those of others (Bransford et al., 2005; Schraw & Moshman, 1995; Shamir et al., 2009; Whitebread et al., 2007, 2009).

Future research should examine effects of more nuanced types of mediated instruction and different types of contexts and learning environments on various aspects of children's developing metacognitive processes. It may be that a two-tiered level of 'intervention' (i.e., receiving a targeted intervention such as a repeated DA intervention in addition to daily exposure to a "metacognitive savvy" teacher) will facilitate children in not only developing greater metacognitive processes but also learning when and how to apply these skills across situations

and domains affecting their long-term developmental and academic trajectories. Therefore, future research should include longitudinal experiments beginning early in the preschool years through early elementary school years to examine cognitive change and such trajectories. Researchers conducting these studies should be precise about which aspects of Mc they are measuring and cautious about measurement as discussed earlier. These studies will be instrumental in further (and comprehensively, precisely) conceptualizing and assessment metacognitive processes in young children. The information learnt from these studies would additionally advance our knowledge of optimal educational intervention designs and approaches related to metacognitive processes, learning, cognition, and academic achievement.

Outlook

Taken together, the findings, discussions, and suggestions for future research in this series of dissertation studies points to exciting possibilities for future research on a topic that has been described as being "at the very roots of the learning process" (Brown, 1987, p. 66) and continues to hold this central role in fields such as cognitive development, educational psychology, developmental psychology, and increasingly, educational practice and policy. As Kuhn (2000) concluded her paper on metacognitive development: "There would seem few more important accomplishments than people becoming aware of and reflective about their own thinking and able to monitor and manage the ways in which it is influenced by external sources, in both academic, work and personal life settings. Metacognitive development is a construct that helps to frame this goal", Kuhn, 2000, p. 181

Important steps, as outlined across the previous chapters and summarized in this chapter, should be undertaken in order to refine the way this critical construct is studied so that (a) the

construct itself can be more comprehensively and precisely conceptualized and assessed and (b) important information can be passed onto practitioners and policy makers regarding the development of nuanced metacognitive processes and precise associations and predictions to cognitive and academic skills.

Lastly, this series of studies provided encouraging evidence regarding the metacognitive processed and abilities of preschool-aged children. Across measures and coding schemes, there was consistent evidence found in this sample of preschoolers including both children in Tuition-based classrooms and need-based Great Start Readiness Program (GSRP) classrooms. Furthermore, these young children were able to articulate a considerable amount of their metacognitive knowledge. This program of linked studies, along with previous related research (e.g., Marulis, Kim, Grammer, Carrasco, Morrison, & Gehring, 2013; Shamir et al., 2009; Whitebread et al., 2007, 2009), provides robust evidence of metacognitive processes in 3-5 year old children. Consequently, the notion that metacognitive processes do not emerge until age 7-8 or beyond (e.g., Veenman et al., 2006) should be put to rest. This would open the field up to exciting avenues of work studying this important developmental period.

Specifically, the results from this series of dissertation studies are intended to contribute in both theoretical (clarifying this important cognitive construct) and applied (aiding in the design and implementation of effective interventions for preschool-aged children intended to boost their development, learning and academic achievement, which is my ultimate goal) ways to the fields of cognitive development and education. Specifically, my research on this critical developmental period has elucidated the conceptualization and assessment of metacognitive processes—skills vital to learning and academic achievement—and implicate mechanisms underlying their development. My findings have contributed to the fields of cognitive

development and education in two significant ways. First, a clearer and more comprehensive conceptualization of metacognitive knowledge and metacognitive behaviors was revealed through Studies 1 and 2 (presented in Chapters II and III), which is fundamental to moving forward in examining its importance to academic success. Second, instructional information critical to the later design and enactment of effective early metacognitive intervention programs was revealed through Study 3 (presented in Chapter IV) with the long-term goal of informing early educational curriculum and policy and improving developmental, educational and life outcomes for all children. Additionally, because this research has contributed to understanding how metacognition is associated with learning and development for diverse children, including children at risk for learning difficulties, it has the potential to advance knowledge about its ability to serve as a protective, mediating, factor for children at risk of learning difficulties (Matthews, Kizzie, Rowley, & Cortina, 2010; National Center for Education Statistics, 2001; Sektnan, McClelland, Acock, & Morrison, 2010), promoting higher levels of cognitive development, learning, and academic achievement in these children despite their risk factors and limited metacognitive experiences at home. Providing metacognitive intervention and instruction (in a two-tiered approach ideally as described earlier) would be similar to the Mediated Learning Experiences (MLE) that Feuerstein and colleagues (Feuerstein, Rand, & Hoffman, 1979; Feuerstein, Rand, Hoffman, & Miller, 1980) emphasized (described in Chapter IV) as being what the children from lower SES families (and other risk factors) were missing, and thus what was responsible for their reduced (or what they described as "masked") learning and academic achievement. Feuerstein and his colleagues (1979, 1980) argued that cognitive development and learning was masked for these children because of limited *experiences* rather than individual deficits. In the same way, providing all children (but particularly those at risk for learning

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difficulties) with a two-tiered metacognitive intervention at the child and classroom level would give them the experiences and support they need to develop greater metacognitive processes and, subsequently, enhanced cognitive development, learning and academic achievement.

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