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Children's engagement with learning is important as children enter school, as it facilitates both future learning engagement and academic success. Current measures of learning engagement focus on engagement within a classroom setting and be confounded by contextual characteristics. A laboratory measure of engagement may also broaden available lines of research. This study first aimed to investigate the longitudinal measurement invariance and criterion validity of this measure and explore mean level changes of engagement across this time. Second, this study also assessed how the mechanism of emotion regulation, an important factor of early childhood, may influence the development of engagement in multiple contexts.

A community sample of 278 children were brought to the lab for assessments at preschool-age, kindergarten-age, and first grade-age. Children's learning behaviors and emotion regulation were observed in the lab, and questionnaire data were procured from primary caregivers and children's teachers at kindergarten and first grade.

Results demonstrated that five learning engagement behaviors, attention to instructions, on-task behavior, persistence, monitoring progress/strategy use, and negative affect cohered into a single factor at preschool-age, kindergarten, and first grade. This factor demonstrated partial scalar invariance across the three waves of data collection and was concurrently and longitudinally associated with classroom learning behaviors, academic performance, and, in some instances, school attitude. Thus, this study supports

the construct and criterion validity of a laboratory learning engagement measure for young children.

Results also indicated that emotion regulation at preschool-age was positively associated with behavioral learning engagement, assessed by both observe behaviors in a laboratory, teacher-reported behaviors in the classroom and affective learning engagement, operationalize as children's school attitude. This suggests that early regulatory skills may promote or constrain children's engagement with learning. However, kindergarten emotion regulation was not predictive of later engagement, suggesting that emotion regulation before the start of school may be particularly important for engaged learning processes. One bidirectional was also found: Learning behaviors in the kindergarten classroom were predictive of emotion regulation in first grade. As such, emotion regulation may be affected by children's behaviors in formal learning contexts.

This study provided support for a new measure of learning engagement and expanded current knowledge about the mechanisms that support early engagement. This measure can be useful for researchers who may have difficulty collecting classroom data or are more interested in engagement specific to learning tasks. Moreover, this study suggests that early emotion regulation is important for future engagement, and that any effort to improve emotion regulation should be targeted toward children before the beginning of formal education.

LEARNING ENGAGEMENT ACROSS THE TRANSITION TO SCHOOL:

INVESTIGATING THE MEASUREMENT OF LEARNING

ENGAGEMENT AND THE EFFECTS OF EARLY

EMOTION REGULATION

by

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To Fletcher Halliday.

Thank you for your confidence, comfort, and continuous encouragement. With your support, I have been able to push my limits and explore my dreams.

I am so glad that we're a team.

APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Young children's ability to engage with learning tasks and within learning contexts is critical in promoting successful school outcomes, as early approaches to learning have strong implications for later achievement and learning skills (Kagan, Moore, & Bredekamp, 1995; Ladd & Dinella, 2009; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; McClelland, Acock, & Morrison, 2006). As such, gaining a better understanding of learning engagement during early childhood may help advance current theory about school success and inform new research and programming aimed at helping children succeed. This study attempts to further current knowledge through two main objectives: to investigate a novel measure of learning engagement among young children and assess how engagement may be influenced by another important early developmental process, emotion regulation.

As current measures of learning engagement tend to focus on learning behaviors in a classroom setting, it is unclear whether these measures assess children's engagement with learning specifically or more broadly with their classroom environment. Additionally, having multiple instruments that can measure engagement in various contexts may broaden the types or research questions that can be addressed. One promising laboratory measure of learning engagement was validated among a group of preschoolers (Halliday, Calkins, & Leerkes, 2018) but has not yet been investigated with older children. This study evaluated the validity of this learning engagement measure among kindergarteners and first graders and use this assessment to explore how early learning behaviors develop across the transition to school.

In addition to issues of measurement and development, it is also important to consider the mechanisms that may support adaptive learning behaviors and feelings. One potential mechanism that may be a particularly important process to consider during early childhood is emotion regulation, which is also rapidly developing during this developmental period (Calkins & Hill, 2007). The transition into formal schooling is marked by increased expectations for children to act autonomously while simultaneously confronted with new challenges that may both elicit strong emotions and tax self-regulatory capabilities (Denham, 2006; Rimm-Kaufman, Pianta, & Cox, 2000). As such, children must learn to cope with such negative emotions as fear, frustration, and boredom in order to remain actively and positively involved with learning. Therefore, this study also investigates how emotion regulation may promote the development of learning engagement across the transition to school and specifically assesses how children's ability to handle negative emotions may affect their ability to engage both within the laboratory and the classroom as well as their feelings about school.

Learning Engagement

Learning engagement is a multidimensional construct that can broadly be defined as a child's behavioral, affective, and cognitive approach to learning (Fredricks, Blumenfeld, & Paris, 2004; Jimerson, Campos, & Greif, 2003; Reschly & Christenson, 2012). At an individual level, cognitive engagement generally refers to children's persistence, desire for challenge, strategy use, effort, and investment in learning. In contrast, affective engagement refers to children's emotional connection to and experience with school. This may be operationalized as children's enjoyment of school, interest in learning, and pleasure, pride, and excitement while working on learning tasks. Finally, whereas both cognitive and affective engagement are primarily internal processes, behavioral engagement refers to observable actions, such as active participation, focused involvement, and rule adherence (Fredricks et al., 2004). When measuring learning engagement, it is very difficult to disentangle these three levels of engagement. This is likely because behavioral engagement can also encompass the observable manifestations of both affective and cognitive engagement through such behaviors as expressed enjoyment, enthusiasm, and strategic behavior.

As engagement at the cognitive and affective levels can be difficult to observe, their behavioral manifestations are more easily and commonly assessed than the internal processes themselves. This may be particularly true in early childhood when self-report is a less valid means of assessment. As such, most research during this developmental period tends to focus on behavioral engagement, affective-behavioral engagement (e.g., expressed positivity), and, to a lesser extent, affective engagement, whereas cognitive engagement is less emphasized. This is also in-line with more classic theories of learning engagement, which often only described two forms of engagement: behavioral and affective (Finn, 1989; Marks, 2000; Newmann, Wehlage, & Lamborn, 1992; Stipek, 2002). Given this current focus, this paper also primarily focuses on engagement at the behavioral and affective levels.

In cases where engagement is studied as a dichotomous variable during early childhood, affective engagement is often measured as the degree to which children enjoy school, which can be assessed through child report (e.g., The School Liking and Avoidance Scale [SLAQ; Birch & Ladd, 1997]), or teacher report (e.g., The School Liking and School Avoidance subscales of The Teacher Rating Scale of School Adjustment [TRSSA; Birch & Ladd, 1997]). Although school attitude is only one aspect of affective engagement, this variable may meaningfully address something distinct from a child's instantaneous emotional expression during a given learning experience.

Behavioral engagement is most often measured by teacher questionnaires that commonly assess children's work habits, cooperation, and persistence or, to a somewhat lesser extent, structured observation of children's classroom behaviors, such as involvement, cooperation, and independence. Within the early childhood literature, behavioral learning engagement is commonly referred to by broad terms, such as learning behaviors, learning skills, approach to learning, or, simply, engagement. Furthermore, most current empirical research with young children tends to focus on less discrete forms of the construct. For example, the widely used teacher questionnaires, The Preschool Learning Behavior Scale (PLBS; McDermott, Green, Francis, & Stott, 2000) and the related Learning Behavior Scale (LBS; McDermott, Green, Francis, & Stott, 1999) for children in kindergarten through high school, include items and subscales that address various observable aspects of engagement at the cognitive, affective, and behavioral levels. As such, behavioral engagement, here defined to include observable displays of cognitive and affective engagement, may be particularly useful when studying the development of engagement in young children, as it allows for a rich and complex depiction of engaged behaviors.

Learning engagement is an important construct to study, as it may facilitate successful academic and school outcomes (Appleton, Christenson, & Furlong, 2008). Specifically, children who are more behaviorally engaged may spend more time interacting with stimulating materials, and children who enjoy learning may be more likely to seek out new opportunities to learn than children who are less engaged. Children who engage in more prosocial and self-reliant behaviors and have a more positive outlook may develop more positive relationships with teachers, who may in turn be more supportive (Birch & Ladd, 1998; Stuhlman & Pianta, 2001). Further, as The National Education Goals Panel argue, attitudes, habits, and learning styles determine whether children will utilize their learning competencies in practice and actively apply the skills they have learned (Kagan et al., 1995). As such, this panel suggests that children's approaches toward learning is one of the key abilities that are most important for early learning and development.

The relation between learning engagement and success is also supported empirically. Behavioral learning engagement, measured in the form of teacher-reported classroom learning behaviors, has empirically predicted academic skills and achievement across the preschool and early elementary years (Fantuzzo et al., 2007; McDermott & Beitman, 1984; McDermott, Rikoon, & Fantuzzo, 2014; McDermott, Rikoon, Waterman, & Fantuzzo, 2012; Rikoon, McDermott, & Fantuzzo, 2012; Schaefer & McDermott, 1999; Vitiello, Greenfield, Munis, & George, 2011; Yen, Konold, & McDermott, 2004).

Greater teacher-reported engagement in preschool was also longitudinally associated with literacy in kindergarten and first grade (Bulotsky-Shearer & Fantuzzo, 2011), and greater learning engagement in kindergarten predicted greater gains in reading and math through the fifth grade (Li-Grining et al., 2010). Impressive results were also found when engagement was measured by trained observers in the classroom, whereby engagement in kindergarten predicted greater math and reading achievement at the end of both the second grade (McClelland, Morrison, & Holmes, 2000) and sixth grade (McClelland et al., 2006). Affective engagement has also demonstrated associations with school success, even among younger children: Ladd and Dinella (2009) found that both behavioral engagement and affective engagement, operationalized as children's school liking versus avoidance, each uniquely predicted school achievement from the 1st through the 3rd grade.

Ladd and Dinella's (2009) study also had another important finding: Behavioral and affective engagement predicted one another across time through early elementary school. Thus, these two dimensions of engagement not only promoted academic achievement but also cyclically reinforced one another. It is possible that greater positivity toward learning materials, the classroom, teachers, and peers may encourage more on-task behavior and participation. Similarly, behaving in a more engaged manner may result in greater opportunities for success, which may in turn promote feelings of pleasure, pride, and social camaraderie with teachers and learning partners. Early learning engagement may therefore facilitate subsequent engagement, which may in turn promote positive academic outcomes during the later school years (Connell, Spencer, & Aber, 1994; Furrer & Skinner, 2003; Marks, 2000; Reschly & Christenson, 2006; Voelkl, 1997). In sum, learning engagement during children's early school years may have important implications for children's future academic careers. Thus, it is important to have the tools to adequately measure this construct in various contexts and developmental periods. The following section discusses a new measure of learning engagement during early childhood and the development of engagement at this important stage.

Measuring Learning Engagement in the Laboratory During Early Childhood

Current research methodology for measuring learning engagement is primarily limited to teacher-report or classroom observations, and this may constrain the type of inquiries researchers can pursue in regard to children's engagement with learning tasks. For example, Stipek (2002) hypothesized that children's behavior during learning tasks may depend upon the context in which learning occurs and that school engagement, characterized more by participation in the social aspects of education and learning, may differ from academic engagement, which pertains more to task persistence and effort. A laboratory measure may help isolate task learning engagement from classroom engagement so that these two processes may be independently assessed and compared.

A laboratory measure may also benefit the research community for more practical reasons. First, teachers' reports of children's engagement may be biased by their relationship with that child more than a trained coder. Second, for researchers whose work is primarily laboratory-based or who work with large community samples, it may be challenging to add a teacher questionnaire or classroom observation, as it may not be feasible to make contact with or enter many schools at once. These researchers may also be more likely to study other constructs such as emotion regulation, parenting behavior, and physiology that are best measured in a laboratory setting. As such, a laboratory measure may facilitate analyses exploring the relations between learning behaviors and these processes, which may help further our understanding about the development of learning engagement and academic success. Finally, a laboratory measure may be particularly important when conducting research with children before the entry to formal education, as not all young children attend prekindergarten programs. This population is ignored in current research that focuses on engagement measured in the classroom. Furthermore, even among children who do attend preschool or daycare, academic expectations may vary greatly, and it may be challenging to compare children across programs. Thus, although there are challenges to getting certain populations of children into a laboratory, having the option of measuring engagement in a setting outside of the classroom may help reach new children not included in current analyses and better equalize children with different preschool experiences.

One laboratory measure designed specifically to assess children's learning engagement has demonstrated good construct and criterion validity among a group of preschool-aged children (Halliday et al., 2018). This measure, which aimed to consider a broad and complex set of learning behaviors, assessed seven indicators of engagement during two learning-based laboratory tasks. Until this measure, most laboratory measures of constructs similar to learning engagement (e.g., mastery motivation) primarily focused on the proportion of time spent working on a task (Deci, Driver, Hotchkiss, Robbins, & Wilson, 1993; Frodi, Bridges, & Grolnick, 1985; Morgan, Harmon, & Maslin-Cole, 1990), which does not fully explore the many presentations of engagement. In contrast, the coding scheme of the new observational assessment considered such varying displays of engagement as how children behaved when the task became partiularly challenging, approached problem-solving when presented with both novel and repeated difficulties, reacted when presented with a new task, responded to minor failures and successes, and listened to and utilized the experimenter in the room. By being sensitive to these diverse manifestations of engagement, a more nuanced depiction of engagement could be measured.

This measure was also novel in that it specifically measured these behaviors in a learning context. In order to measure children's engagment with learning specifically, and not challenging tasks more generally, tasks were designed to ceneter around a learning goal and to mimic activities that might occur in a typical classroom. This is in contrast to other analog assessments that have assessed a wider array of emotional and behavioral indicators in the face of challenge while observed in a laboratory (e.g., completing impossible puzzles; Berhenke, Miller, Brown, Seifer, & Dickstein, 2011). In the current measure of learning engagement, behaviors were assessed during two problem-solving tasks, a puzzle tangrams task, which requires children to exercise visuo-spatial problem-solving skills, and a story-sequencing task, which draws on reading comprehension, story-telling, and temporal ordering skills. Both tasks involved a short teaching component, similar to classroom instruction, and grew more challenging as they progressed. Thus, children needed to attend to, retain, and adapt information as well as draw and build upon their prior experience. The increasing difficulty of the tasks also helped ensure that most children would eventually be faced with a problem that was challenging enough to require increased effort and test persistence.

Halliday and colleagues (2018) found that six of the seven original behavioral indicators of learning engagement, *persistence*, *attention to instructions*, *on-task behavior*, *monitoring progress/strategy use*, *energy/enthusiasm*, and *negative affect* cohered into a single factor representing behavioral learning engagement during each task. Although the seventh observed variable, *positive* affect, was not cohesive with the rest of the indicators, the coherence of the other six behaviors demonstrated that a single behavioral engagement factor could be observed within the laboratory. Moreover, this factor was concurrently associated with better standardized academic skills and greater parent-reported mastery motivation and predictively associated with more adaptive classroom learning behaviors and both math and reading performance, as reported by children's kindergarten teachers. This measure thus demonstrated strong concurrent and predictive validity. However, although this measure seems promising, it has so far only been assessed among preschool-aged children. To be useful for longitudinal analysis, it is necessary to investigate this measure further and establish its validity among older children. If validated, exploring children's behaviors on this measure across early childhood may help elucidate how children engage with learning as they transition to formal schooling and how engagement with learning tasks may develop around this period.

A lack of measurement invariance may also be informative, as it may reveal important differences in the manifestation of learning engagement across the transition to school. Although each behavior may continue to be relevant for children's engagement and school outcomes, the level at which they operate and magnitude of their importance may differ across age. Thus, any changes in the learning engagement construct at kindergarten and first grade may indicate that the way in which certain engagement behaviors function may be sensitive to the context of time and development. The next section focuses on how learning engagement may operate and change across early childhood and the early school years.

Development of Learning Engagement in Early Childhood

Given that learning engagement is an important factor throughout the school years—from early childhood though early adulthood—it is important to understand its development across age, both from a theoretical and measurement perspective. Developmental tasks change from early childhood through adolescence and these tasks provide the foundation upon which our understanding of engagement must be interpreted (Mahatmya, Lohman, Matjasko, & Farb, 2012). Although certain behaviors such as rule adherence, focused involvement, and attentiveness may remain important throughout one's school career, other aspects of engagement may become more or less salient and important for success over a protracted period. For example, whereas learning to behave prosocially during cooperative tasks and learning contexts may be an important task of early childhood (Bierman, Torres, Domitrovich, Welsh, & Gest, 2009; Mahatmya et al., 2012), these behaviors may become less of a developmental challenge as children develop. In contrast, other behaviors such as self-initiating active involvement, voluntarily participating in extracurricular activities, and remitting work punctually may become more informative indicators of children's engagement as they are given greater responsibility and have more autonomy in their decisions and actions (Mahatmya et al., 2012). To reflect this, some models focusing on adolescents propose a fourth component of learning engagement, academic engagement, defined by such indicators as homework and course credit completion (Reschly & Christenson, 2006), which would make little sense to measure in early childhood. Across the early and middle childhood, similar albeit smaller shifts may occur in the relevance and predominance of engaged learning behaviors. In order to understand how learning engagement operates during this transitionary period, it is necessary to better understand how the construct itself develops.

Although prior empirical work investigating this developmental progression is limited, one recent teacher-report measure of learning engagement, The Learning-to-Learn Scales (LTLS; McDermott et al., 2011) was specifically designed to be sensitive to longitudinal changes in early childhood by including items that reflected incrementally more complex behaviors associated with similar underlying processes. The LTLS, validated among a sample of Head Start children, yielded seven subscales, Strategic Planning, Effectiveness Motivation, Interpersonal Responsiveness in Learning, Vocal Engagement in Learning, Sustained Focus in Learning, Acceptance of Novelty and Risk, and Group Learning, and each of these scales demonstrated significant positive linear and cubic growth as well as negative quadratic growth over two years. Thus, children appear to become generally more behaviorally engaged within the classroom across the transition to school.

Further examination of how engaged behaviors may change across the transition to school is also necessary to clarify this potential growth. For example, similar investigation using a laboratory measure would further demonstrate that this developmental change is due to engagement with learning and not something more specific about the preschool versus kindergarten and first grade classroom. Moreover, although engagement may be particularly important for low-income children like the Head Start Children who were assessed using the LTLS, conducting these analyses among a large-scale inclusive and economically diverse population may allow for broader conclusions about the general development of engagement.

Increases in learning engagement may be explained by several factors, especially given that the transition into formal school is marked by dramatic changes in children's context and internal regulatory skills. For example, in contrast to preschool or the home, kindergarten classrooms rely on formalized instruction, which may require a different set of behaviors than previously experienced (Rimm-Kaufman et al., 2000), and children may become more focused, compliant, and strategic in order to meet these new expectations. Furthermore, children's ability to manage arousal, cope with emotion, and flexibly and efficiently store, manipulate, inhibit automatic behavior, and flexibly switch between rules and tasks develops rapidly over the course of children's preschool-age and kindergarten years (Calkins & Hill, 2007; Fox & Calkins, 2003; Garon, Bryson, & Smith, 2008). This developmental change may facilitate shifts in engaged learning, which may also experience a critical period of development at this time.

Exploring the relation between children's self-regulation and learning engagement may therefore help illuminate the mechanisms that support adaptive engagement and in turn promote positive learning experiences and academic success. The regulation of emotion may be particularly critical in fostering strong learning engagement, especially considering the novel and potentially arousing conditions of the early school environment. Emotion is thought to play an important role as children transition into school, and the regulation of emotion may be critical for successful adjustment (C. Blair, 2002; Denham, 2006; Eisenberg et al., 1996; Raver, 2002). Thus, examining the specific way emotion regulation may influence children's engagement with learning could deepen our understanding of why children become or remain engaged and why they succeed or fail at school. The next section discusses the construct of emotion regulation and its relation to children's ability to engage with learning.

Early Predictors of Learning Engagement: Emotion Regulation

Emotion regulation encompases the processes that maintain, inhibit, or enhance the intensity, latency, and persistence of emotion (Eisenberg & Spinrad, 2004; Thompson, 1994), which is defined as a state of arousal and readiness for action that can be either conscious or unconscious (Cole, Martin, & Dennis, 2004). Children's ability to regulate their emotions begins to develop early in infancy, when infants begin to use rudimentary strategies to control emotion and alleviate distress (Braungart-Rieker, Hill-Soderlund, & Karrass, 2010; Calkins, 1994; Calkins & Fox, 2002; Crockenberg & Leerkes, 2004; Grolnick, Bridges, & Connell, 1996; Stifter & Braungart, 1995). These strategies become more purposeful and directed as a result of parental scaffolding and motor, language, and neurophysiological development (Calkins & Hill, 2007; Fox & Calkins, 2003; Posner & Rothbart, 1998). Thus, self-soothing strategies move from being primitive and reflexive (e.g., crying, thumb sucking) to more coordinated, organized, and complex (e.g., petitioning caregiver for support, shifting focus to something calming or positive) as children move from infancy to toddlerhood to early childhood.

Given its early ontological development, emotion regulation may exert a strong influence over several key developmental outcomes ranging from cognitive to behavioral to social functioning (Calkins & Fox, 2002). Children who are unable to adaptively regulate emotion may be unable to successfully interact with their environments and have more difficulty controlling their behavior. For example, children who demonstrated less strategic regulatory abilities exhibited worse social functioning and greater problem behaviors than more emotionally well-regulated children (Calkins & Dedmon, 2000; Dollar & Stifter, 2012; Eisenberg et al., 1995; Rubin, Coplan, Fox, & Calkins, 1995). Emotion regulation therefore has strong implications for the development of children's adaptive functioning and emotional wellbeing.

Emotion regulation may also be integral to the development of learning engagement, particularly during the transition to formal education. The classroom environment, even during preschool, poses many potential challenges to a young child, as one-on-one interaction with a caregiver may be limited and behavioral expectations may be more stringent than in the home. When children transition to kindergarten, these challenges may become more extreme. The kindergarten environment is markedly different from earlier developmental contexts, and many kindergarteners demonstrate some form of maladjustment (Rimm-Kaufman et al., 2000). Part of the challenge of the kindergarten context may be that children are faced with novel experiences and increased expectations to autonomously cope with new challenges. Behaviors that were acceptable in preschool may no longer be permissible in kindergarten, and teachers may have fewer resources to scaffold children's behavior as closely. Successfully navigating the transition to school therefore requires some ability to regulate one's own emotions.

Although emotion regulation pertains to the regulation of all emotions, be they positive or negative, most research has focused on the regulation of negative emotions. The regulation of negative emotion may be particularly relevant when considering maladaptive outcomes. In learning contexts, children may feel negative due to critical feedback, novel or undesired social interactions, and high expectations to focus and cooperate despite possible boredom or frustration. Children must be able to cope during situations that provoke fear, frustration, or boredom, such as peer aggression, delayed attention from their teacher, or task failure, and remain attentive when required to sit through lengthy instructions and complete undesired activities (Denham, 2006). Although these school-related emotions may help motivate children to change their behavior, they may also derail productivity, effortful focus, enthusiasm and the enjoyment of learning if they are not regulated in an adaptive manner.

The ability to adaptively regulate negative emotion may therefore be of great importance for successful learning and particularly relevant in promoting engaged behaviors and feelings. When considering the effect of emotion regulation on engagement, it is useful to investigate its effects not only on observed indicators of engagement but also on the non-visible feelings children have about school and the learning process. As such, the ways in which emotion regulation may promote engagement at both the broad behavioral level as well as the affective level is discussed.

Emotion regulation and behavioral learning engagement. From a funcionalist perspective, emotions serve a purpose for motivating behavioral action (Campos, Frankel, & Camras, 2004; Campos, Mumme, Kermoian, & Campos, 1994). In relation to engaged behaviors, negative emotions may specifically serve to alert the individual that sufficient progress toward a task goal is not being made or to promote more vigilent focus on the learning environment. Conversely, other negative emotions such as boredom or hopelessness may promote the withdrawl of involvement (Linnenbrink, 2007; Pekrun & Linnenbrink-Garcia, 2012). However, the response to the emotion, rather than the emotion itself, may be the cause of the behavioral reaction. For example, although it has been hypothesized that 'activating' negative emotions (e.g., anxiety) may be more beneficial for behavioral engagement than deactivating emotions (e.g., boredom), because activating emotions may motivate changes in behavior, empirical research has demonstrated negative correlations between behavioral engagement and both deactivating and activating negative emotions among both school-aged children and young adults (Linnenbrink, 2007). Thus, if adaptive regulation does not occur, even those emotions whose function is to motivate action may inhibit behavioral involvement during school. The ability to manage these emotions is therefore critical for maintained engagement with school.

While learning, children must be able to recruit regulatory strategies that align with classroom rules and expectations, as the use of maladaptive strategies to regulate emotion may undermine their ability to engage behaviorally. Specifically, attempting to regulate negative emotion through such methods as avoiding challenge, disruptively or aggressively venting, ignoring expectations, or distracting oneself with task-irrelevant behavior directly obstruct learning goals and classroom expectations. In contrast, more adaptive strategies, such as quiet self-soothing or help seeking, may support more well-maintained focus and participation.

Emotion regulation may be particularly relevant to the development of behavioral learning engagement during early childhood. Young children's attempts to autonomously self-regulate may be insufficient during particularly challenging learning contexts due to immature regulatory capacities. As such, children may not be able to fully benefit from the motivating effects of negative emotions, as it may be difficult for them to act on the motivational signals of certain emotions without the ability to first manage their concurrent arousal. Even if the negative emotion itself can be assuaged, the magnitude of effort needed to autonomously cope may be so great that few resources may remain to support sustained effort and attention on learning materials or tasks. Children who are better at regulating emotions may thus find it easier to continue to interact with learning materials or environments, particularly if those stimuli are concurrently a source of negativity.

Children who are better at regulating emotions may also demonstrate greater learning engagement because children with poorer emotion regulation may be more likely to exhibit more pervasive psychological problems within the classroom that disrupt behaviors conducive to engagement. Children who are less emotionally regulated are more likely to demonstrate externalizing problem behaviors such as defiance, aggression, destructiveness, inattention and impulsivity (Calkins & Dedmon, 2000; Eisenberg et al., 1995; Graziano, Keane, & Calkins, 2010) and internalizing problems such as unhappiness and social avoidance (K. A. Blair, Denham, Kochanoff, & Whipple, 2004; Eisenberg et al., 2001) than more adaptively regulated peers. These behavioral and emotional problems have in turn been empirically correlated with diminished behavioral learning engagement in the preschool classroom (Bulotsky-Shearer et al., 2011; Fantuzzo, Bulotsky-Shearer, Fusco, & McWayne, 2005; McDermott, Leigh, & Perry, 2002). In a learning setting, poorly regulated children may thus have difficulty remaining on task, filtering distractions, and attending to a teacher's instructions. Moreover, the use of aggression and defiance may be both disruptive and counter to established classroom rules. Finally, poorly regulated children who are anxious or withdrawn may avoid learning tasks by going off-task and fail to actively or cooperatively participate.

Children who are less emotionally well-regulated are also more likely to be less socially skilled and behave more negatively with peers than children who are better regulated (Dollar & Stifter, 2012; Eisenberg et al., 1995) and may thus be less cooperative or less eager to participate in learning activities. In research conducted in a school setting, emotion regulation skills among preschool-aged children were related to teacher-rated social skills (K. A. Blair et al., 2004; Miller, Gouley, Seifer, Dickstein, & Shields, 2004), classroom peer likability (Denham et al., 2003), and stable, high quality peer play (Cohen & Mendez, 2009). As such, children who are less socially skilled or have poorer relationships with their teachers and peers may be less likely to actively participate within the classroom, either avoid or struggle to successfully engage in interactive group activities or fail to develop a strong rapport with their teacher (Bulotsky-Shearer et al., 2012; Coolahan, Fantuzzo, Mendez, & Mcdermott, 2000; Denham, Bassett, Zinsser, & Wyatt, 2014; Hamre & Pianta, 2001; Ladd, Birch, & Buhs, 1999; Ladd, Herald, & Kochel, 2006; Yang & Lamb, 2014).

The limited empirical research testing the direct association between emotion regulation and learning behaviors generally supports their facilitative relation. For example, teachers who rated preschool children as more emotionally well-regulated also rated them as more engaged in the classroom (Fantuzzo, Perry, & McDermott, 2004). Similarly, preschoolers who were observed to be more emotionally dysregulated in the classroom were rated as less engaged and self-motivated by their teachers (Herndon, Bailey, Shewark, Denham, & Bassett, 2013). Among kindergarteners, emotion regulation was also found to be related to children’s overall academic competency, which included a measure of productive and compliant learning behaviors (Graziano, Reavis, Keane, & Calkins, 2007). However, another study found no evidence for a significant direct effect of emotion regulation on engagement among a sample of preschoolers after several other factors were also accounted for (Bailey, Denham, Curby, & Bassett, 2016). Instead, this study found an interaction between emotion regulation and teacher support, such that children who were more emotionally regulated were more likely to be engagement only within classrooms that provided little emotional or organizational support. Thus, the empirical evidence for the relation between emotion regulation and engagement is not entirely conclusive.

There is also little clarity about the particular nature of the relation between emotion regulation and learning behaviors and how these two constructs interact with one another over time. On one side, emotion coping skills at the beginning of preschool predicted better adjustment, measured as a composite of academic skills and learning engagement, at the end of the school year (Ann Shields et al., 2001), and emotion regulation in preschool predicted greater teacher-reported engagement in kindergarten (Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). However, another study found that positive engagement with tasks at the beginning of the preschool year was related to stronger emotion regulation at the end of the year (Williford, Vick Whittaker, Vitiello, & Downer, 2013). These conflicting findings are mostly driven by the fact that each research group only tested their a priori hypothesized direction of effect. Studies that directly test these competing directional hypotheses are needed to better understand this relation. Furthermore, longer-term studies that continue into early elementary school may also help establish potentially more stable developmental patterns between emotion regulation and learning engagement across the early school years.

Further research is also needed to elucidate whether emotion regulation directly affects children's engagement with learning tasks or with classroom engagement more broadly. As prior work has primarily investigated learning engagement through either teacher report or classroom observation, it is unclear whether emotion regulation specifically influences children's learning behaviors rather than their classroom behaviors. One study found support for the relation between emotion regulation and task learning engagement, although the direction of their findings was opposite to that of the current hypothesis. Specifically, they found that children's active engagement with tasks, observed by trained researchers in the classroom, in the beginning of preschool year were related to improved emotion regulation in the spring. In contrast, other forms of engagement, namely positive engagement with teachers, were associated with gains in executive functioning. However, task engagement here was still measured within the classroom context, and emotion regulation was measured solely by teacher report. By measuring engagement outside of the classroom and constrasting it with engagement measured within the classroom, a clearer understanding of the association among these constructs may be achieved.

Emotion regulation and affective learning engagement. The ability to regulate negative emotions may not only influence engagement at the behavioral level but also promote engagement at the affective level. Specifically, if the duration and intensity of negative emotions are not sufficiently inhibited, children may begin to associate these feelings with learning tasks or the classroom. As negative emotions can turn into longer lasting negative moods, this negativity has the potential to affect children's perceptions of the classroom (Linnenbrink & Pintrich, 2002). Repeatedly experiencing dysregulated negative emotion in the classroom environment or during learning-related tasks may, over time, erode children's desire to participate in learning environments or with learning materials. As such, children who are better able to regulate their negative emotions in effortful and adaptive ways may maintain a sense of enjoyment with school and learning whereas more poorly regulated children may become increasingly ambivalent or negative.

As with behavioral engagement, affective engagement may similarly be influenced by emotion regulation through its effect on social relationships. As children with stronger emotion regulation may also be more skilled socially and develop more positive relationships with teachers and peers (K. A. Blair et al., 2004; Cohen & Mendez, 2009; Denham et al., 2003; Miller et al., 2004), more emotionally regulated children may be more likely to develop a sense of social belonging and comfort within the classroom and thus become more interested in or excited about attending school. Extant research has found that positive classroom relationships and feelings of relatedness within the classroom were related to school enjoyment and interest during young childhood (Birch & Ladd, 1997), middle childhood (Furrer & Skinner, 2003) and early adolescence (Goodenow, 1993). Emotion regulation may therefore support affective engagement by promoting more positive social relationships and suppressing the effect of negative social experiences in the classroom.

Although there is currently little empirical evidence for the direct association between emotion regulation and children's affective engagement, current work demonstrating a correlation between emotion regulation and learning engagement more generally supports this proposed relation. For example, Shields and colleagues (2001) found associations between emotion regulation and a global school adjustment variable that not only included academic skills and learning behaviors but also children's engagement with teachers and peers. Taking a less broad approach, Fantuzzo and colleagues (2004) found that preschoolers' emotion regulation was correlated with children's learning attitude, measured as a subscale of the PLBS. However, data from these studies may be less reliable due to reporter bias, as the same teacher provided information on both emotion regulation and engagement. Moreover, the items on the attitude subscale of the PLBS include behaviors, such as "acts without sufficient time" and "invents silly ways of doing things," that may not fully pertain to the construct of affective engagement. In another set of studies, several engagement measures were collected, including the PLBS attitude scale and teachers' reports of children's school liking, which both loaded onto a positive-engaged component. Although it is unclear how much of these associations were driven by affective processes, lower scores on this component were associated with greater emotional dysregulation in the classroom (Herndon et al., 2013). However, this component was not with how well children regulated their emotion during a set of self-regulation tasks (Bailey et al., 2016).

Further studies are needed to assess the specific associations between emotion regulation and affective engagement. Specifically, research investigating how children's ability to cope with negative emotions may affect their feelings about school may help elucidate how the ability to self-regulate may influence the intrinsic processes that encourage the enjoyment of learning. Although one's attitude about school is only one element of affective engagement, assessing children's feelings about school rather than their affective expressions may provide important insight into children's motivations that is distinct from what can be infered from observable learning behaviors. As affective and behavioral engagement may cyclically reinforce one another, such that a more positive attitude about school promotes more engaged learning behaviors and vice versa (Ladd & Dinella, 2009), understanding how each of these processes are influence by emotion regulation is important for understanding the broader development of children's early school adjustment and success.

Current Study

The current study intended to test two broad questions, each composed of several aims. First, this study assessed how engaged learning behaviors, observed during a novel laboratory assessment, develop across the transition to school. Individual behaviors, such as attention to instructions, enthusiasm, and persistence were investigated from preschool-age through first grade and the invariance and validity of the overall behavioral engagement factor were assessed. Second, this study examined how learning engagement in early childhood might be influenced by a child's ability to regulate emotions. In order to take a more fine-grained view of learning engagement and mechanistic approach, this study individually assessed how emotion regulation may affect three types of learning engagement: children's learning behaviors in the laboratory, learning behaviors in the classroom, and attitude about school. These analyses also considered the bidirectional effects between emotion regulation and learning engagement in order to better assess the temporal directionality of any potential associations. The following specific aims were addressed.

Question 1: How does learning engagement, measured in a laboratory task, change across preschool-age, kindergarten, and first grade?

- ***Hypothesis 1.*** It was hypothesized that a single factor would sufficiently describe the variance and covariance across the six indicators in kindergarten and first grade, and that this factor would be invariant across time. In order to analyze a construct over time, it is necessary to establish what type of change that construct undergoes and, specifically, whether the construct and scale remain the same (Golembiewski, Billingsley, & Yeager, 1976). We assessed what kind of change learning engagement undergoes during the transition to school and attempted to establish a stable construct that can be reliably compared across time. We hypothesized that all six learning engagement behaviors found to be cohesive in a single factor at preschool age (Halliday et al., 2018) would continue to be cohesive in kindergarten and first grade and that this learning engagement factor would exhibit configural, metric, and scalar measurement invariance across the transition to school.
- ***Hypothesis 2.*** It was hypothesized that mean levels of learning engagement would increase over time. We first tested how an overall learning engagement composite changed at each time point, with the expectation that engagement would increase with time. We then explored how each behavioral indicator of engagement varied across the early school transition. We expected children's attention to instructions, on-task behavior, persistence, enthusiasm,

monitoring/strategy use, and positive affect to increase, whereas children's negative affect to decrease across time.

- ***Hypothesis 3.*** It was hypothesized that observed learning engagement in the laboratory would be associated with teacher ratings of children's engagement in the classroom as well as children's academic performance. Specifically, we posited that kindergarten learning engagement would be related to both concurrent and first grade academic success, classroom learning behaviors, and school attitude, and first grade learning engagement would be concurrently related to academic success, classroom learning behaviors, and school attitude. We further hypothesized that preschool-age learning engagement would be predictive of academic success, classroom learning behaviors, and school attitude measured through first grade. By assessing associations with children's classroom engagement and academic performance, we hoped to establish the criterion validity of the learning engagement construct at kindergarten and first grade.

Question II: How do emotion regulation and learning engagement influence each other across the transition to school?

- ***Hypothesis 1.*** It was hypothesized that emotion regulation would positively and predictively influence children's laboratory observed learning engagement. Specifically, we posited that emotion regulation at preschool-age would predict laboratory learning engagement in kindergarten and emotion regulation in kindergarten would predict laboratory learning engagement in the first grade.

- ***Hypothesis 2.*** It was hypothesized that emotion regulation at preschool-age and kindergarten would positively influence children's classroom learning behaviors in kindergarten and first grade.
- ***Hypothesis 3.*** It was hypothesized that emotion regulation at preschool-age and kindergarten would positively influence children's school attitude in kindergarten and first grade.

CHAPTER II

METHODS

Participants

Children and families (N = 278) were recruited from a mid-sized southeastern city of the USA as a part of a larger longitudinal study, the School Transition and Readiness (STAR) Project, investigating trajectories of early academic success. Data collection occurred in three waves, at preschool-age (April 2013 - August 2014), kindergarten (August 2014 - August 2015), and first grade (August 2015 - August 2016), conducted approximately one year apart. At each time point, primary caregivers also completed questionnaire packets, including demographic information. At preschool-age, questionnaire data were completed by primary caregivers (96.4% mothers) of 277 children. These children (54.9% female) ranged in age from 45 to 70 months (M = 56.38, SD = 4.69) and were racially diverse (30% African American, 59.2% European American, 1.8% Asian, 9% multi-racial; 6.9% Hispanic). Primary caregivers (267 mothers, 10 fathers) ranged in age from 19 to 58 (M = 35, SD = 6.35). Among primary caregivers, 28.8% had completed a graduate degree, 31.8% completed a 4-year college degree, 10.8% completed a 2-year college degree, 18.1% completed some college, 10.5% completed a high school degree or less. Average income-to-needs ratio, calculated by dividing the total family income by the appropriate poverty threshold, was 2.11 (SD = 1.41). At kindergarten, 249 children (M = 79.8 months old, SD = 3.86) returned to the lab for follow-up assessments and 262 primary caregivers (96.6% mothers) completed questionnaires. At first grade, 240 children (*M* = 83.47 months old, *SD* = 4.24 months) returned for in-lab assessments and 257 primary caregivers (97.7% mothers) completed questionnaires. Average income-to-needs ratios were 2.18 (N = 257, *SD* = 1.37) in kindergarten and *2*.35 (N = 247, SD = 1.39) in first grade.

During this second and third waves of data collection, 243 parents provided permission to contact their children's teachers. Teacher questionnaires were returned for 222 children in kindergarten and 206 children in first grade. Two children were held back in preschool for one year, so kindergarten teacher data was collected for these children two years after their initial laboratory assessment.

Procedure

Children and their primary caregiver were invited to the laboratory to complete a series of tasks assessing self-regulation, social-cognitive understanding, and physiological functioning. During the visit, which lasted approximately 2-3 hours, children were videotaped completing several tasks with an experimenter while their caregiver completed a set of questionnaires in an adjacent room. Families were invited back to the lab approximately one year after their initial visit and again the following year. At the beginning of the second and third data collection years, parents were asked permission to contact their children's teacher, who were contacted via email in the spring and asked to complete a series of questionnaires using Qualtrics. Families were compensated $50 for their time at the pre-kindergarten visit, $75 at the kindergarten visit, and $100 at the first-grade visit, and children were given a small toy at the completion of each visit. Kindergarten and first grade teachers were compensated $75.

Measures

Observed learning engagement. Children's learning behaviors were coded during a learning-focused Tangrams task, which lasted 10 minutes or until the most difficult puzzle was completed. The task began with a short demonstration about how to fit shaped blocks onto laminated 2-dimensional templates. At preschool-age, children were first shown a template depicting outlines of all shapes individually and shown how they can fit the shapes in the lines and how the parallelogram needed to be flipped in order to be placed correctly. Next, they were given a template with a big square and a small square. The experimenter demonstrated how two big triangles can be put together to make a big square and then told children to try making both the big square and the little square (using small triangles). In the kindergarten and first grade phases, the training was modified to meet children's abilities. Children were first given a template of a complex shape with all internal lines drawn in and shown how to turn or flip shapes in order to fit them in the lines. After children completed the first puzzle, a second template was presented with one internal line missing, and experimenters demonstrated how to put two shapes together to make a larger shape within the greater picture and then asked children to complete the puzzle. Some scaffolding was given if requested.

After the training, children were then presented novel templates and instructed to fit the blocks into their shapes on the paper and to ask for help if needed. Experimenters provided minimal help when requested and only gave redirection if a child was off-task for over 15 seconds or tried to get out of his or her seat. All templates differed between time points so that children did not receive a puzzle they had previously seen. The puzzles became more challenging (e.g., more missing lines) as children got older. Although the original Halliday et al. (2018) paper included two tasks, the tangrams task described above and a story-sequencing task, the design of the tangrams task was more methodologically invariant across each point of data collection and was thus the only task used for the current study.

Behavior was coded on seven dimensions. Each item was rated on a Likert scale ranging from 1 (no indication of behavior) to 5 (high indication of behavior) and is described below.

- ***Attention to instruction*** measured children's attentiveness during both the initial task description and other interactions with the experimenter. Highly attentive children might nod, ask questions, or directly respond to the experimenter whereas an inattentive child might interrupt or look away from the experimenter. As children got older, there was a greater expectation that they would wait until the experimenter had finished the instructions before beginning the task**.**
- ***On-task behavior*** described children's task-orientation, continued involvement with task-relevant actions, and focus on task materials. Lower scores were given to children who performed actions or discussed topics that were not relevant to the current ask.

- ***Energy/enthusiasm*** related to the quality of children's behavior. Enthusiastic children began tasks quickly and eagerly and maintained a high level of purpose and energy whereas un-enthusiastic children worked passively, slouched, and appeared uninterested.
- ***Persistence*** measured how well children were able to remain actively involved even when the task became difficult for that child. For example, when asking for help, a more persistent child might remain engaged whereas a less persistent child might wait for the experimenter complete the task.
- ***Monitoring/strategy use*** assessed the flexibility of children's strategy use. High scorers might try something new when their current strategy does not work, ask for help on a specific component of the task, and be less likely to repeat mistakes or unhelpful strategies on subsequent trials.
- ***Negative affect*** assessed amount and intensity of verbal and physical cues of negative emotions such as frustration, anger, annoyance, and sadness.
- ***Positive affect*** assessed amount and intensity of verbal and physical cues of positive emotions such as happiness, excitement, and pride.

Six of these behaviors – attention to instructions, on-task behavior, energy / enthusiasm, persistence, monitoring progress / strategy use, and negative affect – were used as potential indicators of a learning engagement factor and used for initial CFA models. Coding was conducted by two trained researchers. Intraclass correlation coefficients (ICC's) for individual ratings ranged from .70 to .84 (mean = .79) at preschool-age, .70 to .87 (mean = .80) in kindergarten, and .70 to .93 (mean ICC = .77) in first grade (see Table 1).

Table 1. Observed Learning Engagement: Intraclass Correlations (*ICC*)

	Preschool-age	Kindergarten	First grade
Attention to Instructions	.70	.84	.71
On-Task Behavior	.77	.81	.69
Enthusiasm/Energy	.79	.70	.81
Persistence	.84	.81	.75
Monitoring Progress/Strategy Use	.83	.79	.70
Negative Affect	.82	.87	.97
Positive Affect	.82	.84	.86

Emotion regulation. Children's emotion regulation was measured both by observed regulatory ability during frustrating tasks administered in the lab and by questionnaire data. A composite of both observed and parent-reported regulation was calculated to form the Emotion Regulation Composite Score.

Observed emotion regulation. Children's ability to regulate emotion was observed during a series of frustrating tasks at preschool-age, kindergarten, and first grade. At preschool-age, children were administered a locked box task and a toy removal task adapted from the Preschool version of the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1999). During the locked box episode, children were first taught how to use a key to unlock a padlock and asked to select one of three attractive toys, which was then locked in a transparent box. Children were given a large ring of misfit keys and told they must unlock the box in order to play with the toy. Children were prompted to open the box every 15 seconds. After 4 minutes, or when the child became very upset, the experimenter presented a “lost” key that fit the lock and the child was able to open the box. After the box was opened, the child was able to play with the toy for briefly before the experimenter took the toy and exclaimed that she wanted to play with it. The experimenter kept the toy and commented on how fun it was for two minutes or until the child became very upset.

In kindergarten, children were administered a not-sharing task, an impossible-to-open-gift task, and a disappointing-gift task, adapted from The Middle Childhood Lab-TAB (Goldsmith, Reilly, Longley, & Prescott, 2001) and Carlson & Wang (2007). During “not sharing,” experimenters divided candy between themselves and the child, at first fairly then mildly unfairly, and very unfairly. Finally, the experimenter took all the child’s candy for themselves. After a pause (about 20 seconds), the experimenter admitted to being unfair and allowed the child to eat one piece of candy and take another home while the rest were saved for other children. After children finished eating, they were given a gift-wrapped present that had been taped so that it was impossible to open. The experimenter told the child to open the box while she went to the other room and left for one minute. When she returned, she brought a new box that was easily opened and declared that the wrong box had been given. However, the new box contained only a piece of bark (a disappointing gift). Children were left to interact with the bark for one minute, while the experimenter acted busy. In the end, children were given a small plush animal as reward to take home.

Finally, in first grade, children were first given a hidden puzzle task (Eisenberg et al., 2000, 2001), whereby they were presented with a large box that contained a wooden puzzle. On the side facing away from the child was a Plexiglas window whereas the side facing the child had a felt cover with two arm holes. Children put their arms through the holes and were instructed to complete the “very easy” puzzle, which they could not see. Every 15 seconds, the experimenter reminded the child how easy the puzzle was or commented that they were doing the puzzle incorrectly. After 4 minutes, the puzzle was removed from the box and children completed the puzzle. Next, children were administered a broken toy task, modeled after the transparent box task from The Lab-TAB. The experimenter showed the child a handheld computer toy and showed the child how to turn it on. She then gave the child a second identical toy that had no batteries and told the child that they could each play. For two minutes, the experimenter played with her computer in front of the child, after which she gave the toy to the child.

Children’s affect and regulation were coded during these tasks. *Negative verbal expression* was the frequency of the child’s verbal negativity, coded on a scale of 0 (none) to 3 (4 or more instances); *global regulation* described how well a child was able to maintain or regain neutral or positive affect, rated on a scale from 1 (unregulated) to 5 (well-regulated); and *Latency to distress* was calculated as the amount of time between the start of the task and the child’s first display of distress. Interrater reliability was calculated on a subset of cases and intraclass correlations can be found in Table 2. Each code was averaged across task to create one variable for each behavior across time. These averaged scores were then transformed into z-scores and averaged together within each time point, with negative verbal expression reverse coded. Internal consistency of the behavioral emotion regulation composite was good at preschool-age (α = .90), kindergarten (α = .87), and first grade (α = .89).

Table 2. Observed Emotion Regulation: Intraclass Correlations (*ICC*)

	Preschool-age (N = 53)		Kindergarten (N = 40)			First grade (N = 40)	
	LB	TR	NS	IOG	DG	PB	BT
Global regulation	.88	.83	.89	.91	.90	.82	.91
Negative verbal expression	.87	.90	.92	.96	.89	.81	.95
Latency to distress	.70	.91	.80	.95	.65	.67	.80

Note. LB = locked box; TR = toy removal; NS = not sharing; IG = impossible to open gift; DG = disappointing gift; PB = puzzle box; BT = broken toy.

Parent-reported emotion regulation. Children's emotion regulation skills were also measured by the Lability/Negativity subscale of The Emotion Regulation Checklist (ERC; A. Shields & Cicchetti, 1997), reported by children's primary caregiver at preschool-age, kindergarten, first grade. This subscale included 15 items, set to a 4-point Likert scale, and assessed volatility (e.g., "displays wide mood swings"), anger (e.g., "is prone to angry outbursts or tantrums easily"), and dysregulated positivity ("displays exuberance that others find intrusive or disruptive"). Internal consistency was good at preschool-age (α = .82) and kindergarten (α = .81) and acceptable at first grade (α = .74).

Emotion regulation composite score. A composite emotion regulation score was calculated by averaging z-scores of the lab observed emotion regulation composite with z-scores of parent-reported emotion regulation. Correlations between observed and parent report scores were small to moderate in size ($r_{\text{preschool-age}} = .23$; $r_{\text{kindergarten}} = .23$; $r_{\text{first grade}} = .31$) but significant ($p < .001$), and each score contributed unique information.

Observed emotion regulation provided a standardized reaction to a frustrating stimulus whereas parent-report provided information about behavior in daily life. In cases where an observed emotion regulation score or a parent-report score was unavailable, the z-score of the available measure was used in place of the composite (N = 5 at preschool-age, N = 15 at kindergarten, N = 17 at first grade). Scores were averaged such that higher scores indicated greater regulation.

School attitude. Children's attitude about school was measured by teacher report on The School Liking and Avoidance Questionnaire (SLAQ; Ladd, Buhs, & Seid, 2000), composed of 13 items and consisting of two subscales, *school liking* (e.g., "likes being in school") and *school avoidance* (e.g., "makes up reasons to go home from school"). Items were set to a 3-point Likert scale ranging from 0 (*doesn't apply*) to 2 (*Certainly applies*). A total score was calculated for the current analyses to evaluate children's overall attitude about school, with higher scores indicating greater liking and less avoidance. Internal consistency was good in both kindergarten (α = .85) and first grade (α = .85).

Classroom learning behaviors. Children's behavioral learning engagement within the classroom context was assessed by *The Learning Behaviors Scale* (LBS: McDermott, 1999). Teachers indicated the prevalence of learning behaviors in the classroom on 29 items, measured on a 3-point Likert scale. This scale has yielded four subscales: competence motivation, attitude toward learning, attention/persistence, and strategy/flexibility (McDermott, 1999) or competence motivation, discipline/persistence, cooperation, and emotion control (Rikoon et al., 2012). Sample items include "is reluctant to tackle a new task," "is distracted too easily by what is going on in the classroom, or seeks distraction," "unwilling to be helped in difficulty," "gets aggressive or hostile when frustrated or when work is corrected." For the purposes of the current study, the total score was calculated ($\alpha_{\text{kindergarten}}$ = .91; ($\alpha_{\text{first grade}}$ = .90) and used to represent children's classroom engagement. Scores were reversed so that higher scores indicated more engaged behavior.

Academic performance. Teachers reported children's academic performance on the Mock Report Card (MRC; Pierce, Hamm, & Vandell, 1999). Teachers rated children's reading, oral language, written language, math, social studies, and science performance on a 5-point scale (1=below grade level, 5=excellent/above grade level). Previous research has demonstrated large correlations between scores on the MRC and children's standardized achievement test scores (Pierce, Bolt, & Vandell, 2010). Children's reading and math performance were considered most indicative of academic functioning in kindergarten and were therefore the only two domains investigated in the current study. As Halliday and colleagues (2018) found that the lab measure of learning engagement at preschool-age was related to both math and literacy, teacher's ratings of children's math and reading ability were averaged into a single construct of *academic performance* for the purposes of this study.

Demographics. Primary caregivers provided information about their family, including family income, mother's highest level of education, and child's gender, race and ethnicity. A child minority status variable was created by dummy coding children as white non-Hispanic or non-white/Hispanic. At preschool-age, 164 children were "non-minority" and 113 were coded as "minority."

Data Analysis

Missing data. Given the longitudinal nature of the current paper, attrition accounted for some missing data in the kindergarten and first grade years. Although 278 children were assessed in the laboratory at preschool-age, only 249 were assessed in the lab at kindergarten and 240 at first grade. Primary caregiver questionnaires were only completed for 277 children at preschool-age, 262 children at kindergarten, and 257 children at first grade, and teacher questionnaires were returned for 222 children in kindergarten and 206 in first grade. At first grade, six teachers failed to fill out the LBS questionnaire, so six children were missing data on classroom learning behaviors at this time point. Additionally, at preschool-age, one child did not receive scores for *enthusiasm/energy, positive affect, negative affect,* and *strategy use* due to a problem with video recording. No demographic information was available for one child, and income-to-needs ratio was missing for an additional six children. The methods used to handle this missing data differed between analyses and are discussed within the sections below.

Question 1: How does learning engagement, measured in a laboratory task, change across preschool-age, kindergarten, and first grade?

Hypothesis 1. Confirmatory factor analysis (CFA) was used to assess the hypothesis that learning engagement is invariant across the transition to school. Analyses were conducted using M*plus* version 8.0 (Muthén & Muthén, 1998-2017). Data were collected on a 5-point scale and treated as ordinal. Parameters were estimated using a robust Diagonally Weighted Least Square (WLSMV) and Theta parameterization. The decision to use WLSMV over Maximum likelihood (ML) was made because WLSMV allows for correlated residuals and provides overall model fit information. The WLSMV estimation makes no assumptions about the underlying distribution of the observed variables and can therefore be used with violations of normality. However, because WLSMV is not a full-information estimator, pairwise deletion was used to account for missing data. At preschool-age, one child did not receive scores for *enthusiasm/energy*, *positive affect, negative affect,* and *strategy use* due to a problem with video recording. Due to attrition, there were 29 fewer cases at kindergarten and 38 fewer cases at first grade than during the preschool-age time point.

Measurement invariance was tested in a four-step approach. First, the best-fitting model of learning engagement was identified at kindergarten and first-grade. Two CFAs were run to test whether the six-indicator factor of learning engagement, originally established using preschool-age sample, fit the data well at kindergarten and first grade. Good fit would indicate that these six indicators explain learning engagement at kindergarten and first grade well whereas poor fit would indicate that learning engagement may be explained by a different pattern of indicators at different ages. As longitudinal models with configurally invariant constructs are difficult to interpret, alterations to the learning engagement factor at all time-points were made in order to obtain a stable, well-fitting construct. Modification indices and factor loadings were assessed to help identify a stable factor. Any loading equal to or less than .30 were considered for elimination. Models were refit and repeated until a well-fitting model at all three time-points was discovered.

Once a factor that fit the data well at each time point was identified, baseline configural invariance across time was tested. All invariance models were fit based on guidelines in the M*plus* 8.0 User Manual (Muthén & Muthén, 1998-2017). Configural invariance, defined as the invariance of form or pattern, was first assessed by fitting a single model that specified learning engagement factors at the preschool-age, kindergarten, and first grade time points. These factors were allowed to correlate across time to represent the longitudinal structure, and within-item residual correlations were modeled to account for residual dependence across time.

Metric and scalar variance were next tested independently in two separate steps. First, metric invariance, also referred to as weak factorial invariance or factor-loading invariance, was tested by estimating a new model that constrains the factor loadings of each indicator to be identical over time. The satisfaction of metric invariance would suggest that each indicator contributes to the learning engagement factor in equal value across time. This in turn implies that the learning engagement factor is measured on the same metric at each time point – a requirement for comparing variance across time.

Last, scalar invariance, or strong factorial invariance, was assessed by fitting an additional model that constrained both factor loadings and factor thresholds to be identical across time. For categorical variables, there is an assumption of an underlying continuous distribution or responses, and thresholds refer to the cutoffs that divide this distribution and signal shifts from one ordinal score to the next (Bowen & Masa, 2015; Liu et al., 2017). The invariance of item thresholds is necessary to validly examine factor means across time. A meta longitudinal invariance model is depicted in Figure 1.

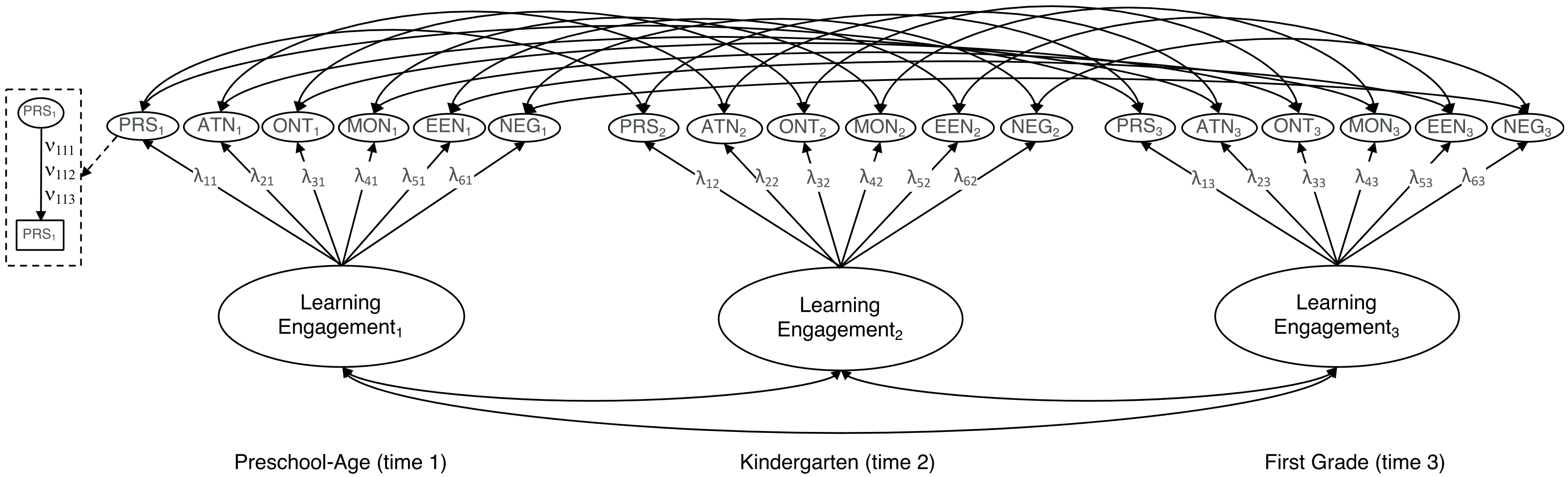

Figure 1. Longitudinal Measurement Invariance Metamodel. λ represents factor loadings and ν represents threshold parameters. Threshold structure is only represented for persistence at time 1 but is present for all indicators at all times. Indicators in square shapes represent observed ordinal variables and indicators in circle shapes represent continuous latent responses based on corresponding observed variable. In the metric model, all λ_{jt} of the *j*th indicator were held constant across time. In the scalar model, all ν_{jkt} of the *j*th indicator and *k*th threshold were held constant across time. PRS = persistence, ATN = attention to instructions, ONT = on task behavior, MON = monitoring progress/strategy use, EEN = enthusiasm/energy, NEG = negative affect. Figure adapted from Liu et al. (2017).

Model fit was evaluated by the root mean square error of approximation (RMSEA), with values less than or equal to .08 considered acceptable and less than .05 considered good; the comparative fit index (CFI), with values greater than or equal to .95 considered good; and the standardized root mean squared residual (SRMR), with values of less than .08 considered acceptable and less than .06 considered good (Browne & Cudeck, 1992; Hu & Bentler, 1999). If invariance is not found at any step, constraints may be weakened in order to obtain partial invariance. Partial invariance was considered acceptable if the proportion of noninvariant parameters to the total number of parameters is small. Specifically, a partial invariance model with less than 20% of parameters freed was considered reasonably invariant for the practical purposes of the current study (Dimitrov, 2010).

All models were compared using chi-square difference tests, such that a nonsignificant chi-square difference between two models would indicate the more parsimonious model is the best and measurement invariance is achieved. However, because the chi-square parameter is sensitive to both sample size and violation of normality assumptions, we also considered changes in RMSEA and CFI when comparing models. For the current analyses, models were considered equivalent if differences in CFI were less than or equal to .005 (ΔCFI value greater than -.005) and differences in RMSEA were less than or equal to .010, as our sample was less than 300 and sample size differed across time (Chen, 2007). These cutoff values were moderately conservative, as suggested cutoffs of CFI range from .002 (Meade, Johnson, & Braddy, 2008) to .01 (Cheung & Rensvold, 2002). Evaluating measurement invariance with multiple indices is increasingly recommended (Chen, 2007; Cheung & Rensvold, 2002; Dimitrov, 2010), and these specific indices have a history of use in testing measurement invariance in psychology research (e.g., Marsh, Nagengast, & Morin, 2013; Orri et al., 2018; Wu, 2017).

***Hypothesis 2*.** Analysis of variance (ANOVA) was used to test the hypothesis that learning engagement increases from preschool-age through first grade. If scalar invariance of the learning engagement factor is achieved, factor means at preschool-age, kindergarten, and first grade were compared in a one-way ANOVA with repeated measures in order to investigate differences in overall learning engagement across time. Differences among the individually observed learning engagement indicators across time were also explored by a one-way MANOVA with repeated measures. This provided a more fine-grained look at the change of engagement behaviors across time. Significant responses were probed with planned comparisons to assess how engagement may differ across age. For these analyses, listwise deletion was used to account for missing data.

Hypothesis 3. To test the hypothesis that analog, laboratory-observed learning engagement demonstrated criterion validity through associations with classroom engagement and children's academic performance, a set of three structural equation models (SEMs) were fit to the data. First, concurrent associations at kindergarten were assessed by modelling the effect of kindergarten laboratory learning engagement on concurrent academic performance, classroom learning behaviors, and school attitude. Second, predictive associations were investigated by modelling the effects of kindergarten laboratory learning engagement on first grade academic performance, classroom learning behaviors, and school attitude. Third, concurrent associations at first grade were assessed by modelling the effect of first grade laboratory learning engagement on concurrent academic performance, classroom learning behaviors. Finally, a single SEM was run to assess the predictive associations between preschool-age laboratory learning engagement and academic performance, classroom learning behaviors, and school attitude at both kindergarten and first grade. These SEMs were evaluated using the RMSEA, CFI, and SRMR fit indices. Significant associations between laboratory learning engagement with classroom indicators of engagement and performance would support the concurrent and predictive validity of the current observational measure of engagement. Given that WLSMV was used to estimate these models, which included ordinal observed variables, pairwise deletion was used to account for all missing data.

Question 2. How do emotion regulation and learning engagement influence each other across the transition to school?

The reciprocal relations among learning engagement and emotion regulation were investigated by fitting a series of SEMs estimated using full information maximum likelihood (FIML) to account for missing data. FIML is a preferred method for dealing with missing data, as it estimates parameters based on both available data and implied values of missing data, derived from other observed values in the dataset (Schlomer, Bauman, & Card, 2010). However, this method still requires that cases with data missing from exogenous variables are dropped from analyses.

To test whether emotion regulation facilitates the development of laboratory-observed learning engagement or vice versa (*hypothesis 1*), a full reciprocal model of emotion regulation and laboratory-observed learning engagement was estimated. Pathways were assessed to investigate whether emotion regulation promotes engagement and whether it is reciprocally influenced by engagement. For the purposes of this analysis, analog learning engagement was calculated as a composite rather than a latent factor.

Nearly identical models were fit to test the hypotheses that emotion regulation influences classroom learning behaviors (*hypothesis 2*) and school attitude (*hypothesis 3*) by estimating two additional cross-lagged models. As data on classroom learning behaviors and school attitude were not collected at preschool-age, these models included emotion regulation at all three time-points but the engagement outcome variable at only the latter two time-points. As with the first set of SEMs, individual pathways were analyzed to determine the pattern of effects between emotion regulation and classroom learning behaviors and school attitude.

CHAPTER III

RESULTS

Validity of Learning Engagement Factors Across Time

The first goal of this study was to investigate the construct and criterion validity of learning engagement measured in a laboratory setting. To this end, descriptive statistics and bivariate associations of each observed learning engagement behavior was assessed in relation to one another. Next confirmatory factor analysis (CFA) was used to investigate the coherence of these behaviors into a single construct. The longitudinal measurement invariance of this construct was then tested through a series of CFA models. This study then investigated the mean differences of the laboratory learning engagement construct and individual observed behaviors across time. Finally, the construct of laboratory learning engagement at preschool-age, kindergarten, and first-grade was evaluated in relation to children's classroom learning behaviors, attitude about school, and academic performance.

Descriptive statistics and bivariate correlations. Descriptive statistics of the observed learning engagement behaviors can be found in Table 3. All indicators fell within accepted ranges of skewness and kurtosis, except on-task behavior at first grade. However, because robust Diagonally Weighted Least Square (WLSMV) estimation is less strict in its assumptions of normality with respect to observed indicators (Li, 2016), no transformation was made.

Table 3. Learning Engagement: Descriptive Statistics

	N	Min	Max	Mean	SD	Skew (SE)	Kurtosis (SE)
Preschool-age							
Attention to Instructions	278	1	5	4.22	0.86	-0.95 (.15)	0.38 (.29)
On-Task Behavior	278	1	5	4.28	0.87	-1.09 (.15)	0.57 (.29)
Enthusiasm/Energy	277	1	5	3.31	0.77	0.17 (.15)	-0.07 (.29)
Persistence	278	1	5	3.87	1.06	-0.72 (.15)	-0.17 (.29)
Monitoring Progress/ Strategy Use	278	1	5	3.86	0.87	-0.52 (.15)	0.00 (.29)
Negative Affect	277	1	5	1.77	0.89	1.10 (.15)	0.76 (.29)
Positive Affect	277	1	5	2.35	0.92	0.62 (.15)	0.39 (.29)
Kindergarten							
Attention to Instructions	249	2	5	4.39	0.65	-0.76 (.15)	0.34 (.31)
On-Task Behavior	249	3	5	4.61	0.59	-1.25 (.15)	0.55 (.31)
Enthusiasm/Energy	249	2	5	3.3	0.64	0.59 (.15)	0.52 (.31)
Persistence	249	1	5	4.03	0.87	-0.66 (.15)	-0.04 (.31)
Monitoring Progress/ Strategy Use	249	2	5	4.05	0.72	-0.40 (.15)	-0.01 (.31)
Negative Affect	249	1	5	1.71	0.80	1.10 (.15)	1.12 (.31)
Positive Affect	249	1	5	2.11	0.90	0.48 (.15)	-0.35 (.31)
First grade							
Attention to Instructions	240	2	5	4.44	0.77	-1.11 (.16)	0.17 (.31)
On-Task Behavior	240	2	5	4.73	0.54	-2.05 (.16)	4.14 (.31)
Enthusiasm/Energy	240	2	5	3.34	0.67	0.49 (.16)	0.25 (.31)
Persistence	240	2	5	4.37	0.76	-1.08 (.16)	0.72 (.31)
Monitoring Progress/ Strategy Use	240	2	5	4.39	0.69	-0.77 (.16)	-0.26 (.31)
Negative Affect	240	1	5	1.53	0.75	1.38 (.16)	1.69 (.31)
Positive Affect	240	1	4	2.10	0.83	0.22 (.16)	-0.74 (.31)

Note. ICC = intraclass correlation; SE = standard error.

Correlations among learning engagement behaviors can be found in Table 4. Among preschool-aged children, all five of the focal learning engagement behaviors, attention to instructions, on-task behavior, enthusiasm/energy, persistence, monitoring progress/strategy use, and negative affect, were intercorrelated. Correlations were primarily moderate to large in size and ranged in size from |.32| (attention to instructions and negative affect) to |.73| (on-task behavior and persistence). In kindergarten, all intercorrelations were significant except the association between enthusiasm and on-task behavior. Correlations were generally small to moderate in size, ranging from |.20| (attention to instructions and persistence) to |.63| (persistence and negative affect). In first grade, all intercorrelations were significant except the association between enthusiasm and negative affect. Significant correlations ranged from |.17| (persistence and enthusiasm) to |.61| (persistence and negative affect). Correlations among kindergarten and first grade behaviors were weaker than those among preschool-age behaviors. All significant correlations were positive in direction except correlations with negative affect, which were all negative. Positive affect, which was not a focal behavior in the current study, demonstrated moderate correlations with enthusiasm/energy but either weak or nonsignificant correlations with other engagement behaviors.

Learning engagement behaviors demonstrated moderate temporal stability. Significant correlations among focal learning engagement behaviors at preschool-age and kindergarten ranged from .19 (persistence and negative affect) to .31 (attention to instruction) (M = .25), whereas correlations between kindergarten and first grade behaviors ranged from .22 (attention to instructions) to .42 (negative affect) (M = .31). Positive affect also demonstrated large cross-time correlations. All learning engagement behaviors demonstrated modest correlations between preschool-age and first-grade except negative affect, which was not related between these two time points. In sum, children's engagement with learning was moderately stable across the transition to school.

Table 4. Correlations Among Observed Learning Engagement Behaviors

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Attention to Instructions (PS)	-																			
2	On-Task Behavior (PS)	.50**	-																		
3	Enthusiasm/Energy (PS)	.35**	.38**	-																	
4	Persistence (PS)	.45**	.73**	.45**	-																
5	Monitoring/Strategy Use (PS)	.48**	.57**	.41**	.67**	-															
6	Negative Affect (PS)	-.32**	-.41**	-.34**	-.49**	-.39**	-														
7	Positive Affect (PS)	.16**	.02	.48**	.13**	.18**	-.11	-													
8	Attention to Instructions (K)	.31**	.24**	.16*	.16*	.16*	-.14*	.06	-												
9	On-Task Behavior (K)	.21**	.29**	.02	.19**	.24**	-.11	-.15*	.28**	-											
10	Enthusiasm/Energy (K)	.21**	-.02	.28**	.12	.10	-.08	.21**	.22**	.05	-										
11	Persistence (K)	.13*	.14*	-.03	.19**	.19**	-.16*	-.07	.20**	.51**	.25**	-									
12	Monitoring/Strategy Use (K)	.13*	.12	.06	.18**	.21**	-.14*	-.04	.24**	.34**	.31**	.63**	-								
13	Negative Affect (K)	-.06	-.13*	.01	-.14*	-.09	.20**	.09	-.24**	-.37**	-.15*	-.54**	-.43**	-							
14	Positive Affect (K_	.12	-.17**	.24**	-.05	-.05	-.04	.32**	.18**	-.11	.54**	-.10	-.02	.11	-						
15	Attention to Instructions (FG)	.22**	.35**	.05	.23**	.07	-.17**	-.10	.22**	.31**	-.11	.16*	.03	-.22**	-.17**	-					
16	On-Task Behavior (FG)	.16*	.18**	.03	.16*	.11	-.10	-.11	.19**	.25**	-.05	.29**	.17**	-.32**	-.13*	.51**	-				
17	Enthusiasm/Energy (FG)	.00	-.13*	.18**	.00	-.01	.02	.23**	.03	-.13*	.33**	.06	.09	-.06	.35**	-.23**	-.13*	-			
18	Persistence (FG)	.19**	.23**	.18**	.25**	.23**	-.10	-.04	.11	.33**	.10	.28**	.24**	-.31**	-.03	.28**	.48**	.17**	-		
19	Monitoring/Strategy Use (FG)	.30**	.16*	.17**	.23**	.32**	-.02	.21	.15*	.27**	.12	.34**	.34**	-.16*	.01	.16*	.31**	.18**	.49**	-	
20	Negative Affect (FG)	-.07	-.14*	-.02	-.10	-.06	.08	.15*	-.12	-.27**	-.06	-.27**	-.23**	.42**	.10	-.28**	-.38**	-.02	-.61**	-.34**	
21	Positive Affect (FG)	-.02	-.11	.19**	-.07	-.08	-.04	.30**	.06	-.11	.30**	-.04	-.01	.07	.46**	-.25**	-.20**	.53**	-.06	.01	.10

Note. PS = preschool-age, K = kindergarten, FG = first grade. * $p < .05$, ** $p < .01$.

Confirmatory factor analyses. A six-indicator single factor model was fit to the kindergarten and first grade data, based on the original factor established with a sample of preschool-aged children in prior research (Halliday et al., 2018). However, a few modifications to the data were made before invariance analyses were conducted. Specifically, the decision was made to collapse the behavioral codes of 1 and 2 for attention to instructions, on-task behavior, persistence and monitoring progress/strategy use as well as between 4 and 5 for negative affect because of sparse data at these ends of the scales, particularly at the kindergarten and first grade time points. As sparse data can lead to low expected cell frequencies in the observed contingency table and therefore inaccuracies in the polychoric correlations used to estimate parameters, collapsing across adjacent sparse response categories may yield clearer results for multigroup and longitudinal analyses (Bauer & Curran, 2017; Liu et al., 2017; Wellman & Liu, 2004). Descriptive statistics and intercorrelations for the newly coded learning engagement indicators can be found in Appendix A.

The 6-indicator single factor model poorly fit the kindergarten data ($\chi^2(9)$ = 30.489, p < .001; RMSEA = .098, 90% CI [.061, .137]; CFI = .969; SRMR = .052) and first grade data ($\chi^2(9)$ = 99.077, p < .001; RMSEA = .204, 90% CI [.169, .241]; CFI = .857; SRMR = .092). Results indicated that enthusiasm/energy had a nonsignificant factor loading in the first grade model and the smallest standardized loading (λ = .38) of all indicators in the kindergarten model (see Table 5). Enthusiasm/energy also demonstrated lower overall bivariate correlations with other focal indicators and was the only indicator at both the kindergarten and first-grade time points that had at least one nonsignificant bivariate correlation with another learning engagement behavior (see Table 4). These results suggested that enthusiasm/energy indicator may not fit well with the other five observed variables in the model.

Table 5. Final CFA Factor Loadings

	6-Indicator Model		5-Indicator Model	
	Loading (SE)	Standardized Loading	Loading (SE)	Standardized Loading
Preschool-age				
Persistence	1.00 (.00)	.93	1.00 (.00)	.93
Attention to instructions	.66 (.06)	.61	.64 (.06)	.60
On-task behavior	.90 (.05)	.84	.91 (.05)	.85
Enthusiasm/Energy	.61 (.05)	.57	--	--
Monitoring/Strategy Use	.85 (.04)	.79	.85 (.05)	.79
Negative affect	-.60 (.06)	-.56	-.59 (.06)	-.55
Kindergarten				
Persistence	1.00 (.00)	.90	1.00 (.00)	.92
Attention to instructions	.44 (.08)	.40	.40 (.08)	.37
On-task behavior	.73 (.08)	.66	.75 (.08)	.68
Enthusiasm/Energy	.42 (.07)	.38	--	--
Monitoring/Strategy Use	.88 (.06)	.80	.84 (.07)	.77
Negative affect	-.74 (.07)	-.67	-.74 (.07)	-.68
First-grade				
Persistence	1.00 (.00)	.88	1.00 (.00)	.94
Attention to instructions	.68 (.07)	.60	.45 (.08)	.42
On-task behavior	.89 (.08)	.78	.69 (.09)	.65
Enthusiasm/Energy	.00 (.08)	.00	--	--
Monitoring/Strategy Use	.66 (.07)	.58	.65 (.07)	.61
Negative affect	-.88 (.08)	-.77	-.83 (.08)	-.78

Note. All loadings significant (p < .001) except enthusiasm/energy in first grade, which was nonsignificant. Parameters listed for first grade 5-indicator model were derived from model wherein residual variances of attention to instruction and on-task behavior were allowed to correlate. SE = standard error.

To further consider the best model fit for the data, models were rerun with enthusiasm/energy dropped from the model. Although the new five-indicator factor model fit the preschool-age data ($\chi^2(5) = 9.843$, $p = .08$; RMSEA = .059, 90% CI [.000, .113];CFI = .997; SRMR = .021) and kindergarten data ($\chi^2(5) = 9.986$, $p = .08$; RMSEA = .063, 90% CI [.000, .121]; CFI = .992; SRMR = .031) reasonably well, fit to the first grade data remained poor ($\chi^2(5) = 44.714$, $p < .001$; RMSEA = .182, 90% CI [.135, .233]; CFI = .935; SRMR = .065). Modification indices of the first-grade model suggested that model fit would greatly improve if the residual variances of on-task behavior and attention to instructions were correlated. When the model was rerun with this correlation specified ($\chi^2(4) = 5.436$, $p = .25$; RMSEA = .039, 90% CI [.000, .111]; CFI = .998; SRMR = .020), fit dramatically improved ($\Delta\chi^2(1) = 23.414$, $p < .001$). The association between the residuals of attention to instruction and on-task behavior was relatively large ($r = .58$, $p < .001$).

When the preschool-age and kindergarten models were rerun to include this correlated residual, model fit did not improve. Chi-square difference tests suggested that the more constrained models that did not allow for this correlation were equally as well-fitting as the models that did allow this correlation. Moreover, the residual correlation between on-task behavior was nonsignificant at preschool-age ($r = .12$, $p = .27$) and only marginally significant at kindergarten ($r = .17$, $p = .07$). Thus, the original models, which did not include any within-time residual correlations, were retained at preschool-age and kindergarten. The final baseline first-grade model therefore differed by one model specification from the baseline preschool-age and kindergarten models. Although it is ideal for all baseline models to be identical, minor differences may be acceptable (Bowen

& Masa, 2015; Byrne, Shavelson, & Muthén, 1989). Factor loadings of the final baseline 5-indicator models were moderate to high in magnitude at all time points (see Table 5).

Measurement invariance. To test the invariance of the 5-indicator learning engagement factor across time, a new series of CFAs were fit to the data. However, it should be noted that, even after the collapse of response categories, the on-task behavior variable at kindergarten continued to contain no data for one response category, as no child received a score of 1 or 2 on on-task behavior at this age. Thus, only two thresholds could be modeled for this variable at the kindergarten time point.

First, a configural invariance model, which allowed all factor loadings and thresholds to be freely estimated, was investigated to test whether the pattern of factor loadings remained constant across time. The configural invariance model fit the data well (see Table 6), indicating an invariance of form across time. Next, a metric invariance model, which constrained all within-item factor loadings to be the same across time, was fit to test whether the value of each factor loading is invariant across time. For model identification purposes, the second threshold was used as the reference threshold for on-task behavior, given that the first threshold contained no data in kindergarten. The resulting metric model fit the data well. Changes in RMSEA and CFI were below the cutoff of .010 and .005, respectively, and the change in χ^2 between the configural and metric models was nonsignificant (see Table 6). This provided evidence for the equivalence of factor loadings across the three time points and support for metric invariance of the laboratory learning engagement factor.

Table 6. Fit Statistics of All Measurement Invariance Models

	X2	*df*	*p*	RMSEA	RMSEA (90% CI)	CFI	SRMR	ΔX2	Δdf	Δp	ΔRMSEA	ΔCFI
Configural Model	155.164	72	<.001	.064	[.051 - .078]	.965	.063	--	--	--	--	--
Metric Model	167.599	80	<.001	.063	[.049 - .076]	.964	.063	15.313	8	.053	.001	-.002
Scalar Model	220.333	97	<.001	.068	[.056 - .079]	.949	.067	62.634	17	<.001	.005	-.015
Partial Scalar Model 1	209.193	96	<.001	.065	[.053 - .077]	.953	.065	49.592	16	<.001	.002	-.011
Partial Scalar Model 2	201.685	95	<.001	.064	[.051 - .076]	.956	.065	41.029	15	<.001	.001	-.008
Partial Scalar Model 3	189.998	94	<.001	.061	[.048 - .073]	.960	.064	27.133	14	.019	-.002	-.004
Partial Scalar Model 4	184.218	93	<.001	.059	[.047 - .072]	.962	.063	19.451	13	.110	-.004	-.002

Note. Partial scalar model 1 = second threshold of attention to instructions at kindergarten free; Partial scalar model 2 = second threshold of negative affect at preschool-age free; Partial scalar model 3 = third threshold negative affect at preschool-age free; Partial scalar model 4 = second threshold of attention to instructions at preschool-age and first grade free; All models were built upon the previous model. Differences in X^2, RMSEA, and CFI were calculated by comparing the metric model to the configural model and all scalar models to the metric model. The X^2 difference tests were computed in M*plus* 8.0, using corrections for WSLMV estimation (Muthén & Muthén, 1998-2017).

Scalar invariance was next investigated by fitting a new model that constrained both loadings and thresholds across time. As one response category was missing for one variable at one time point, even after collapsing the data, 44 rather than 45 thresholds were modeled and constrained in the full scalar model. The scalar model demonstrated acceptable but significantly worse fit than the metric model based on all indices (see Table 6).

To test whether the learning engagement factor could achieve partial scalar invariance, a series of models were fit to the data that sequentially relaxed the constraints on threshold invariance based on modification indices. Although ΔRMSEA and ΔCFI indicated the invariance of earlier models, scalar invariance was supported by the χ^2difference test after fitting the fourth partial scalar model, wherein five thresholds were freed from their equivalency constraints (see Table 6). In this final partial scalar model, the second threshold of attention to instructions at preschool-age, kindergarten, and first grade; the second threshold of negative affect at kindergarten; and the third threshold of negative affect at preschool-age were all noninvariant across time. After accounting for these five noninvariant thresholds as well as the missing threshold of on-task behavior at kindergarten, 90% of parameters remained constrained, thus meeting the guideline of fewer than 20% unconstrained parameters (Dimitrov, 2010). These results suggest that the majority of thresholds were invariant across time and that learning engagement measured in the laboratory during early childhood may be partially invariant at the scalar level. The means, variances, and correlations among the learning engagement factors in the final partial scalar model can be found in Table 7.

Table 7. Means, Variances, and Correlations of Learning Engagement Latent Factor Across the School Transition

				Correlations		
	Learning Engagement	Mean	Variance	1	2	3
1	Preschool-age	0	7.02	--		
2	Kindergarten	0.47	3.35	0.35	--	
3	First grade	1.69	4.64	0.38	0.55	--

Note. The mean of learning engagement at preschool-age was constrained to zero.

Describing laboratory learning engagement. To further investigate learning engagement in the laboratory, a composite variable was calculated based on the previous CFA results. Specifically, the mean of persistence, attention to instruction, on-task behavior, monitoring/strategy use, and negative affect was computed, with negative affect reversed scored. Enthusiasm/energy and positive affect were not included in this composite. For the purposes of this analysis, the non-collapsed learning engagement scores were used in order to capture full variability. Summary descriptive statistics can be found in Table 8. The composite variable was next investigated in relation to time and children's demographic information.

Table 8. Descriptive Statistics of the Laboratory Learning Engagement Composite Variable

Learning Engagement	N	Min	Max	Mean	SD	Skew (SE)	Kurtosis (SE)
Preschool-age	278	1.40	5.00	4.09	0.71	-1.16 (.15)	1.29 (.29)
Kindergarten	249	2.40	5.00	4.27	0.52	-0.94 (.15)	0.73 (.31)
First Grade	240	2.60	5.00	4.48	0.50	-1.22 (.16)	1.32 (.31)

Note. SE = standard error.

Laboratory learning engagement across time. Changes in learning engagement across the transition to school were analyzed in a one-way analysis of variance

(ANOVA) with repeated measures using the General Linear Model (GLM) procedure in SPSS 25. Mauchly's test of sphericity was significant ($\chi^2(2) = 29.31$, $p < .001$; $\varepsilon = .90$) indicating that the variance of learning engagement differed across time and that sphericity could not be assumed. As epsilon (ε) was greater than .75, the Huynh-Feldt correction was used to adjust degrees of freedom. Analyses indicated that there was a significant difference across time ($F(1.80, 423.51) = 35.21$, $p < .001$; $\eta^2 = .13$). Pairwise comparisons revealed a significant increase in learning engagement between preschool-age and kindergarten ($p = .01$) and between kindergarten and first-grade ($p < .001$) as well as between preschool-age and first-grade ($p < .001$) (see Figure 2). As such, children displayed more engaged behavior as they aged and transitioned from pre-school to post-school entry.

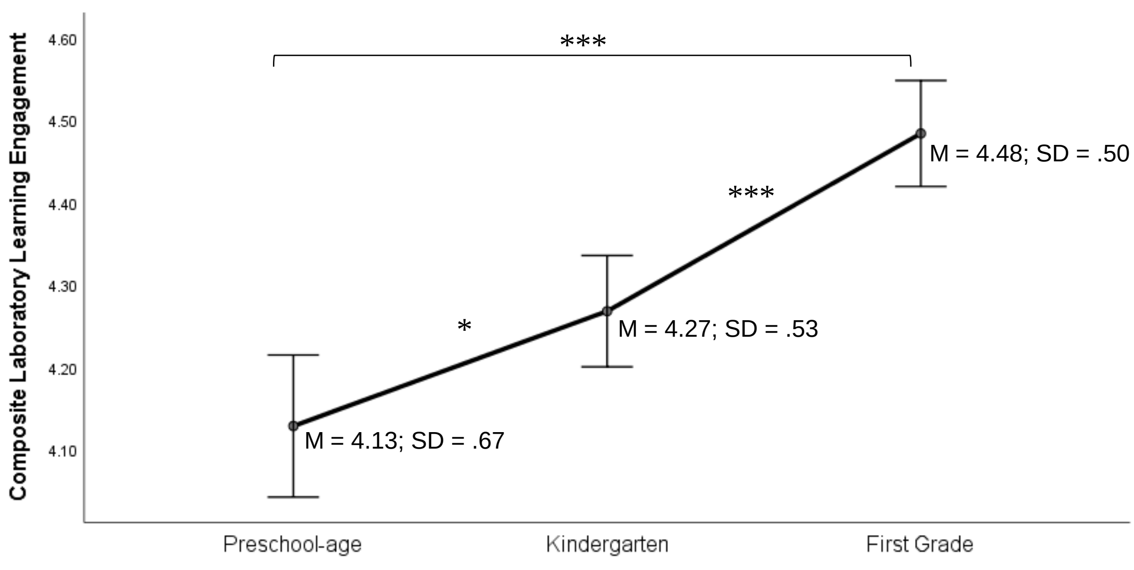

Figure 2. Changes in Learning Engagement from Preschool-age Through First Grade.
M = estimated marginal mean. SD = standard deviation. Error bars represent 95% confidence interval around the mean. Significance levels were adjusted for multiple comparisons using the Bonferroni correction. *$p < .05$, ***$p < .001$.

To probe potential changes in variance across time, the coefficient of variance was calculated at each time point so as to obtain a measure of relative variability. This was done by dividing the standard deviation of the learning engagement composite at each age by the age-specific mean and multiplying by 100. Based on this descriptive statistic, the variability of laboratory learning engagement appeared to decrease from preschool-age ($CV = 173.59$) to kindergarten ($CV = 121.78$) to first grade ($CV = 111.61$). This pattern was partially supported by changes in the variance of the learning engagement latent factor across time. Latent learning engagement, derived from the collapsed learning engagement data, exhibited a decided decrease from preschool-age to kindergarten but a small increase between kindergarten and first grade (see Table 7).

Next, the mean change of each observed learning engagement indicator across time was investigated using a one-way multivariate analysis of variance (MANOVA) with repeated measures. Although enthusiasm/energy and positive affect were not included in the learning engagement factor, they were included in the current analysis. As such, the MANOVA included seven dependent variables. Again, the full, non-consolidated data were used for this analysis. Results showed that there were differences in the indicators across time (Wilk's $\lambda = .004$; Pillai's Trace = .996; $F(7, 228) = 8047.09$, $p < .001$; $\eta^2 = .996$). Mauchly's Test of Sphericity revealed that sphericity could not be assumed for any engagement indicator (see Table 9), again suggesting that the variance of each learning engagement varied across time. As epsilon was greater than .75 for all indicators, the Huynh-Feldt correction was used to adjust degrees of freedom for all univariate tests. Univariate tests indicated that there was an effect of time on persistence, attention to instructions, on-task behavior, monitoring/strategy use, negative affect, and positive affect, as expected (see Table 10). Enthusiasm/energy was the only indicator that did not significantly differ across time.

Table 9. Mauchly's Test of Sphericity for Individual Learning Engagement Behaviors

	χ^2	*df*	*p*	ε
Persistence	12.470	2	.002	.96
Attention to Instructions	6.206	2	.045	.98
On-Task Behavior	22.241	2	< .001	.92
Monitoring/Strategy Use	14.598	2	.001	.95
Negative Affect	23.389	2	< .001	.92
Enthusiasm/Energy	12.070	2	.002	.96
Positive Affect	11.900	2	.003	.96

Note. Epsilon derived using Huynh-Feldt calculation.

Table 10. Univariate Analyses of Variance (ANOVA) Between Individual Learning Engagement Behaviors and Time

	F	df_{time}	df_{error}	*p*	Partial η^2
Persistence	21.51	1.92	378.75	< .001	.08
Attention to Instructions	5.76	1.97	467.24	.003	.02
On-Task Behavior	31.80	1.85	323.12	< .001	.12
Monitoring/Strategy Use	37.54	1.90	419.18	< .001	.14
Negative Affect	6.16	1.84	421.50	.003	.03
Enthusiasm/Energy	0.65	1.92	464.29	.52	.00
Positive Affect	11.66	1.92	462.26	< .001	.05

Note. Degrees of freedom calculated using Huynh-Feldt correction.

Pairwise comparisons revealed several patterns of change over time, primarily in the expected direction. Children displayed an increase in attention to instructions between preschool-age and kindergarten (p = .04) as well as between preschool-age and first grade (p = .01) but not between kindergarten and first grade. Conversely, children displayed greater persistence and monitoring/strategy use from preschool-age to first grade ($p < .001$) as well as from kindergarten to first grade ($p < .001$) but not from preschool-age to kindergarten. Children demonstrated less negative affect from preschool-age to first grade ($p = .01$) and from kindergarten to first grade ($p = .002$) but not from preschool-age to kindergarten. Children also displayed increases in on-task behavior at all time points: between preschool-age and kindergarten ($p < .001$), between preschool-age and first grade ($p < .001$), and between kindergarten and first grade ($p = .02$). In contrast to expectations, children showed less positive affect from preschool-age to kindergarten ($p = .001$) and from preschool-age to first grade ($p < .001$). There was no change in positive affect between kindergarten and first grade. Significance levels were adjusted for multiple comparisons using the Bonferroni correction.

Laboratory learning engagement and demographics. The bivariate associations among learning engagement at each time-point and demographics were calculated (see Table 11). Household income-to-needs ratio was positively correlated with learning engagement at preschool-age and kindergarten but not first grade, such that preschool-aged and kindergarten children from households with higher incomes were more likely to be engaged with learning. Maternal education and gender were also associated with learning engagement, but at preschool-age only. Specifically, preschool-aged girls were on average more engaged than preschool-aged boys, and preschool-aged children of more highly educated mothers were on average more engaged than children of mothers with less education. Because of its relatively large correlation with income-to-needs ratio, maternal education was dropped as a potential covariate for subsequent analyses.

Table 11. Correlation Among Study Variables and Demographics

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Gender	-														
2	Minority status	.02	-													
3	Maternal education	-.01	-.25**	-												
4	Income-to-Needs Ratio	.10	-.29**	.49**	-											
5	Learning Engagement Composite: PS	.15*	-.12*	.17**	.25**	-										
6	Learning Engagement Composite: K	-.07	-.04	.10	.19**	.57**	-									
7	Learning Engagement Composite: FG	.07	.02	.11	.12	.62**	.68**	-								
8	School Attitude: K	.19**	-.17*	.09	.06	.26**	.16*	.10	-							
9	School Attitude: FG	.10	-.14*	.21**	.16*	.25**	.13	.15*	.35**	-						
10	Classroom Learning Behavior: K	.18**	.21**	.19**	.18**	.27**	.22**	.15*	.64**	.37**	-					
11	Classroom Learning Behavior: FG	.19**	.15*	.23**	.20**	.33**	.24**	.25**	.36**	.75**	.46**	-				
12	Academic Performance: K	.01	-.16*	.29**	.27**	.21**	.20**	.20**	.31**	.27**	.39**	.34**	-			
13	Academic Performance: FG	.03	-.18**	.33**	.22**	.28**	.25**	.25**	.24**	.40**	.27**	.57**	.57**	-		
14	Emotion Regulation: PS	.12*	.07	.00	.06	.39**	.41**	.48**	.19**	.17*	.18**	.32**	.17*	.16*	-	
15	Emotion Regulation: K	.16**	.02	.13*	.12	.27**	.31**	.35**	.24**	.22**	.26**	.30**	.18**	.14*	.54**	-
16	Emotion Regulation: FG	.14*	.02	.09	.11	.23**	.27**	.46**	.17*	.24**	.32**	.35**	.17*	.17*	.63**	.67**

Note: PS = preschool-age, K = kindergarten, FG = first grade. * $p < .05$, ** $p < .01$.

Tests examining the association between minority status and learning engagement demonstrated that non-Hispanic white preschool-aged children were on average more engaged than Hispanic-white and non-white children at preschool-age, but not in kindergarten or first grade. This correlation was further probed at preschool-age with a one-way ANOVA. For the purposes of the analysis, children were categorized as non-Hispanic white (N = 149), Hispanic white (N = 15), black (N = 83), and multi-racial (N = 24). As there were only 2 Hispanic black children and 1 Hispanic multi-racial child, ethnicity was combined for these racial categories. Moreover, the 5 Asian children were eliminated from the analysis due to small group size. Results showed that preschool-age learning engagement differed by race (F(3, 268) = 4.964, p = .002).

Post hoc analyses using Tukey HSD suggested that both non-Hispanic white children (M = 4.18, SD = .64, p = .007) and Hispanic white children (M = 4.40, SD = .59; p = .03) demonstrated greater learning engagement than black children (M = 3.86, SD = .79). There was no significant difference between Hispanic white, non-Hispanic white, or multi-racial children (M = 4.14, SD = .72) and no difference between multi-racial children and black children. Minority status was not considered further in this project, but future analyses with greater power and more equal group sizes should be conducted to further investigate issues of race and ethnicity in relation to learning engagement.

Criterion validity. Analyses were next run to test the concurrent and predictive associations between learning engagement and both academic performance and indicators of school engagement. Bivariate correlations among learning engagement (calculated as a composite of attention to instructions, on-task behavior, persistence, monitoring progress/strategy use, and negative affect-reversed), academic performance, and classroom learning behaviors were concurrently and longitudinally correlated at all three time points (see Table 11). Learning engagement was also concurrently associated with school attitude. However, although learning engagement at preschool-age was positively related to school attitude in kindergarten and first grade, engagement in kindergarten was not longitudinally related to school attitude in first grade.

In order to further examine the multivariate associations between learning engagement and classroom outcomes, four SEMs were fit to the data: (1) a model testing the longitudinal associations between preschool-age learning engagement and classroom outcomes at kindergarten and first grade, (2) a model testing the concurrent associations within kindergarten, (3) a model testing the longitudinal associations between kindergarten learning engagement and first grade classroom outcomes, and (4) a model testing the concurrent associations within first grade. Although a six-indicator factor of learning engagement at preschool-age was found to demonstrate criterion validity, the predictive validity of learning engagement at this age was reexamined using the 5-indicator factor that showed longitudinal measurement invariance in the current study. Based on bivariate associations with children's demographics, gender and income-to-needs ratio were controlled when appropriate. Specifically, pathways were included from these covariates to any dependent or independent variable with which they shared a bivariate association. Descriptive statistics for all outcome variables can be found in Table 12.

Table 12. Teacher Questionnaire and Emotion Regulation: Descriptive Statistics

	N	Min	Max	Mean	SD	Skew (SE)	Kurtosis (SE)
Preschool-age							
Emotion Regulation	278	-2.80	1.56	0.00	0.80	-0.77 (.15)	0.75 (.29)
Kindergarten							
Emotion Regulation	262	-3.16	1.86	0.00	0.81	-0.61 (.15)	0.51 (.30)
Classroom Learning Behaviors	222	-0.38	1.00	0.62	0.31	-1.30 (.16)	1.22 (.33)
School Attitude	222	0.85	2.00	1.86	0.22	-2.09 (.16)	4.13 (.33)
Academic Performance	222	1.00	5.00	3.52	0.99	-0.30 (.16)	-0.44 (.33)
First-grade							
Emotion Regulation	257	-2.61	1.54	0.00	0.83	-0.52 (.15)	-0.03 (.30)
Classroom Learning Behaviors	200	-0.62	1.00	0.60	0.33	-1.06 (.17)	0.60 (.34)
School Attitude	206	0.69	2.00	1.82	0.24	-1.90 (.17)	4.00 (.34)
Academic Performance	206	1.00	5.00	3.52	1.06	-0.43 (.17)	-0.52 (.34)

Note. SE = standard error.

Preschool-age. A single model (see Figure 3) that analyzed the predictive associations between the 5-indicator factor of learning engagement at preschool-age and classroom outcomes in both kindergarten and first grade demonstrated excellent fit ($\chi^2(47) = 56.727$, $p = .16$; RMSEA = .028, 90% CI [.000, .051]; CFI = .993; SRMR = .047). Laboratory learning engagement among preschool-aged children was associated with academic performance and classroom learning behaviors in both kindergarten (academic performance: $B = .19$, SE = .07, $p = .009$; classroom learning behaviors: $B = .07$, SE = .02, $p = .001$) and first grade (academic performance: $B = .19$, SE = .07, $p = .013$; classroom learning behaviors: $B = .06$, SE = .03, $p = .02$). Preschool-age learning engagement was also positively associated with school attitude in kindergarten ($B = .06$, SE = .02, $p = .001$) but not in first grade ($B = .04$, SE = .02, p = .11). As such, children who were more engaged in the lab at preschool-age were more likely than less engaged children to be more engaged and successful in both their kindergarten and first-grade classrooms and to have a more positive attitude about school during kindergarten. Thus, the five-indicator construct of learning engagement at preschool-age demonstrated good predictive validity through the first grade.

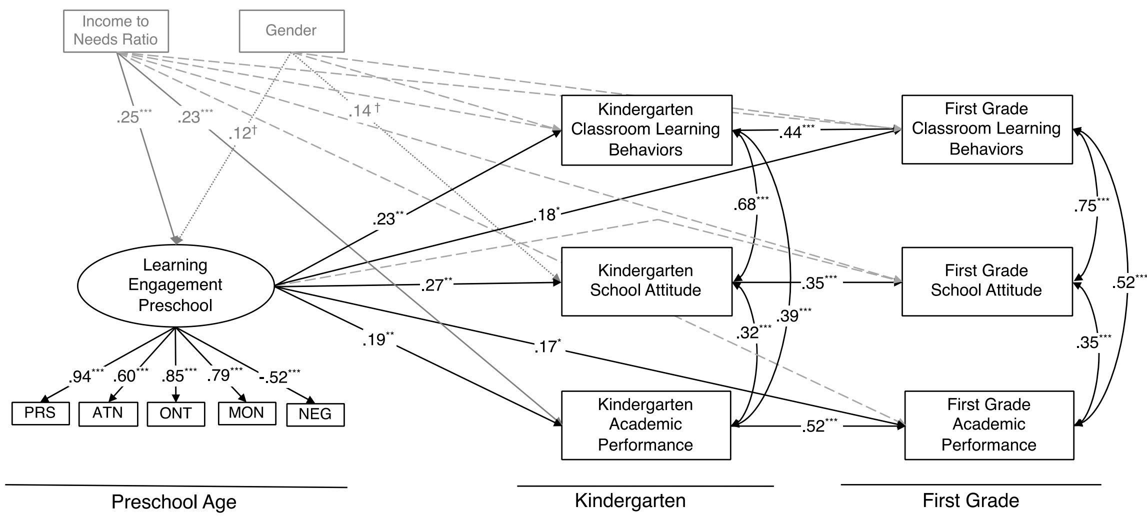

Figure 3. Model Testing the Longitudinal Associations Between Laboratory Learning Engagement at Preschool-Age and Classroom Adjustment in Kindergarten and First Grade. Values are standardized coefficients (β). PRS = persistence, ATN = attention to instructions, ONT = on-task behavior, MON = monitoring/strategy use, NEG = negative affect. Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths. † $p < .08$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Kindergarten. The concurrent associations among learning engagement in the laboratory and classroom adjustment and achievement in kindergarten were investigated. Overall fit for this model was good ($\chi^2(28) = 42.404$, $p = .04$; RMSEA = .045, 90% CI [.010, .072]; CFI = .976; SRMR = .052), and all hypothesized pathways were significant (see Figure 4). Learning engagement in kindergarten was associated with academic performance ($B = .22$, SE = .08, $p = .005$), classroom learning behaviors ($B = .09$, SE = .03, $p = .001$), and school attitude ($B = .05$, SE = .02, $p = .003$). As such, kindergarten children who were more engaged during laboratory learning activities were more likely than less engaged children to be concurrently more engaged in their classroom, more successful in school, and more positive about their kindergarten experience.

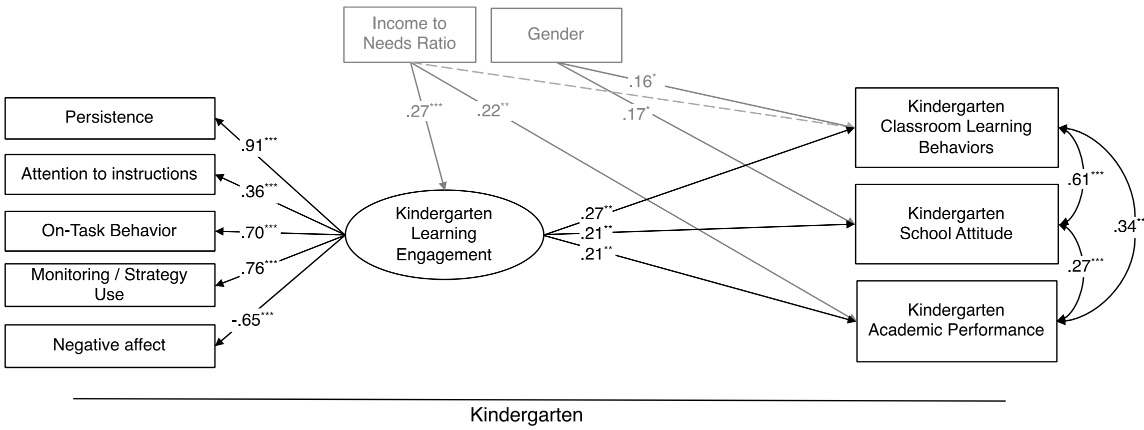

Figure 4. Model Testing the Concurrent Associations Between Laboratory Learning Engagement and Classroom Adjustment in Kindergarten. Values are standardized coefficients (β). Solid lines reflect significant paths. Dashed lines reflect statistically non-significant paths. * $p < .05$, ** $p < .01$, *** $p < .001$.

Another model was run to investigate the predictive validity of kindergarten learning engagement through its associations with first grade classroom outcomes. This model also fit the data well ($\chi^2(28) = 50.047$, $p = .006$; RMSEA = .056, 90% CI [.029, .081]; CFI = .966; SRMR = .062) and supported most hypothesized pathways (see Figure 5). Specifically, learning engagement in kindergarten significantly predicted academic performance ($B = .26$, SE = .09, $p = .003$) and classroom learning behaviors ($B = .09$, SE = .03, $p = .002$) in first grade but only marginally predicted first grade school attitude ($B = .04$, SE = .02, $p = .06$). Thus, kindergarten children who were more engaged during laboratory learning activities were more likely than less engaged children to be more engaged in their classroom and academically successful one year later. Kindergarteners who were more engaged in the lab also tended to enjoy first grade more than children who were less engaged in the lab.

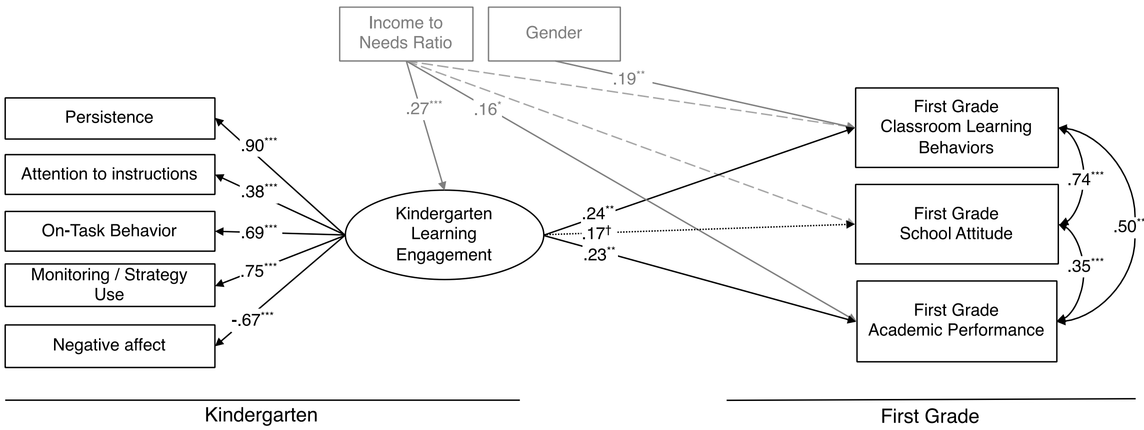

Figure 5. Model Testing the Longitudinal Associations Between Kindergarten Laboratory Learning Engagement and Classroom Adjustment in First Grade. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths.
† $p < .08$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Taken together, these results indicate that increases in learning engagement in the lab at kindergarten parallel increases in classroom learning behaviors and academic performance in both kindergarten and first grade. Increases in kindergarten learning engagement also coincided with a more positive school attitude in kindergarten and a tendency for more positivity in first grade. Thus, kindergarten learning engagement displayed both concurrent and predictive validity in relation to these school outcomes.

First grade. The concurrent validity of laboratory-measured learning engagement in first grade was next assessed by examining its multivariate associations with first grade outcomes. In this model, the residual variances of on-task behavior and attention-to-instructions were allowed to correlate, as found in the original CFA analyses. This model (see Figure 6) had excellent fit to the data ($\chi^2(28) = 28.414$, $p = .44$; RMSEA = .008, 90% CI [.000, .050]; CFI = .999; SRMR = .052). However, although learning engagement was associated with both school performance ($B = .23$, SE = .09, $p = .01$) and classroom learning behaviors ($B = .09$, SE = .03, $p = .001$) as expected, there was only a marginal effect of learning engagement on children's attitude about school ($B = .04$, SE = .02, $p = .06$). Thus, first grade children who demonstrated greater learning engagement in the lab were more engaged and successful at school but only tended to enjoy school more than children who demonstrated less engagement in the lab.

These results support the concurrent validity of the laboratory learning engagement measure in the first grade. As first graders' learning engagement in the lab increased, concurrent ratings of their engaged behaviors and academic performance also increased. Furthermore, as children's lab-measured learning engagement increased, their attitude about school in first grade also increased, although not significantly.

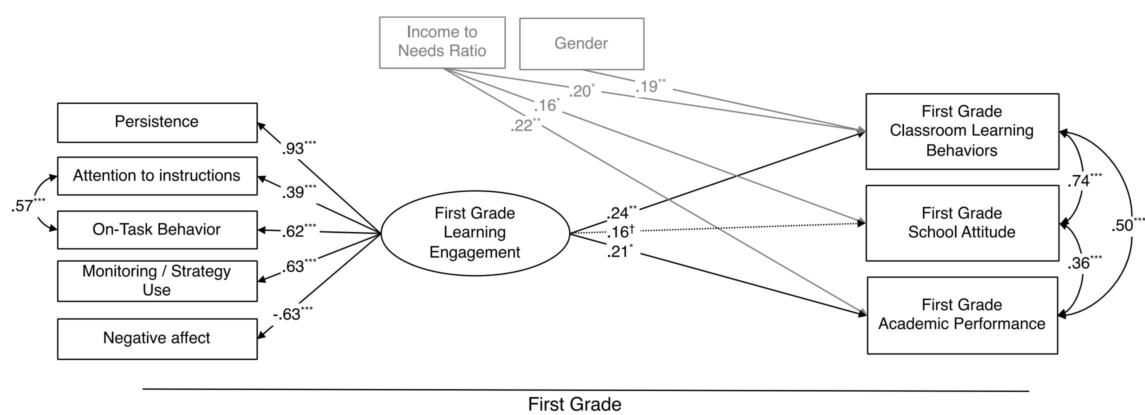

Figure 6. Model Testing the Concurrent Associations Between Laboratory Learning Engagement and Classroom Adjustment in First Grade. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths. † $p < .08$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Learning Engagement and Emotion Regulation

The second goal of the current study was to assess the influence of emotion regulation on various levels of children's learning engagement across the transition to school. A series of analyses were therefore run to investigate the longitudinal associations between emotion regulation and learning engagement, measured as engaged behaviors during a laboratory learning task, engaged behaviors in the classroom, and children's attitude about school. Emotion regulation demonstrated small to moderate correlations with the laboratory-measured learning engagement composite, teacher-reported classroom learning behaviors, and teacher-reported school attitude (p_{min} = |.27| – p_{max} = |.48|; see Table 11). Emotion regulation was moderately stable between preschool-age and kindergarten (r = .54) and between kindergarten and first grade (r = .69), as were classroom learning behaviors (r = .46) and academic performance (r = .57) between kindergarten and first grade. Descriptive statistics for emotion regulation and all classroom variables can be found in Table 12.

The associations between emotion regulation and the three operationalizations of learning engagement were next assessed in three separate SEM analyses. As the behavioral codes of positive affect and enthusiasm/energy did not load onto the current learning engagement factor, two ad hoc analyses separately investigated how emotion regulation associated with these behaviors (see Appendix B). In all models, the stability path from preschool-age emotion regulation to first-grade emotion regulation was retained, as fit significantly deteriorated when it was removed. Income-to-needs ratio and gender were controlled for in all variables with which they exhibited a bivariate relation (see Table 11).

Emotion regulation and laboratory learning behaviors. The model assessing the cross-lagged associations between emotion regulation and laboratory-observed learning engagement, computed as a composite of attention to instructions, on-task behavior, persistence, monitoring/strategy use, and negative affect (reversed), fit the data well ($\chi^2(7) = 15.543$, $p = .03$; RMSEA = .067, 90% CI [.020, .112]; CFI = .983; SRMR = .040) and revealed significant positive associations between emotion regulation at preschool-age and laboratory learning behaviors in both kindergarten ($B = .16$, SE = .04, $p < .001$) and first grade ($B = .18$, SE = .04, $p < .001$) (see Figure 7). Thus, children who were more emotionally well-regulated at preschool-age were more likely to be highly engaged during learning tasks in both kindergarten and first grade than less emotionally well-regulated children. However, there was no association between emotion regulation in kindergarten and laboratory learning behaviors in first-grade ($B = .04$, SE = .04, $p = .34$). Emotion regulation and laboratory learning behaviors were also concurrently associated with one another at preschool-age ($\psi = .20$, SE = .04, $p < .001$) and in first-grade ($\psi = .06$, SE = .01, $p < .001$) and marginally associated at kindergarten ($\psi = .04$, SE = .02, $p = .08$), such that more well-regulated children were also more engaged. Learning engagement in the laboratory did not longitudinally predict emotion regulation at any time point.

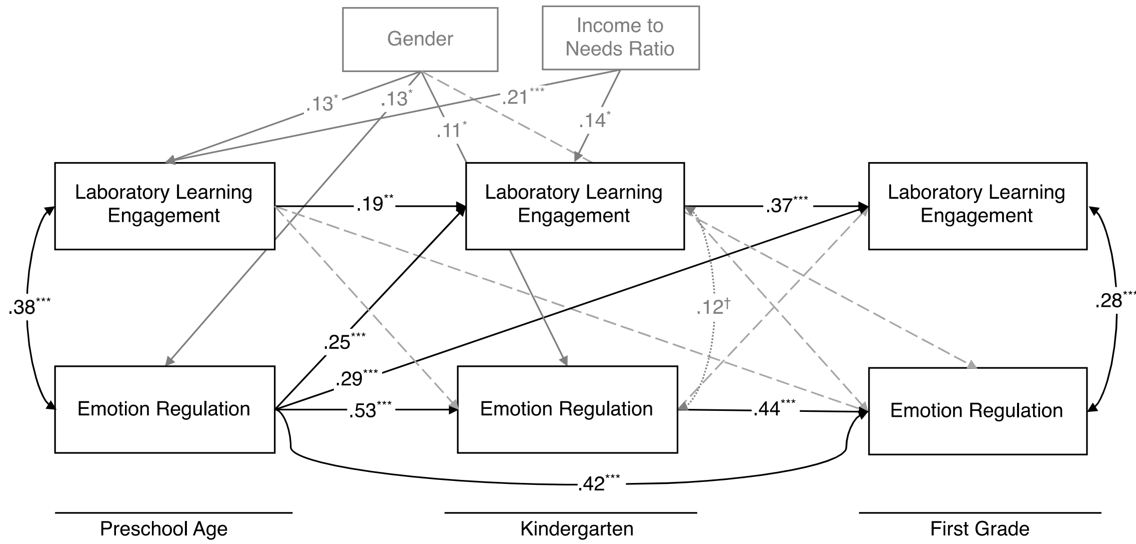

Figure 7. Model Testing the Longitudinal Associations Between Emotion Regulation and Laboratory Learning Behaviors Across the School Transition. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths.
† $p < .08$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Emotion regulation and classroom learning behaviors. The model assessing the longitudinal associations between classroom learning behavior and emotion regulation demonstrated excellent fit to the data ($\chi^2(4) = 6.271$, $p = .18$; RMSEA = .046, 90% CI [.000, .111]; CFI = .994; SRMR = .033) and revealed that emotion regulation at preschool-age was associated with classroom learning behaviors at both kindergarten (B = .06., SE = 03, $p = .01$) and first grade (B = .08., SE = 03, $p = .005$) (see Figure 8). However, emotion regulation in kindergarten did not predict future engagement (B = .03, SE = 03, $p = .37$). Emotion regulation and classroom learning behaviors were concurrently associated at kindergarten (ψ = .03, SE = .01, $p = .03$) such that more emotionally regulated kindergarteners were, at the same time, more engaged in their classroom, but there was no association between classroom emotion regulation and learning behaviors at first grade (ψ = .01, SE = .01, p = .35). According to these results, preschool-aged children who were more emotionally well-regulated were more likely to be engaged in their kindergarten and first-grade class rooms than children who were less well-regulated at preschool-age. Moreover, the more emotionally well-regulated children were in kindergarten, the better concurrent classroom learning behaviors they displayed.

This model also revealed a longitudinal effect of prior learning behaviors on subsequent emotion regulation. Specifically, there was a significant positive association between kindergarten classroom learning behaviors and first grade emotion regulation (B = .31., SE = 13, p = .02). Children who were more engaged in their classroom at kindergarten were more emotionally well-regulated in the first grade.

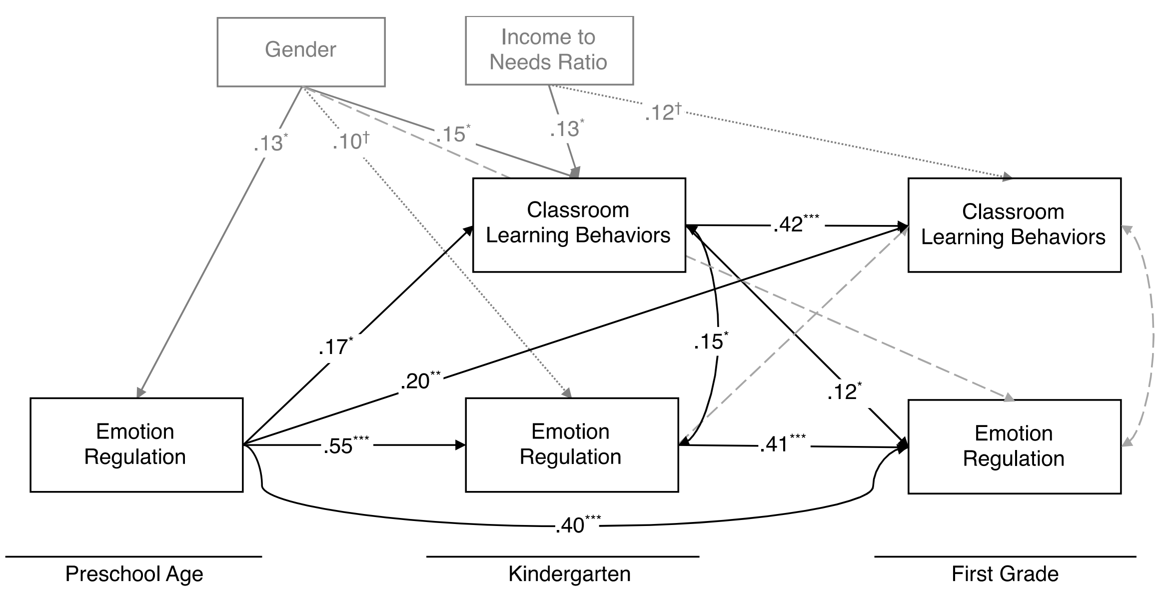

Figure 8. Model Testing the Longitudinal Associations Between Emotion Regulation and Classroom Learning Behaviors Across the School Transition. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths.
† p < .08, * p < .05, ** p < .01, *** p < .001.

Emotion regulation and school attitude. Because of the kurtotic and slightly skewed shape of the school attitude variable, the SEM analyzing the associations between emotion regulation and school attitude was estimated using robust maximum likelihood (MLR) estimation. The school attitude model demonstrated excellent fit to the data ($\chi^2(5) = 4.200$, $p = .52$; RMSEA = .000, 90% CI [.000, .077]; CFI = 1.000; SRMR = .032). This model (see Figure 9) revealed one significant longitudinal effect: emotion regulation at preschool-age was positively associated with school attitude at kindergarten (B = .05, SE = 02, p = .03). Thus, more emotionally well-regulated preschool-aged children were more likely than less emotionally well-regulated preschool-aged children to have a more positive attitude about school in kindergarten.

First grade school attitude was not associated with emotion regulation at either preschool-age (B = .02, SE = .02, p = .37) or kindergarten (B = .03, SE = .02, p = .16). Kindergarten school attitude was associated with emotion regulation concurrently in kindergarten (ψ = .02 SE = .01, p = .02) and marginally associated with emotion regulation in first grade (ψ = .02, SE = .01, p = .07), such that more emotionally well-regulated kindergarteners were more likely to have a positive attitude about school at the same time. Learning engagement in the laboratory did not longitudinally predict emotion regulation at any time point.

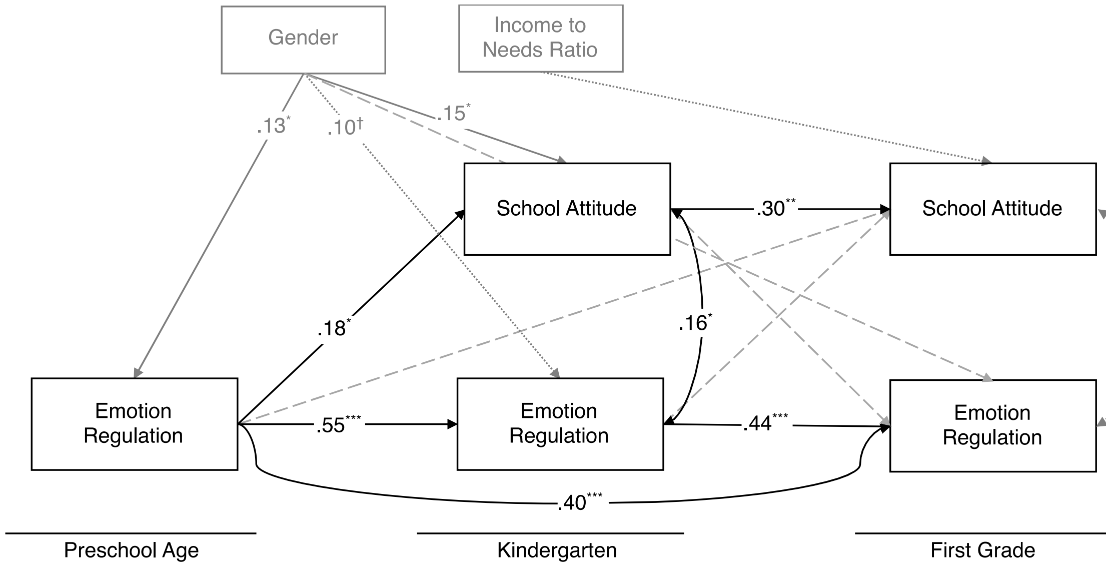

Figure 9. Model Testing the Longitudinal Associations Between Emotion Regulation and School Attitude Across the School Transition. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths. † p < .08, * p < .05, ** p < .01., *** p < .001.

CHAPTER IV

DISCUSSION

Engagement during learning plays a key role in children's academic achievement and school success, particularly during early childhood as children transition to school (Kagan et al., 1995; Li-Grining et al., 2010; McClelland et al., 2000). It is therefore important to understand how engagement looks and functions across this period and the processes that may influence its development. Moreover, to adequately explore these topics, it is necessary to establish a variety of measurement tools that can validly assess young children's engagement with learning. This study addressed these issues through two overarching objectives. First, this study aimed to better understand learning engagement across the transition to school by examining the measurement of children's learning behaviors in a laboratory environment. As most current methods of measuring learning engagement are based on teacher-report or children's behavior within a classroom, there had been no valid laboratory measure of learning engagement that demonstrated a longitudinally invariant construct across the transition to school. Second, this study aimed to assess emotion regulation as a potential early predictor of learning engagement, measured across context and type of engagement. Although prior research generally supports the association between children's emotion regulation and learning engagement (Fantuzzo et al., 2004; Graziano et al., 2007), less work has examined this relation longitudinally or across context. To explore these questions, a representative community sample was followed from preschool-age through first grade, a period that spanned from one year before children entered formal school to one year after.

Validity of Measuring Learning Engagement in the Laboratory

The current study extends prior work that has supported a valid learning engagement factor at preschool-age (Halliday et al., 2018) by assessing the validity of this factor through the first grade. Moreover, as most longitudinal analyses require some stability of measurement across time in order to ensure that observed changes are due to developmental differences and not changes in how the focal construct is defined and measured, this study investigated the invariance of learning engagement from the preschool-age through first grade. Mean-level changes across time were assessed, and associations with children’s classroom learning behaviors, school attitude, and academic performance were explored in order to evaluate the criterion validity of this measure.

Factors of learning engagement across early childhood. The construct validity of a single learning engagement factor at preschool-age, kindergarten, and first grade was assessed through a series of confirmatory factor analyses. These analyses found empirical support for a cohesive factor composed of five observed indicators – persistence, attention to instructions, on-task behavior, monitoring/strategy use, and negative affect – at all three time points. This construct is best described as children’s behavioral learning engagement in the laboratory setting, as it primarily described children’s ability to remain task-focused, attentive, and compliant. However, certain elements of children’s cognitive and, to a lesser extent, affective engagement with learning may also be represented by this construct. Specifically, this construct considered demonstrations of discontent, distress, determination, and ability work on and attend to tasks purposely and thoughtfully.

The five-indicator construct of learning engagement supported by the current study differed from the six-indicator construct supported by the preschool-age data only (Halliday et al., 2018), in that enthusiasm/energy did not strongly load onto the learning engagement factor at kindergarten or significantly load at first grade. There are several reasons why the association between enthusiasm/energy and the other observed indicators of engagement may degrade with time. First, as the laboratory tangrams task remained largely similar at each testing session, children may have found the activity less interesting over the three years that they participated in the study. Although children were only tested once a year, other experiences with similar puzzle-like activities may also have diminished excitement surrounding the particular task.

An alternative explanation is that children may have become more skilled at regulating the expression of enthusiasm in a learning context with age and experience. Although displays of energy and enthusiasm are generally considered positive and appropriate behaviors, they may not always lead to positive developmental outcomes. Just as positive affect may be impede effortful control and focus in some contexts (Denham et al., 2012; Kochanska, Murray, & Harlan, 2000), so might excessive enthusiasm. For example, high approach behavior, when paired with poor regulation, has been predictive of greater social and behavioral problems in young children (Dollar & Stifter, 2012; Jonas & Kochanska, 2018). With respect to learning, uncontrolled activating emotions such as overexcitement may disrupt concentration by distracting from the learning task (Pekrun & Linnenbrink-Garcia, 2012). As such, more engaged children may be inhibiting speed, vigor, and excitement while working on the learning tasks in order to better focus and problem-solve. More research is needed to understand the nature of this variable and its relation to learning engagement as a whole.

In addition to the elimination of enthusiasm/energy from the model, the learning engagement factor also differed in first grade from preschool-age and kindergarten in that the residual variances of on-task behavior and attention to instructions needed to be correlated in order to achieve good fit. This correlation indicates that these two indicators were related to one another over and above their common association with the learning engagement factor in the first grade. As the instructions of the current task were primarily concentrated in the beginning of the task, it may have been that younger children were able to focus during the instructions but unable to maintain this focus throughout the duration of the task. In first grade, children may be better at maintaining focus for longer periods of time due to improvements in executive functioning, which quickly develop throughout early and middle childhood (Anderson, 2002; Best, Miller, & Jones, 2009; Garon et al., 2008). Thus, first graders may be more likely to stay on-task throughout, especially if they had been on-task at the start of the task when instructions were given.

Although the current coding scheme, which judged overall behavior during the entire duration of the task, was unable to ascertain these temporal nuances, these results indicate that children may be able to tolerate longer periods of independent learning activity as they progress through the early transition to school. It is also possible that younger children, even those who showed good initial focus, may require more unprompted instruction throughout a long task in order to remain on-task. Indeed, the current 10-minute tangrams task may be quite long for a preschool-age child or kindergartener to sit and concentrate. A study design wherein greater instructions were given every few minutes or a different coding scheme that is sensitive to dynamic changes in behavior may provide greater insight into the nature of the residual association between on-task behavior and attention to instructions found in this study.

Measurement invariance. After establishing the good fit of the 5-indicator laboratory learning engagement factor at each time point, this study examined the measurement invariance of this factor over time. This was done to test the stability of the current measure as well as assess any qualitative, metric, or scalar changes in learning engagement that may occur with development. Although full scalar invariance was not supported, results did provide evidence for partial scalar invariance. Small amounts of non-invariance are generally considered acceptable, and scale scores from various groups or time points can still be regarded as invariant if the majority of parameters demonstrate equivalency (Bowen & Masa, 2015; Dimitrov, 2010). In the current study, all factor loadings and 39 out of 44 modeled thresholds were deemed equivalent across preschool-age, kindergarten, and first grade. This relatively large proportion of invariant parameters indicate overall measurement invariance.

Despite this general invariance, it is important to acknowledge the areas of non-invariance in the model. According to the chi-square difference test criterion, certain thresholds of attention to instruction and negative affect differed across time. This indicates that the way in which the assumed underlying normal distribution of scores was divided into corresponding categorical responses differed across age for these variables (Bowen & Masa, 2015; Liu et al., 2017). Although it is difficult to interpret the specific points of non-invariance, these differences suggest that certain observed scores may have a different underlying meaning at different ages. For example, a preschool-age child may be more likely than a kindergartener or first grader to receive a score of 3 instead of 4 on negative affect, even if these children's behaviors were distributionally similar. This may be due to coder biases or expectations about children's behavior. For example, younger children may need to express greater or more intense negative affect to be given as high of a score as older children, and older children may need to restrain themselves more in order to be considered attentive during instructions. In the current model, these points of invariance are minimal, suggesting that factor means and variances of the current measurement of laboratory-assessed learning engagement can be compared across the preschool to first grade age period.

Laboratory learning engagement across time. Levels of learning engagement were assessed across time using analysis of variance and multivariate analysis of variance methodology. When examined as a composite variable, calculated as an average of the five cohesive observed behaviors, learning engagement in the laboratory displayed a significant increase from preschool-age through first grade. As expected, children became more engaged overall with time. When each of the engagement behaviors were assessed individually, the five behaviors that cohered to the learning engagement factor all showed an overall increase across time, except negative affect, which showed a general decrease over time. Although pairwise comparisons suggested that behavioral changes did not occur at each time point for all variables, a significant change in the expected direction was observed between at least two points of observation for all five of these behaviors.

These findings support and extend prior research that found increases in classroom learning engagement, measured through teacher-report, across two years among a group of Head Start children (McDermott et al., 2011). The current study suggests that similar increases may occur with respect to processes of engagement that occur in less social and more novel contexts (i.e., the lab). Moreover, the increases in engagement demonstrated by McDermott and colleague's (2011) low-income sample may generalize to more economically-diverse samples, such as that of the current study.

Increases in engagement over time may occur for several reasons. First, children are swiftly developing more self-regulatory capabilities during this developmental period (Fox & Calkins, 2003; Garon et al., 2008; Posner & Rothbart, 2000) and may therefore be better able to focus, persist, flexibly problem solve, and temper negative affect. Second, as children progress through school, they gain more experience with formal learning tasks. This exposure may help children become more aware of behavioral expectations and more comfortable working on challenging tasks with a learning objective. As children learn to adjust their behavior to meet new expectations within the classroom, they may become increasingly able to similarly modify their behavior in learning environments outside of the classroom.

The two learning engagement behaviors that did not cohere with the learning engagement factor, enthusiasm/energy and positive affect, demonstrated a different pattern across time: Children's enthusiasm and energy did not change across time, and their positive affect decreased. Although these results were contrary to hypotheses, they may make sense in the context self-regulation development. As discussed above, children may become more skilled at down-regulating their energy and expression of positive affect, and the laboratory tasks may become less novel and less interesting through repeated experience. With experience, it is also possible that small successes may stop conjuring strong feelings of pride and the introduction of a new task items may become less exciting. It is also possible that children demonstrated less energy and positive affect in the kindergarten and first grade as many children came to the laboratory in the late afternoon after attending a full day of school during these waves of data collection.

The lack of growth in enthusiasm/energy and decrease in positive affect also further supports the decision to eliminate these indicators from the overall laboratory learning engagement construct, as their patterns of change are not congruent with those of the other observed behaviors. However, despite not cohering with the other engagement behaviors, enthusiasm/energy and positive affect may still be important aspects of engagement in a broader sense. For example, more positive, interested, and enthusiastic children may develop stronger, more positive relationships with teachers and peers (Ladd et al., 2006). Although the current paper focused on the group of behaviors that united to form the behavioral learning engagement factor, future research should continue to more thoroughly investigate positive affect and enthusiasm in relation to overall engagement and the validity of their assessment.

Finally, results indicated that the variance of learning engagement may change with time. Post hoc analyses suggested the variability of engagement displayed in the lab tended to decrease as children got older, particularly as they progressed from preschool-age to kindergarten. This decrease in variability may be explained by the shared experience of attending school or formal education. Although some children do attend formal prekindergarten programs, the preschool experience is much less uniform than the kindergarten experience. As all children become more accustom to the expectations of a learning environment, their behaviors may become more similar. Future work may continue to explore this issue by investigating how preschool experience may be associated with the variability of learning engagement.

Criterion validity. The latent learning engagement factor was investigated in relation to teacher's report of children's school engagement and performance through a series of structural equation models (SEMs) in order to establish its validity as a measure of engagement and further investigate the relation between learning engagement measured in the laboratory with processes of learning within the classroom. As expected, children of all ages who displayed more engagement in the laboratory were also rated by their teachers as having more engaged behavior in the classroom and performing better academically, even after controlling for children's gender and family income. There was also support for the relation between laboratory learning behaviors and children's feelings about school, particularly at younger ages. These associations are generally consistent with prior literature and theory that posit associations among the different levels of engagement and between learning engagement and school success (Appleton et al., 2008; Ladd & Dinella, 2009) and provide good evidence for the concurrent and predictive validity of the laboratory learning engagement measure.

These results also extend the findings from previous analyses focusing solely at learning engagement at preschool-age. Halliday and colleagues (2018) discussed how the associations between the laboratory measure of learning engagement and teacher-reported classroom outcomes provide some evidence that children's engagement in the laboratory may generalize to more traditional learning environments. One potential drawback to a laboratory measure of learning engagement is that it is not as naturalistic and may elicit different behavior than measures of engagement in more traditional learning contexts, such as a classroom. However, these associations with classroom learning behaviors and academic outcomes support the validity of the laboratory measure despite this potential weakness.

Contrary to hypotheses, the current laboratory measure of learning engagement was not consistently related with children's attitude about school. Laboratory learning engagement showed a marginal positive association with school attitude between kindergarten and first grade and concurrently in first grade, but only the longitudinal association between laboratory learning engagement at preschool-age and school attitude in kindergarten and their concurrent association in kindergarten was statistically significant. As such, laboratory learning engagement was no longer a significant predictor of school attitude by the time children are in the first grade. This may be because children's attitude about school becomes more complex as school progresses. At all ages, there may also be social or environmental factors that influence how children feel about school that have little to do with their feelings about learning. For example, a positive classroom social environment and a caring relationship with one's teacher were related to school satisfaction (Birch & Ladd, 1997) and a sense of belonging within the classroom was associated with greater affective engagement in the classroom (Furrer & Skinner, 2003). However, as children spend more time in school, these contextual influences may play a stronger role in determining the relationship a child has with school. Further effort should be made to investigate how behavioral and affective engagement operate together, both within and outside of a school or classroom context.

Summary. Behavioral learning engagement can be successfully measured in a laboratory context from preschool-age through first grade. Although there are some changes in children's engagement over this developmental period, the observational measurement tool investigated in this paper demonstrates enough construct stability over these three years to justify the use of longitudinal statistical analyses. Moreover, the concurrent and predictive associations with classroom engagement behaviors and performance provide further confidence that this measure is indeed measuring what it purports: children's engagement with learning.

These results also provide important insight into the way in which learning engagement functions during early childhood. Specifically, they suggest that the form, metric, and distribution of learning behaviors, measured in a laboratory setting, is relatively stable across the transition to school and that mean levels of engagement tend to increase across this time. They also indicate that children's behavioral engagement in a novel and primarily independent context such as the lab is related to indicators of engagement and success in the more social environment of the classroom. Together, this study suggests that learning engagement assessed by the current measure is a strong construct that may be useful in the design of future research and informative for developing new theory.

Learning Engagement and Emotion Regulation

The second goal of this study was to evaluate the influence of emotion regulation on learning engagement in early childhood. Notably, this study assessed the relation between emotion regulation and learning engagement across engagement level (i.e., behavioral and affective) and learning context (i.e., laboratory and classroom). The results of the three SEMs fit to test these relations supported current theory positing the importance of emotion regulation for learning processes and engagement (C. Blair, 2002; Denham, 2006; Raver, 2002). Children who were more emotionally well-regulated at preschool-age were more likely to demonstrate higher levels of subsequent engagement than less well-regulated children, regardless of how or where engagement was quantified. Specifically, emotion regulation at preschool-age was positively predictive of children’s learning behaviors in both the laboratory and classroom as well as their attitude about school. In relation to laboratory and classroom learning behaviors, the effect of preschool-age emotion regulation endured through the first grade. In contrast, emotion regulation measured in kindergarten did not have any predictive influence on either affective or behavioral engagement, measured in the classroom or in the lab.

These results suggest that earlier emotion regulation skills may have a stronger impact on the development of engagement than later emotion regulation skills. Emotion regulation, which develops early ontologically, may become well established by early childhood, and the early ability to regulate emotions – even as young as infancy – may have important consequences for later adaptive functioning (Calkins, 1994; Calkins & Keane, 2004; Stifter, Spinrad, & Braungart-Rieker, 1999). Poor emotion regulation during the preschool years may constrain children's ability to develop the skills and motivations needed to adequately engage at school entry and therefore have important and long-lasting effects on children's behavioral and affective learning processes.

In addition to the longitudinal effects of preschool-age emotion regulation on later engagement, emotion regulation was concurrently associated with children's classroom learning behaviors and school attitude in kindergarten and laboratory learning behaviors in first grade, such that children with better regulation were also more engaged. There were also marginally significant positive associations between emotion regulation and school attitude in first grade and emotion regulation and laboratory learning behaviors in kindergarten. As such, a child's later ability to regulate their emotions may still have a bearing on their engagement. As evidenced by the pattern of the current results, this may be particularly true in the kindergarten classroom, a novel and more structured learning environment where children are expected to regulate their emotion and behavior more autonomously. In regard to school attitude, children who are better able to regulate emotions may be better able to form positive concurrent feelings about school. Of course, it is more difficult to interpret the direction of effects of these concurrent correlations without temporal precedent.

The longitudinal, cross-lagged models used to test the relation between emotion regulation and engagement across time do generally support the hypothesis that emotion regulation drives changes in engagement, as posited by previous research (Fantuzzo et al., 2004; Graziano et al., 2007; Howse et al., 2003). However, one model demonstrated a significant longitudinal effect of learning engagement on future emotion regulation: Positive learning behaviors in the kindergarten classroom predicted greater regulation in first grade. Thus, the experience of successfully engaging in a classroom setting may strengthen children's regulatory skills (Bierman et al., 2009; Williford et al., 2013). This pattern may not be evident when measuring learning engagement in a laboratory, as the calmer, less social conditions in which learning tasks are completed may not tax all of the same system that are taxed in the classroom. It is also possible that the social aspects of the classroom may be promoting the development of emotion regulation: More engaged children in the classroom may be learning new regulatory skills from their teacher or peers while observing or participating in group activities. This bidirectional effect may have important consequences for children's trajectories of school success.

Taken together, these results indicate that early emotion regulation is an important predictor of children's learning engagement during the transition to school. The effect of emotion regulation on children's learning behaviors may be particularly enduring, and children's regulatory skills before the beginning of formal schooling may be particularly important. Finally, emotion regulation and engaged learning behaviors in a classroom setting may have a bidirectional promotive relation. Thus, emotions and their regulation should be considered when examining processes of engagement and learning.

Limitations and Future Directions

The current study is not without limitation. First, this study may have been limited by the way in which affective engagement was operationalize and measured. The use of a teacher-report questionnaire to assess children's school attitude may not have captured to complexity of this construct, and the weakness of this measure may partially explain why consistently fewer significant associations with this variable were revealed in the current study. Specifically, the current measure may not have fully or specifically assessed children's emotional experience while learning. As this measure focused primarily about attitude toward school, feelings about other components of the school experience, such as peer or teacher relationships, rather than the learning experience, may also be captured. Furthermore, teachers may not be the most reliable reporters to assess children's school attitude. Although there may also be limitations to child self-report and parent-report, these perspectives may add valuable information not accessible to teachers. New methodology to better measure young children's affective engagement is needed, and associations with affective engagement should continue to be examined. For example, future studies may attempt to explore non-behavioral methods of measuring positive affect, such as neural or cardiac indices, that may help separate its experience, expression, and regulation.

Although the current study's measure of learning engagement in the lab exhibited good construct and criterion validity, further advances to extend or improve this measure should be considered. Specifically, it must be acknowledged that the laboratory environment is not naturalistic and may suffer from problems of ecological validity. For example, inhibited children may feel more anxious in a novel laboratory setting than a more familiar classroom or home environment and therefore behave less engaged. Moreover, the current tasks were conducted in an environment designed to be free of distraction and primarily nonsocial. This differs greatly from a classroom setting, where most of elementary school-aged children's learning occurs. More social tasks could particularly influence children's expressed affect and enthusiasm, which were less cohesive with the other laboratory indicators of engagement in the current learning engagement factor. Although the independent nature of the current laboratory measure was intentional so that engagement with a learning task could be targeted specifically, extending the current coding system to more social tasks may further elucidate the processes underlying children's engagement and provide even more resources for researchers to rely on in the future.

Future research should also consider the cognitive level of engagement, which was largely left out of the current study. Although some of the observable indicators in this study, such as monitoring progress/strategy use and, to some extent, attention to instructions and persistence, may tap into cognitive engagement, behavioral manifestations rather than the internal processes were primarily regarded. It may be challenging to evaluate internal processes, particularly during early childhood when children may be more likely to underreport report strategy use (Winsler & Naglieri, 2003), but it is important not to ignore this level of engagement. Further research is needed to better understand this construct during this point of development.

This study was also limited in its ability to fully explore issues of race in relation to focal analyses. Although the current sample was racially and economically diverse, it was not large enough to compare models across race or ethnicity. The questions addressed in the current study should be reassessed using samples specifically recruited to provide the statistical power to perform multigroup models, which could compare whether learning engagement operated similarly across group. Moreover, the current study's finding that learning engagement may differ across race at preschool-age should be interpreted with caution, as this study was not motivated to actually test these differences. It would be incorrect to conclude from this result that a child's race impacts their engagement directly. Rather, it is likely other variables, such as preschool-exposure, language, acculturation, or teacher biases that drive these differences. Similar processes may also underlie learning engagement's associations with gender and family income. Future studies with a better position to address learning engagement in the context of race, gender, and financial inequality should build off the current paper, which has established a valid measure of learning engagement among a diverse sample, to address these questions.

The current study's support for the general increase in behavioral learning engagement also suggests multiple directions for future research and the development of new theory. For example, as one potential driver of the increase in engagement is exposure to formal learning, one particularly interesting future direction could be to examine how children's experience with a formal prekindergarten program versus unstructured care before the beginning of school may differentially influence children's level of engagement with learning. This design may help isolate school experience from age and therefore more directly test the promotive effect of early learning experience on engagement.

It should also be noted that the current investigation into learning engagement across time was assessed by analysis of variance (ANOVA) methodology. However, the ANOVA procedure requires a continuous response and may therefore not be appropriate, particularly for the individual behavioral indices, which were measured on a 1 to 5 scale. The use of a Likert scale may not preclude the use of ANOVA, as variables measured on a five-point scale or greater may be considered continuous for practical purposes (Rhemtulla, Brosseau-Liard, & Savalei, 2012), but the sparse data of certain variables at certain time points may violate assumptions related to this test. Moreover, analyzing change in the latent factor of learning engagement rather than the composite score may be a more precise test of this developmental process. Future research should build upon the current results by assessing discrete change at each time point through structural invariance analysis or evaluating trajectories of change through latent growth curve analysis. The current work lays a foundation for these future analyses.

Further research should also continue to investigate the association between learning engagement and self-regulation. First, latent growth curve analysis may address how changes in emotion regulation across time may affect trajectories of change in learning engagement. Second, as the current study primarily focused the ability to down-regulate negative affect in the observable measure of emotion regulation, future analyses may assess how the regulation of positive affect – both its suppression and augmentation – may specifically affect children's ability to engage with learning. Third, assessing the role that other self-regulatory processes beyond emotion regulation may play in relation to learning engagement may further elucidate the mechanisms that promote or inhibit its development. Executive functioning in particular may help facilitate learning engagement, especially at the behavioral and cognitive levels (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Fitzpatrick & Pagani, 2012; Nesbitt, Kimberly Turner; Farran, Dale Clark; Fuhs, 2015; Neuenschwander, Röthlisberger, Cimeli, & Roebers, 2012; Sasser, Bierman, & Heinrichs, 2015; Vitiello et al., 2011). Examining the comparative effects of emotion regulation and executive functioning may thus help to further reveal the complex function of self-regulation for children's learning.

Finally, more frequent assessments or additional follow-up may better inform current knowledge of learning engagement. A study design that allows for more micro-assessments to be conducted during the time span between preschool to first grade may provide more refined details regarding the development of learning engagement and its interactions with other variables across the transition to school. Additionally, following children beyond first grade could reveal how enduring the effect of early emotion regulation on later engagement is or whether the nature of the relation between emotion regulation and engagement changes as children get older and the learning context becomes even less novel.

Implications and Conclusions

The current study provides evidence that learning engagement can successfully be assessed in a laboratory environment and that the current measure may be invariant from preschool-age through early elementary school. The current laboratory measure of learning engagement may therefore be a strong new assessment tool that can be added to the limited methodology of measuring children's engagement with learning. By establishing the strength of this measure, this study may specifically help make learning engagement research more accessible for investigators who do not already work within a school setting and therefore facilitate new lines of inquiry regarding the relations between learning engagement and other variables more easily measured in a lab. Moreover, this measure allows investigators to consider children's engagement with learning outside of the classroom context and under more standardized conditions. By examining learning engagement in different contexts and in relation to new variables, researchers can expand current understanding about the mechanisms that promote the development of learning engagement and the specific function of engagement in promoting children's learning and academic success.

The current study also helps describe the function of laboratory learning engagement in relation to both time and classroom learning processes. This not only has practical importance for future research, but also extends current theory about the construct of engagement as a whole. For example, this study provides further support for the general increase of engagement across the school transition and suggests that there are similarities between engagement across environmental context (i.e., the lab and the classroom) and level (i.e., behavioral and affective).

The importance of learning engagement in promoting academic success is also further supported by the current study, which found that engagement was concurrently and predictively associated with both academic performance and later engagement. Thus, children's engagement with learning, even before the beginning of formal schooling, may have enduring effects on school success. Although not measured by the current study, children's early ability to engage with learning tasks may continue to cyclically affect school success through its effects on not only academic performance itself but also classroom learning behaviors and, possibly, school attitude. This paper thus adds to the growing literature documenting the importance of learning engagement for academic achievement and school success and further supports the necessity of continued research on this construct.

This study has also demonstrated emotion regulation to be an important process facilitating the development of learning engagement. The results from this study support the promotive role of regulation by examining these constructs longitudinally across the transition to school and highlight the importance of early regulatory ability. The importance of emotion regulation is further underscored by its empirical effects on learning engagement in two different contexts, the classroom and the laboratory. As such, future educators, program officers, and policy makers may decide to focus on emotion regulation when considering ways to improve early engagement. This study specifically implicates emotion regulation during the preschool-age period as being critical for future engagement and therefore indicates that any intervention or prevention programming aimed at improving emotion regulation skills should occur at or before this time.

Altogether, this study extends current methodology and theory and may have the power to inform future policy. Extensions of the current work should continue to evaluate the ways in which learning engagement operates in different contexts and at different levels across age in order to improve our understanding about this multidimensional construct and the processes that underlie its development. Given the importance of learning engagement for academic outcomes, this research may help uncover valuable ways to promote active and successful learning among young children.

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APPENDIX A

CONDENSED LEARNING ENGAGEMENT VARIABLES

Data were recoded to limit sparse data at the end of the coding scale (see Table 13). A score of 1 and 2 were consolidated into a single score for attention to instructions, on-task behavior, enthusiasm/energy, persistence, and monitoring progress/strategy use, and the rest of the scale was adjusted. Scores were transformed as such: 1 = 1, 2 = 1, 3 = 2, 4 = 3, 5 = 4. For negative affect, original scores of 4 and 5 were consolidated into a single score labeled '4' and all other scores remained the same. See Table 14 for bivariate correlation among the newly calculated data.

Table 13. Descriptive Statistics of Learning Engagement, Recoded to Condense Sparse Data

	N	*ICC*	Min	Max	Mean	SD	Skew (SE)	Kurtosis (SE)
Preschool-age								
Attention to Instructions	278	.70	1	4	3.22	0.85	-0.86 (.15)	0 .00 (.29)
On-Task Behavior	278	.77	1	4	3.29	0.86	-1.01 (.15)	0.18 (.29)
Enthusiasm/Energy	277	.79	1	4	2.31	0.76	0.24 (.15)	-0.22 (.29)
Persistence	278	.84	1	4	2.89	1.00	-0.49 (.15)	-0.84 (.29)
Monitoring Progress/ Strategy Use	278	.83	1	4	2.87	0.85	-0.38 (.15)	-0.46 (.29)
Negative Affect	277	.82	1	4	1.76	0.87	0.96 (.15)	0.11 (.29)
Kindergarten								
Attention to Instructions	249	.84	1	4	3.39	0.65	-0.76 (.15)	0.34 (.31)
On-Task Behavior	249	.81	2	4	3.61	0.59	-1.24 (.15)	0.55 (.31)
Enthusiasm/Energy	249	.70	1	4	2.30	0.64	0.59 (.15)	0.52 (.31)
Persistence	249	.81	1	4	3.04	0.86	-0.57 (.15)	-0.37 (.31)
Monitoring Progress/ Strategy Use	249	.79	1	4	3.05	0.72	-0.4 (.15)	-0.01 (.31)
Negative Affect	249	.87	1	4	1.70	0.79	0.98 (.15)	0.48 (.31)
First grade								
Attention to Instructions	240	.71	1	4	3.44	0.77	-1.11 (.16)	0.17 (.31)
On-Task Behavior	240	.69	1	4	3.73	0.54	-2.05 (.16)	4.14 (.31)
Enthusiasm/Energy	240	.81	1	4	2.34	0.67	0.49 (.16)	0.25 (.31)
Persistence	240	.75	1	4	3.37	0.76	-1.08 (.16)	0.72 (.31)
Monitoring Progress/ Strategy Use	240	.70	1	4	3.39	0.69	-0.77 (.16)	-0.26 (.31)
Negative Affect	240	.97	1	4	1.53	0.74	1.21 (.16)	0.6 (.31)

Note: SE = Standard Error.

Table 14. Correlations Among Observed Learning Engagement Behaviors, Recoded to Condense Sparse Data

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Attention to Instructions (PS)	-																
2	On-Task Behavior (PS)	.49**	-															
3	Enthusiasm/Energy (PS)	.34**	.36**	-														
4	Persistence Score (PS)	.42**	.71**	.44**	-													
5	Monitoring/Strategy Use (PS)	.46**	.55**	.39**	.66**	-												
6	Negative Affect (PS)	-.31**	-.39**	-.32**	-.46**	-.37**	-											
7	Attention to Instructions (K)	.31**	.24**	.16*	.15*	.16*	-.13*	-										
8	On-Task Behavior (K)	.21**	.30**	.02	.20**	.25**	-.10	.28**	-									
9	Enthusiasm/Energy (K)	.21**	-.02	.28**	.11	.10	-.07	.22**	.05	-								
10	Persistence (K)	.13*	.15*	-.02	.18**	.19**	-.16**	.20**	.51**	.25**	-							
11	Monitoring/Strategy Use (K)	.14*	.12	.06	.17**	.21**	-.14*	.24**	.34**	.31**	.63**	-						
12	Negative Affect (K)	-.06	-.14*	.00	-.13*	-.09	.20**	-.24**	-.37**	-.14*	-.53**	-.42**	-					
13	Attention to Instructions (FG)	.22**	.36**	.05	.22**	.07	-.15*	.22**	.31**	-.11	.16*	.03	-.23**	-				
14	On-Task Behavior (FG)	.16*	.19**	.03	.16*	.11	-.10	.19**	.25**	-.05	.28**	.17**	-.31**	.51**	-			
15	Enthusiasm/Energy (FG)	.01	-.13*	.18**	-.02	-.01	.02	.03	-.13*	.33**	.06	.09	-.05	-.23**	-.13*	-		
16	Persistence (FG)	.18**	.23**	.18**	.25	.23**	-.11	.11	.33**	.10	.27**	.24**	-.30**	.28**	.48**	.17**	-	
17	Monitoring/Strategy Use (FG)	.31**	.16*	.17**	.23**	.32**	-.01	.15*	.27**	.12	.34**	.34**	-.15*	.16*	.31**	.18**	.49**	-
18	Negative Affect (FG)	-.07	-.15*	-.02	-.09	-.05	.09	-.12	-.27**	-.04	-.24**	-.22**	.40**	-.29**	-.37**	-.01	-.61**	-.33**

Note. PS = preschool-age, K = kindergarten, FG = first grade. * $p < .05$, ** $p < .01$.

APPENDIX B

POSITIVE AFFECT AND ENTHUSIASM/ENERGY AND EMOTION REGULATION

As the behavioral codes of positive affect and enthusiasm/energy did not fit onto the current learning engagement factor, it was decided to conduct ad hoc analyses to separately investigate how emotion regulation may be related to these behaviors. Positive affect and enthusiasm/energy were modeled as categorical variables, so WLSMV estimation was used. The model investigating the associations between positive affect and emotion regulation ($\chi^2(1) = 0.576$, $p = .45$; RMSEA = .000, 90% CI [.000, .144]; CFI = 1.00; SRMR = .009) revealed a marginal negative association between emotion regulation at preschool-age and positive affect in the laboratory at kindergarten ($B = -.16$, SE = .09, $p = .06$) and a significant negative correlation between emotion regulation and positive affect at kindergarten ($\psi = -.17$, SE = .04, $p < .001$) (see Figure 10). Thus, both preschool-age children and kindergarten children who were more emotionally well-regulated were less likely to positive affect in kindergarten than less emotionally well-regulated children. No other associations were significant. In this model, a direct path between positive affect at preschool-age and positive affect in first-grade was included, as model fit significantly improved when included.

In the enthusiasm/energy model ($\chi^2(4) = 3.143$, $p = .53$, RMSEA = .000, 90% CI [.000, .081] CFI = 1.000, SRMR = .023), no longitudinal associations between enthusiasm/energy and emotion regulation were significant. However, there was a significant negative association between enthusiasm/energy and emotion regulation in kindergarten (ψ = -.14, SE = .05, p = .005), suggesting that more emotionally well-regulated kindergarteners were less enthusiastic and energetic than their less well-regulated peers (see Figure 11).

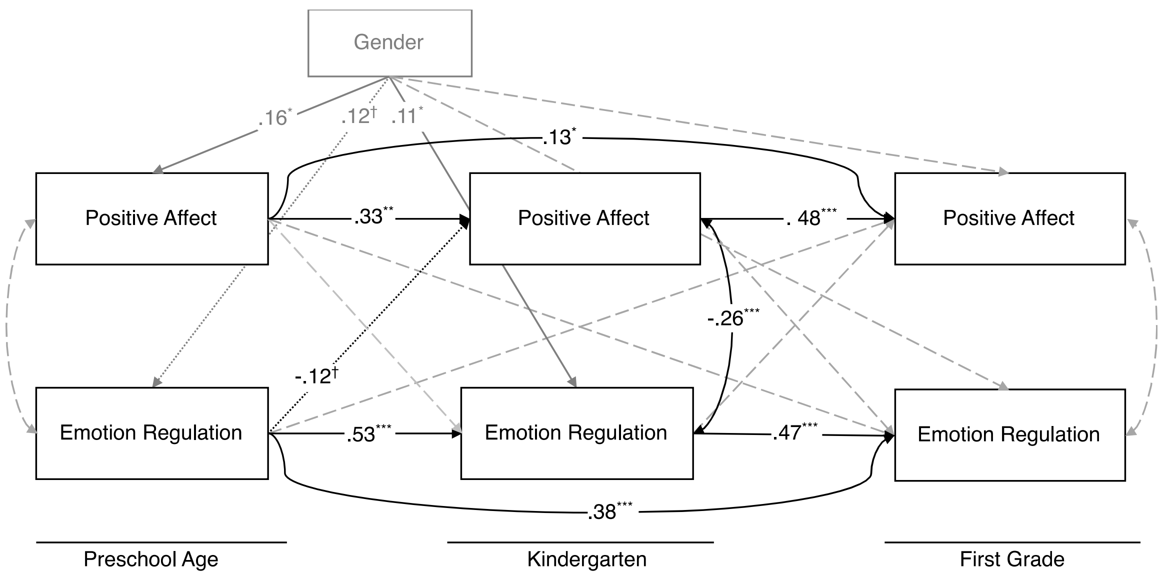

Figure 10. Model Testing the Longitudinal Associations Between Emotion Regulation and Expressed Positive Affect During a Laboratory Learning Task Across the School Transition. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths.
† p < .08, * p < .05. ** p < .01. *** p < .001.

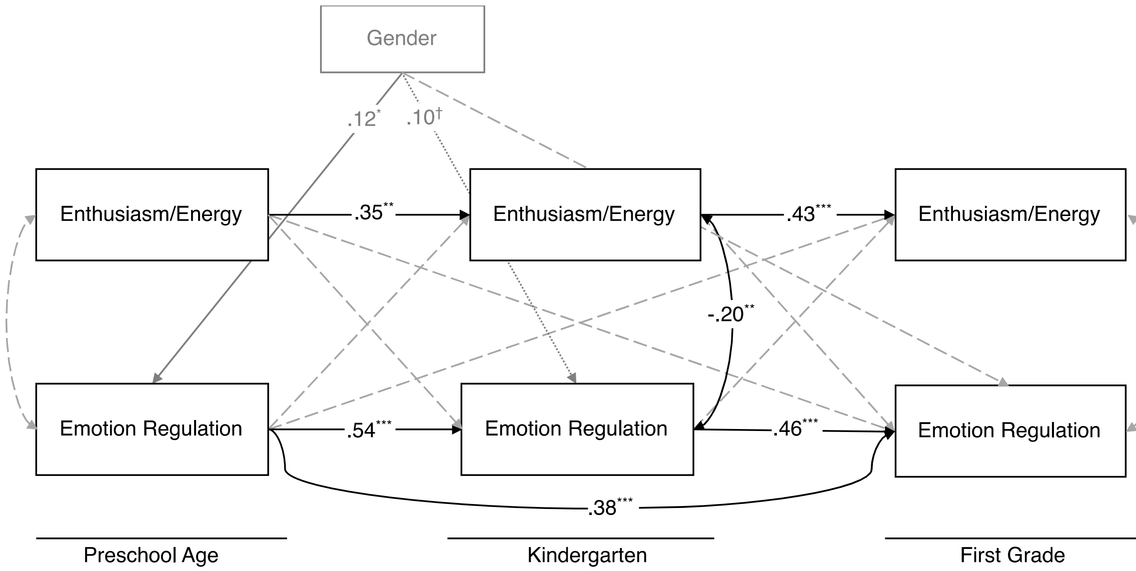

Figure 11. Model Testing the Longitudinal Associations Between Emotion Regulation and Enthusiasm/Energy During a Laboratory Learning Task Across the School Transition. Values are standardized coefficients (β). Solid lines reflect significant paths. Dotted lines reflect marginally significant paths. Dashed lines reflect statistically non-significant paths.
† $p < .08$, * $p < .05$. ** $p < .01$. *** $p < .001$.