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Author

Berzenski, Sara

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Adversity and Regulatory Processes in Preschool Children: Impact on Psychosocial Adjustment

A Dissertation submitted in partial satisfaction
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in

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by

Sara Rebecca Berzenski

June 2013

Dissertation Committee:
Dr. Tuppett M. Yates, Chairperson
Dr. Chandra A. Reynolds
Dr. Misaki N. Natsuaki

The Dissertation of Sara Rebecca Berzenski is approved:

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Committee Chairperson

University of California, Riverside

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Dedication

This dissertation is dedicated to my mother, Rachel Ragland, and my aunt, Miriam Giguere. They have been incredible role models, and embody what it means to be successful academic women and mothers. They inspire me every day and the amazing example they set continues to encourage me along this journey.

ABSTRACT OF THE DISSERTATION

Adversity and Regulatory Processes in Preschool Children:
Impact on Psychosocial Adjustment

by

Sara Rebecca Berzenski

Doctor of Philosophy, Graduate Program in Psychology
University of California, Riverside, June 2013
Dr. Tuppett M. Yates, Chairperson

The purpose of this investigation was to examine the development of self-regulation across preschool and early childhood, with an emphasis on identifying basic developmental processes, implications for adjustment, and contextual influences. Study 1 utilized a path analytic framework to assess longitudinal transactional relations between emotion and behavior regulation. Study 2 utilized a latent change analytic framework to assess the development of self-regulation and the influence of context. The use of these two complementary paradigms sought to clarify individual patterns of growth and stability, and to elucidate the mechanism behind potential cross domain effects.

Data were drawn from a diverse sample of 250 children who completed annual observational assessments of regulation during laboratory tasks at ages four, five, and six. Additional measures included parent report of adversity exposure, teacher report of social competence, internalizing problems, and externalizing problems, and laboratory-measured academic achievement.

Study 1 found modest stability of regulation across early childhood, and bidirectional prospective relations between emotion and behavior regulation. Better behavior regulation at age four predicted better emotion regulation at age six, while better emotion regulation at age five predicted better behavior regulation at age six. Each cross-domain longitudinal relation controlled for the stability of prior within-domain regulation and concurrent cross-domain relations. Behavior regulation evidenced direct relations with adjustment in multiple domains, with indirect effects of emotion regulation emerging through its effect on behavior regulation.

Study 2 found that emotion and behavior regulation evidenced different patterns of growth. Emotion regulation improved from age four to five, and remained relatively constant from age five to six. Furthermore, higher levels of cumulative adversity predicted a decrease in the slope of emotion regulation trajectories, such that children who experienced more adversity improved less in emotion regulation over time. There was no significant effect of adversity on initial levels of regulation. Although behavior regulation appeared to increase in a linear fashion, a latent change model could not be fit successfully, which precluded assessing the effect of adversity on behavior regulation, or interrelations between regulatory trajectories. Implications are for the development of context-sensitive interventions and increased specification of key domains of self-regulation in investigations.

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As the mechanism by which responses to situational demands are modulated, self-regulation figures prominently in how children negotiate developmental challenges, and, by extension, their current and prospective adaptation (Graziano, Keane, & Calkins, 2007; Graziano, Reavis, Keane, & Calkins, 2007; Porges, 1996). However, the transactional relations between regulatory systems across emotional and behavioral domains remain poorly defined, as do factors that influence regulatory coherence broadly. Given the central importance of dysregulation for the development and maintenance of many childhood disorders (P. M. Cole, Michel, & Teti, 1994), efforts to clarify the development and function of regulatory systems will inform practical applications focused on enhancing positive well-being and preventing maladjustment.

The current investigation examined relations within and across emotional and behavioral domains of self-regulation over time, and in relation to children's concurrent and prospective adjustment. Further, it evaluated the distinct influences of early deficits in children's environments (e.g., residential mobility) and caregiving relationships (e.g., child maltreatment) on the development of emotion and behavior regulation across the preschool period. Employing multiple methods and informants in a sample of 250 preschool children from diverse ethnic backgrounds and adversity contexts, this study is novel for its focus on the integration of regulatory systems across multiple domains, and for its examination of the influences of both environmental and relational factors on patterns of regulation and adaptation within and across time.

Consistent with an organizational perspective on development (Sroufe, 1979), difficulties mastering the early developmental task of self-regulation are likely to have cascading effects on the child's capacity to negotiate developmental issues at later points (e.g., inhibiting the formation of peer relationships in later childhood, which, for example, may affect later psychological health and academic achievement; Masten & Cicchetti, 2010; Masten et al., 2005). Because early regulatory abilities are increasingly important across time as a function of the cumulative nature of development (Sroufe, 1997), efforts to understand the development of self-regulation across early childhood are essential to fostering positive development and mental health across the life span.

Finally, guided by the tenets of developmental psychopathology, this study sought to evaluate the influence of adversity on the development of self-regulation. This perspective emphasizes that developmental processes are probabilistic and ordered, and that pathology is an outgrowth of normal developmental processes (Sroufe & Rutter, 1984). Thus, adversity may impact individual developmental trajectories and start points, but it does not fundamentally alter developmental processes themselves. Therefore, this investigation sought to understand generalizable developmental processes of emotion and behavior regulation while considering the influence of adversity on the way these processes unfold over time. In so doing, this investigation seeks to advance developmental science and inform the design and implementation of context sensitive interventions.

Emotion Regulation

Emotion regulation is the process of up- or down-modulating one's emotional response to a situation in an attempt to satisfy both interpersonal and intrapersonal goals (Thompson, 1994; Zeman, Cassano, Perry-Parrish, & Stegall, 2006). Emotion regulation involves the coordination of several integrated responses, including affective, cognitive, and physiological components, which together comprise both felt and expressed emotion (Denham, 1998). Successful regulation involves management of any or all these components such that one's felt and expressed emotion is of appropriate level and valence for a given situation.

Historically, emotion regulation has proven difficult to define, with theorists confusing cognitive and behavioral regulatory processes with emotion regulation (Zimmermann, 1999), or conflating emotion entirely with physiology (Bell & Deater-Deckard, 2007). Yet research has shown that it is more productive to view the broader construct of self-regulation multi-dimensionally, including explicit distinctions among emotional and behavioral domains of analysis (Maughan & Cicchetti, 2002; Raffaelli, Crockett, & Shen, 2005). Although emotion regulation involves some behavioral processes (e.g., controlling vocalizations), it is a separate construct from behavior regulation, which involves inhibiting one's behavior in accordance with situational demands (e.g., not playing with a toy when asked to wait), and can be differentiated based on the ultimate goal of the regulatory process (i.e., modulating an emotion versus a behavior). Therefore, while this investigation adopted an integrative view of the emotional response itself with regards to its component elements, care was taken to maintain and examine the distinction between emotion regulation and the separate process of behavior regulation.

The integrated emotional response is comprised of affective, cognitive, and physiological processes. The affective component of emotion regulation involves the manipulation of facial expression and vocal emotional displays in accordance with felt emotion and in consideration of social/display rules. Cognitive processes involved in emotion regulation include selective attention to and accurate appraisal of the emotionally challenging situation. The physiological component of emotion regulation involves arousal of the sympathetic and parasympathetic nervous system as well as neuroendocrine stress responses. While affective, cognitive, and physiological processes are all part of the emotion regulation process, each constitutes only one component of a multi-systemic and multi-level integrated regulatory response. Although it is important to examine specific facets of the emotion regulatory response, the present investigation evaluated emotion regulation as a fully integrated response, while acknowledging that doing so precluded the ability to evaluate the distinct affective, cognitive, and physiological facets of emotion regulation. In future research, the distinct contributions of these constituent elements and the coordinated mechanisms by which regulation occurs and is integrated at each stage of this model will be explored.

Some researchers have argued that the experience of emotion is inseparable from the regulation of emotion, and that the activation of emotion itself implies that emotion is being regulated (Campos, Frankel, & Camras, 2004). These researchers posit that it is purely theoretical to identify and measure a construct labeled emotion regulation as distinct from emotion activation. However, others maintain that there is a distinction between experiencing emotion and regulating it (P. M. Cole, Martin, & Dennis, 2004). Regardless of whether this distinction can be captured in real time, both camps agree that there is utility in investigating the regulation of emotion and in identifying mechanisms and potential deficits in this process. Thompson (2008) stresses that it is possible to do this without having to make explicit the separate activational and regulatory actions taken by the system. Challenge conditions offer an ideal context for studying emotion regulation because regulation in this context entails both activation and modification of an arousal state. That is, while challenge conditions are not the only contexts in which emotion regulation occurs, they are the most salient and practical conditions in which one can identify inter-individual variations in emotion regulation. Therefore, the present analyses evaluated children's emotion regulation in response to laboratory challenges.

The Development of Emotion Regulation

The development of emotion regulation capabilities stems from both individual and environmental factors. Broadly, the ability to manage one's emotional responses improves over the course of childhood, with coping strategies shifting over development to facilitate this transition (Saarni, 1990). State regulation and the regulation of sleep-wake cycles emerge in early infancy (Fox & Calkins, 2003). During this time, emotion regulation efforts center on self-soothing strategies, as well as distraction and parental monitoring (Denham, 1998; Manian & Bornstein, 2009). With age and the emergence of language, emotion regulation strategies become increasingly social and verbal, less dependent on parental co-regulation, and less purely focused on goal fulfillment

(Denham, 1998; Saarni, 1990; Thompson et al., 2008). The acquisition of display rule knowledge increases emotion regulation resources in middle childhood (Zeman et al., 2006), while the increasing cognitive ability of older children enables self-reflective regulatory strategies such as reappraisal (Denham, 1998).

Longitudinal research on emotion regulation trajectories has been limited. Early research on emotional 'dynamics' which included regulatory as well as activational components, such as emotionality, indicated that while dispositional emotionality evidences moderate stability across infancy, the stability of *regulation* (i.e., persistence of negative affect) is more variable, particularly outside the first few years of life (Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999; Thompson, 1990). Although some research suggests that rank order differences in emotion regulation may be moderately stable across early childhood (Raffaelli et al., 2005; Rydell, Berlin, & Bohlin, 2003), and that group mean levels increase over time (Raffaelli et al., 2005), these studies have focused on parent reports of children's capabilities. Other perspectives suggest that owing to the broad range of factors influencing the development of emotion regulation over early childhood, emotion regulation may be only weakly stable across time (Thompson et al., 2008). Therefore, there remains a need for prospective research designs employing longitudinal observational measurements of emotion regulation capabilities to address both continuity of mean levels and individual rank order stability across early childhood.

The development of emotion regulation capabilities is influenced by intrinsic factors including biological reactivity, neural function, and cognition. Therefore, maturation and the increasing stability of biological stress response systems may partially account for the appearance of consistent emotion regulation patterns over development (Calkins, 1994; Thompson et al., 2008; Zeman et al., 2006). Biological reactivity in both hormonal and cardiovascular domains may underlie emotion regulation (Blandon, Calkins, Keane, & O'Brien, 2008; Stansbury & Gunnar, 1994) and/or emotion reactivity (Rothbart & Sheese, 2007). In addition, the neurological basis of emotion regulation development involves increasing cortical control of motivational systems and emotional expression (Beer & Lombardo, 2007; Bell & Deater-Deckard, 2007), as well as attentional processes (Ochsner & Gross, 2007). Finally, cognitive development across childhood may affect not only the types of emotion regulation strategies used, but also the overall ability to regulate emotion (Calkins, 1994). Cognition is intricately involved in emotion regulation, from initial appraisal and interpretation of the emotionally arousing situation, to understanding display rules, to effortful control of emotions, and finally to the aforementioned ability to access and enact appropriate emotion regulation strategies.

Importantly, these maturational factors interact with experiential and contextual factors (particularly caregiving) in the development of emotion regulation (Calkins, 1994). Early experiences with caregivers may shape several of the biological influences mentioned in the previous section, including cardiovascular and neuroendocrine responses (Calkins & Hill, 2007). In addition, caregiving has direct effects on the development of emotion regulation, through several pathways. First, the emerging attachment relationship may serve to introduce, reinforce, or undermine developing emotion regulation strategies and capabilities, as the child forms expectations of others' responses to her/his emotional needs, as well as of her/his capacity to signal those needs effectively (Calkins & Hill, 2007). The integration of positive and negative experiences that follows from developing a secure attachment relationship with a caregiver is crucial to the ability to successfully modulate emotional responses (Cassidy, 1994). Furthermore, the breadth and degree of challenging experiences children encounter gives them a chance to explore different emotion regulation strategies in varied contexts (Pollak, Cicchetti, Hornung, & Reed, 2000; Raikes, Robinson, Bradley, Raikes, & Ayoub, 2007). Finally, parent socialization of emotion regulation can occur directly through parent coaching and parent feedback regarding the child's emotions, as well as indirectly through the child's observation of parents and the overall emotional climate of the family (Morris, Silk, Steinberg, Myers, & Robinson, 2007; Thompson & Meyer, 2007; Zeman et al., 2006). Thus, the caregiving context influences the child's early attempts and competence at emotion regulation, including whether the child develops a regulatory style oriented toward engagement or withdrawal in challenging situations (Kopp, 1986), and the child's overall ability to successfully regulate emotions.

The Development of Emotion Regulation in Adversity

Just as sensitive and responsive caregiving and broader contexts of safety and security engender the positive development of emotion regulation, so, too, do insensitive caregiving and adverse contexts undermine emotion regulation across multiple levels. Adversity can affect biological reactivity and regulatory systems, which, as noted earlier, form the basis for emotion regulation capabilities. A meta-analysis found that stressful experiences predicted flattened diurnal rhythms of the stress hormone, cortisol, yielding lower morning levels and less of a decline throughout the day (Miller, Chen, & Zhou, 2007). Adversity-induced alterations in cortisol rhythms may have particular salience for the experience of maltreatment in childhood, as these maladaptive patterns of biological responding may influence the development of emotion regulation at precisely the time when the child needs to practice appropriate emotional responding (i.e., times of great emotional challenge). In addition to outright maltreatment (Krause, Mendelson, & Lynch, 2003), other types of relational adversity, such as harsh parenting (L. Chang, Schwartz, Dodge, & McBride-Chang, 2003), marital discord (Porter, Wouden-Miller, Silva, & Porter, 2003), and maternal psychopathology (Blandon et al., 2008) may negatively influence biological systems and subsequent emotion regulation.

Adversity may also exert effects on the development of emotion regulation by affecting cognitive processing (Peterson & Park, 2007). Research has documented the influence of maltreatment on cognitive processes, for example, through self-blaming cognitions (Alessandri & Lewis, 1996).

Finally, previous research has shown that other adverse factors such as prematurity and low birth weight can affect emotion regulation (Clark, Woodward, Horwood, & Moor, 2008; Doussard-Roosevelt, Porges, Scanlon, Alemi, & Scanlon, 1997), with environmental adversity (e.g., poverty) being particularly detrimental to regulatory development (H. Chang, Shelleby, Cheong, & Shaw, 2012; Raver, 2004). Of course, these environmental effects may also be tied to biological influences (Kidwell & Barnett, 2007).

Beyond direct effects, childhood adversity can affect emotion regulation development indirectly by altering the context in which it develops. For example, adversity may influence the breadth and quality of experiences and stimulation provided to the developing child. In the context of appropriate amounts of challenge, the child has a chance to explore different emotions and practice different strategies by which they might be regulated. Too much challenge and the child may become overwhelmed such that coping becomes focused on emotional ‘survival,’ rather than regulation. Too little challenge, or too little exposure to emotion provoking situations, and the child may not have the opportunity to test out strategies and expression patterns, nor will s/he encounter appropriate models of others expressing emotions from which to learn (Trickett, 1998). Others have suggested that maltreatment may limit the number of adaptive coping strategies to which a child is exposed, and/or may interfere with a child’s goals and expected contingencies for emotion expression (Shipman & Zeman, 2001; Shipman, Zeman, Penza, & Champion, 2000).

Finally, adversity may exert a direct effect on the development of emotion regulation in the caregiving domain. Emotion coaching involves discourse between parents and children about emotion, in which children explore possible solutions and are educated about appropriate ways of responding and expressing emotion. Research shows that, relative to non-maltreating mothers, maltreating mothers are less able to come up with flexible and appropriate strategies for emotion regulation, and have less understanding about why children display certain emotions (Shipman & Zeman, 2001). Parents’ emotional reactions toward their child comprise another important piece of the emotion socialization puzzle, one which is particularly vulnerable to adversity in early caregiving. Beginning in infancy, parents' contingent reactions to children's distress shape the types of emotion regulation strategies children adopt. For example, Manian and Bornstein (2009) found that infants of depressed mothers used self-soothing strategies in response to their own negative affect, while infants of non-depressed mothers attempted to signal mothers and sought regulatory assistance from mothers. Children of maltreating mothers report that they are less likely to show emotional displays to parents, and that they expect less support and more hostility following such displays, whereas children of neglectful mothers report more use of avoidance strategies (Shipman, Edwards, Brown, Swisher, & Jennings, 2005; Shipman & Zeman, 2001). Finally, children who have been exposed to domestic violence may use more emotion focused coping because problem-focused coping has proved ineffective in the home environment (Katz, Hessler, & Annest, 2007). Taken together, these findings suggest that the development of emotion competence is composed of multiple interactive intrinsic and contextual factors, and is vulnerable to deviations from the expectable caregiving environment in biological, cognitive, experiential, and socializing domains.

Emotion Regulation and Adjustment

Effective emotion regulation has been linked to competent functioning and adjustment in numerous domains across childhood. In accordance with an organizational perspective on development, emotion regulation skills constitute a core developmental acquisition that underlies the mastery of other key skills later in childhood (Maughan & Cicchetti, 2002; Sroufe, 1979). As such, emotion dysregulation and increased negative affectivity have been linked to a range of difficulties across childhood and into adulthood, including fewer and more problematic peer relationships (Eisenberg, Fabes, Guthrie, & Reiser, 2000; Eisenberg et al., 2001; English, John, Srivastava, & Gross, 2012; Shields, Ryan, & Cicchetti, 2001) and increased behavior problems (Batum & Yagmurlu, 2007). Children who are unable to manage their emotions in accordance with social norms and display rules are more vulnerable to inappropriate social interactions and have difficulty forming normative social bonds with peers. In addition, less sophisticated emotion regulation strategies, such as aggression, are associated with fewer and worse peer relationships (Asher & Rose, 1997). Both internalizing and externalizing psychopathology may follow from over-control and under-control of emotional responses, respectively (Plutchik, 1993). Maladaptive emotion regulation strategies are also linked to later psychopathology, including depression (Zeman et al., 2006), eating disorders (Zeman et al., 2006), ADHD (Mullin & Hinshaw, 2007), substance abuse (Sher & Grekin, 2007), and stress-related health problems (Sapolsky, 2007).

Behavior Regulation

Behavior regulation refers to modulating actions in response to a stressful or challenging situation to conform to situational/goal-oriented demands. Although behavior regulation often follows the emotional and cognitive appraisal of a situation (Batum & Yagmurlu, 2007), a challenge may have emotional content (e.g., waiting one's turn to play), or may be purely behavioral or attentional in nature (e.g., drawing or walking a line slowly). In either case, behavior regulation refers to attempts to control behavioral responses (i.e., actions), not emotional responses.

Researchers have identified several constructs related to behavior regulation. Inhibitory control describes the suppression of a dominant response in favor of a subdominant response (Kochanska, Murray, & Harlan, 2000), and is therefore the component that most clearly captures behavior *regulation*. However, more specific components of the inhibitory response can also be measured, such as effortful control/attention, which taps biological capacities and temperamental proclivities that partially underlie these behaviors (Kochanska et al., 2000). Impulsivity is a dispositional characteristic reflecting the speed of response initiation (Kochanska et al., 2000; Rothbart, Ahadi, Hershey, & Fisher, 2001), and therefore more closely aligned with behavioral reactivity than regulation. As in the emotion regulation domain, the specific facets of behavior regulation and related capacities are important to examine in their own right. However, the present study focused on inhibitory control as the most precise indicator of behavior regulation, while maintaining the distinction between behavior and emotion regulation.

The Development of Behavior Regulation

Behavior regulation capacities generally increase with age, as children shift from primarily external controls on their behavior in infancy to self-control in childhood, and increasingly refine their abilities to control their own behavior (Karreman, van Tuijl, van Aken, & Dekovic, 2006; Raffaelli et al., 2005). Infants' abilities to control their behavior are limited to the modulation of neurological and sensorimotor responses to environmental inputs. In the second and third years of life, however, toddlers become increasingly able to control their behaviors, and to use language as a medium for self-control (Pine, 1985). As described here, however, behavioral regulation in terms of suppressing a dominant response in favor of a subordinate response does not begin to emerge until age three (Kopp, 1982; Posner & Rothbart, 2000).

Children's increasing ability to understand discriminative cues beginning at age three facilitates the development of inhibitory control. However, while young children can begin to understand the required response in discriminative tasks, there remains a disconnect between understanding and behavior (Bell & Livesey,1985). The ability to integrate appropriate behavioral responses with discriminative knowledge develops between ages four and five, as a function of both neurological development and exposure to complex rule implementation (i.e., dominant and subdominant response performance) (Dowsett & Livesey, 2000). A few key life-span investigations of inhibitory control employing cross-sectional designs indicate that this capability continues to increase across early and middle childhood, and well into adolescence. Peak capacities for inhibitory control are attained in adolescence and adulthood, with capabilities declining again in older adulthood (Bedard et al., 2002; Williams, Ponesse, Schachar, Logan, & Tannock, 1999). However, other cross-sectional research suggests that different types of inhibitory control tasks may reflect different capacities (e.g., activation versus inhibition of responses), some of which do not exhibit developmental gains across childhood (Band, Van der Molen, Overtoom, & Verbaten, 2000; Schachar & Logan, 1990). Yet, prospective longitudinal investigations using both observational and parent and teacher report of inhibitory control strongly suggest that behavior regulation increases across toddlerhood and into early childhood, and that individual differences are highly stable

(Kochanska, Coy, & Murray, 2001; Kochanska, Murray, & Coy, 1997; Murphy et al., 1999; Raffaelli et al., 2005).

Behavior regulation is intimately tied to the development of multiple neurobiological systems. Capacities for effortful control, for example, follow directly from constitutional and experiential influences on neural development, and several domain general biological processes including attention, executive functioning, and working memory partially drive behavior regulation (Blair & Ursache, 2011; Kochanska et al., 2000; Kopp, 1982; Rueda, Posner, & Rothbart, 2011). Consistent with broader models of neural plasticity, changes in brain structure over development accompany transitions in attention and other related abilities (Bell & Deater-Deckard, 2007; Posner & Rothbart, 2000). Development of both the prefrontal cortex and the hippocampal region underlie gains in these areas (Diamond, 1988).

Research showing that behavior regulation abilities increasingly cohere across distinct tasks and skills with advancing age supports the notion that these capabilities are in part maturationally driven (Kochanska et al., 2000). Evidence that attention abilities, even in infancy, predict later effortful control (Kochanska et al., 2000), supports the idea that domain general biological functioning influences the development of several constructs related to behavior regulation. Working memory is similarly implicated in behavior regulation, with inhibitory control deficits potentially reflecting in part a failure of the working memory system to maintain goal-directed motivation (Hofmann, Friese, Schmeichel, & Baddeley, 2011). Biological influences, particularly in cortical function, are readily demonstrated in the development of executive functioning. However, while executive functioning exerts a complex, perhaps bidirectional, influence on behavior regulation, it remains a highly distinct process (Blair & Ursache, 2011). The idea that domain general biological processes contribute to, but are not synonymous with, behavior regulation, suggests an additional contribution of experience to the development of behavior regulation.

Mounting evidence indicates that behavior regulation is also affected by external factors. Training studies demonstrate that structured practice can improve behavior regulation, even in children too young to have fully developed neural function in underlying areas (Dowsett & Livesey, 2000). Research on parenting demonstrates that maternal responsiveness predicts the development of effortful control over time (Kochanska, Aksan, Prisco, & Adams, 2008; Kochanska et al., 2000), whereas maternal over-control and intrusion may undermine the development of behavior regulation, above and beyond child effects on parenting (Calkins, Smith, Gill, & Johnson, 1998; Silverman & Ragusa, 1992). Beyond the mother-child relationship, social support in other relationships has demonstrated relations with central features of behavior regulation, such as goal selection and maintenance, as well as with inhibitory control through the enhancement of psychological resources and subsequent capacity for self-regulatory functioning (Finkel & Fitzsimons, 2011). Finally, a growing body of research points to the indirect role of contextual factors, such as early caregiving, on the development of behavior regulation, through their demonstrated influence on underlying biological processes (e.g., neuroendocrine processes; Boyce & Ellis, 2005).

The Development of Behavior Regulation in Adversity

Childhood experiences of various types of adversity can influence behavior regulation via biological and/or contextual mechanisms. Childhood adversity may affect behavior regulation capabilities through physiological pathways, which is consistent with a corpus of research suggesting that adversity affects physiology (Bugental, Martorell, & Barraza, 2003; Cicchetti & Valentino, 2006; Clark et al., 2008; Doussard-Roosevelt et al., 1997; Miller et al., 2007), and with research linking biological dysregulation and behavioral dysregulation (Blair, 2003; Calkins, 1997; Calkins et al., 1998). For example, disruptions in cortisol, such as those that can occur as a result of maltreatment (Miller et al., 2007), are related to deficits in inhibitory control (Lyons, Lopez, Yang, & Schatzberg, 2000). Several studies have also demonstrated that childhood trauma may be related to impulsivity in adulthood (Berzenski & Yates, 2010; Corstorphine, Waller, Lawson, & Ganis, 2007; Roy, 2005). While multiple pathways likely explain this broad relation, neurological effects have been implicated in adversity related variations in impulsivity (Meyer-Lindenberg et al., 2006). Furthermore, differential patterns of brain activity related to inhibitory control have emerged in studies of foster youth (Fisher, Bruce, & Abdullaev, 2011; Mueller et al., 2010), and inhibitory control deficits have also been demonstrated in studies of prenatal substance exposure (Derauf et al., 2012; Lambert & Bauer, 2012).

Although overlooked by some researchers, the neurobiology of behavior regulation may emerge from the joint effects of biology and maladaptive contextual influences. Consistent with the contextual influences on behavior regulation described earlier, over-controlled parenting can have mixed effects on behavior regulation (Calkins et al., 1998; Karreman et al., 2006; Silverman & Ragusa, 1992), suggesting that perhaps some degree of control can be positive for the development of behavior regulation, while too much may undermine attempts to control child behavior and actually decrease children's behavior regulation abilities. Research has also demonstrated relations between parental depression, coercive parenting, and family adjustment on children's developing effortful control (Gartstein & Fagot, 2003).

Behavior Regulation and Adjustment

Behavior regulation is a core competency that develops in early childhood and affects the child's abilities to negotiate subsequent developmental challenges. Inability to adequately control behavior can have consequences in interrelated behavioral, academic, and peer domains. Specifically, behavior regulation deficits have been linked to psychopathology (e.g., ADHD, substance abuse, compulsive behaviors) (Barkley, 2011; Faber & Vohs, 2011; Sayette & Griffin, 2011; Silverman & Ragusa, 1992), overall well-being (Buckner, Mezzacappa, & Beardslee, 2003), and externalizing behavior problems (Eisenberg, Guthrie, et al., 2000). Behavior regulation can also influence peer relationships in numerous domains (Eisenberg et al., 1993; Oberle & Schonert-Reichl, 2012; Shields, Cicchetti, & Ryan, 1994), including appropriateness of interpersonal interactions and disclosures, goal directed behaviors, and particular behavior regulation strategies (e.g., approach and avoidance) (Fitzsimons & Finkel, 2011). Further, behavior regulation evidences strong positive associations with teacher-student relationship quality and academic performance (Berry, 2012).

Transactional Relations between Regulatory Domains

As noted, few studies examine multiple types of regulation, let alone the relations between them. Still fewer examine these relations longitudinally to evaluate predictive relations over time. Addressing these gaps in the literature, the current investigation explored if and how deficits at one age or in one domain of regulation could affect both contemporaneous and prospective functioning in the other domain to yield an integrated model of emotional and behavioral regulatory functioning across early childhood.

The few studies that have examined relations between concurrent emotion and behavior regulation have yielded mixed results, with most finding a positive relation (Carlson & Wang, 2007; Raffaelli et al., 2005; Santucci et al., 2008; Walcott & Landau, 2004), but others not (Calkins et al., 1998; Hinshaw, 2003). Findings from one cross-sectional study suggested that the concurrent relation between emotion and behavior regulation may become stronger with age across the preschool period (ages three to five) (Kalpidou, Power, Cherry, & Gottfried, 2004). Some research has suggested that the relation between emotion and behavior regulation may be more complex, with adaption in one domain acting as a protective factor for deficits in another (Batum & Yagmurlu, 2007; Eisenberg, Fabes, et al., 2000). Still other evidence suggests that emotion and behavior regulation have independent effects on competence (Shields et al., 1994), and that their direct effects on adjustment may be equally strong, at least in the domains of behavior problems and social competence (Batum & Yagmurlu, 2007; Shields et al., 1994). However, in the absence of prospective longitudinal investigations, such as the current study, it is unclear whether these regulatory abilities influence each other, or whether they develop independently at a similar rate and from similar contributing factors (Carlson & Wang, 2007). The mixed evidence in extant research informs competing theories about the relation between emotion and behavior regulation over time.

First, emotion and behavior regulation may evidence concurrent relations because they are both related to a common antecedent but remain independent capabilities with distinct relations to adversity and adjustment over time. This model is supported by research that does not find relations between emotion and behavior regulation (Calkins et al., 1998; Hinshaw, 2003), as well as by evidence of independent effects of these regulatory capabilities on competence (Shields et al., 1994). Research suggests that emotion and behavior regulation share physiological and neurobiological components, including attention, cardiac regulation, and executive functioning (Bell & Deater-Deckard, 2007; Calkins, 1994; Kochanska et al., 2000; Posner & Rothbart, 2000). However, longitudinal methods are necessary to determine whether this underlying structure fully explains the relation between emotion and behavior regulation, or whether there may also be predictive or reciprocal influences between regulatory dimensions.

Second, while emotion and behavior regulation may share antecedent conditions that contribute to their concurrent associations, emotion regulation abilities may also actively contribute to behavior regulation abilities over time. This view draws on the emotional experience itself, asserting that feeling states precede the actions or behaviors that are dictated by those feeling states. Successful regulation of emotion during a challenge (e.g., disappointment) should preclude the need for regulation of behavior. This model is informed, in part, by Zelazo and Cunningham's (2007) regulation model in which the nature of the reciprocal relation between emotion and behavior regulation depends on the nature of the task (i.e., whether it contains an emotional challenge or not). Many challenging tasks that school-age children face may be thought of as simultaneous emotional and behavioral challenges, with emotion embedded in behaviorally demanding situations (Calkins & Hill, 2007). The model predicts that high levels of emotion regulation should contribute to higher levels of behavior regulation at a later time point because effective emotion regulation reduces contextual demands for behavior regulation when emotional elements are adequately controlled. That is, once emotion regulation has developed, future behavior regulation skills can be developed more easily, in less challenging contexts. In support of this assertion, one study found that participating in a frustration task (and thus, attempting to regulate emotion) in between administrations of a behavioral inhibition task was associated with improvements in behavior regulation performance on that task (Walcott & Landau, 2004). Although that study provides some support for the idea that emotion and behavior regulation capabilities draw on related, if not shared, skills, and provides a hint about temporal sequencing, it did not address the underlying developmental question about the direction of these effects. Meanwhile, other recent work has identified effects of early emotion regulation on later executive functioning capabilities, specifically among children high in emotional reactivity (Ursache, Blair, Stifter, & Voegtline, 2013). This work strongly supports the hypothesis that emotion regulation may contribute to behavior regulation broadly.

Third, despite the role of common antecedents, it may be that behavior regulation contributes to emotion regulation over time. This theory reflects the idea that regulation of emotion requires effortful/inhibitory control skills (e.g., to internalize expressive rules to regulate affect and suppress negative feeling states) (Eisenberg, Hofer, & Vaughan, 2007). For example, research on infant control of affective displays indicates that developing attention and control mechanisms are core capabilities in affect regulation (Tronick, Als, & Brazelton, 1977), and that working memory intervention may actually improve affective control (Schweizer, Grahn, Hampshire, Mobbs, & Dalgleish, 2013). This theory is reflected in research that examines the integrated nature of effortful control and emotion regulation abilities (Carlson & Wang, 2007), however, once again, this relation has not been tested over time. The proposed study is among the first to advance beyond presumed bidirectional regulatory influences over time (Carlson & Wang, 2007), to evaluate these competing models of parallel or directional effects.

Aims and Hypotheses

The present study sought to address the development of and transactional relations between emotion and behavior regulation across the preschool and early childhood period. Furthermore, it sought to investigate how these pathways impact child adjustment and if and how they may be influenced by early adversity. In answering these questions, this examination utilized two complementary analytic frameworks: path analysis and growth curve/latent change analysis. As such, the analyses undertaken herein are framed as two progressive investigations: Study 1 and Study 2.

Study 1 Aims

Study 1 investigated the underlying relations between emotion and behavior regulation across development to document transactional influences among these capabilities. In addition, the present design evaluated the longitudinal stability of emotion and behavior regulation capabilities, and their relations to adjustment. Consistent with the idea that adversity should not fundamentally alter the process of development itself, the evaluation of which was the focus of Study 1, adversity exposure was not examined in this study.

Hypothesis 1. Both emotion and behavior regulation were expected to evidence stability across the preschool period, such that individuals were expected to maintain rank order over time. However, owing to individual differences in the development of these capabilities, the constellation of factors that influence their development, and the equivocal prior evidence, stability coefficients were expected to be modest. Overall, behavior regulation was predicted to evidence more stability than emotion regulation.

Hypothesis 2. Consistent with the preponderance of cross-sectional work discussed earlier, emotion and behavior regulation were expected to be correlated within time points.

Hypothesis 3. Emotion and behavior regulation were expected to evidence predictive relations over time. This investigation evaluated the competing theories described above to determine whether emotion regulation predicted behavior regulation at later time points, behavior regulation predicted emotion regulation at later time points, both, or neither.

Hypothesis 4. Direct and indirect effects of emotion and behavior regulation (depending on predictive directionality revealed in the evaluation of hypothesis 3) were expected to predict adjustment in several domains across time, beyond the influence of adjustment at prior time points. These relations were expected to vary by domain of adjustment assessed (i.e., psychopathology, conduct, social competence, academic competence). However, as both emotion and behavior regulation have demonstrated relations in prior studies with each domain of adjustment, and are rarely compared in the same sample, no specific hypotheses were offered regarding these differential relations.

Study 2 Aims

Study 2 explored developmental relations between emotion and behavior regulation by adopting a latent change analysis framework. These analyses sought to document rates of growth in emotion and behavior regulation, as well as whether early capabilities in one regulatory domain predicted rates of growth or change in the other domain. Further, this study sought to investigate the ways in which initial levels and rates of change were predictive of later adjustment, and how each was influenced by early adversity. These hypotheses were informed by the ways in which regulatory abilities at early ages may not only engender concurrent and prospective competence, but also opportunities to develop competence and to enhance those skills at faster rates with these increasing opportunities.

Hypothesis 1. Emotion and behavior regulation were each expected to be discontinuous and to improve (increase) over time. However, assessing the rate/shape of growth between time points was exploratory, owing to the dearth of short term longitudinal research on these capabilities during the preschool period.

Hypothesis 2. Owing to the developmental advantage conferred by early mastery of core competencies, such as regulation, initial levels of emotion regulation were expected to predict the rate of growth of behavior regulation. Similarly, initial levels of behavior regulation were expected to predict the rate of growth of emotion regulation. However, comparison of these two effects sought to further evaluate the directionality of the relations between emotion and behavior regulation across development proposed in Study 1.

Hypothesis 3. Initial levels and the rate of growth of emotion and behavior regulation were expected to predict later adjustment in multiple domains.

Hypothesis 4. Adversity exposure was hypothesized to relate to lower initial levels of emotion regulation and behavior regulation, as well as to decreased rates of growth in these capabilities over time. Owing to the salience of caregiving experiences for the development of regulatory abilities, as well as the understanding that environmental adversity often co-occurs in cases of relational adversity (and not as consistently vice versa), relational adversity was expected to be more detrimental to both initial levels and growth trajectories of regulation.

Method

Participants

This study employed a community sample of 250 four-year-old children (mean age at Time 1 = 49.05 months, *SD* = 2.91; 50% female) and their primary caregivers who were 91.4% biological mothers, 3.6% foster/adoptive mothers, and 5% grandmothers or other kin caregivers. Children were ethnoracially diverse with 46% identified as

Hispanic, 18.4% as Black, 11.2% as White, .4% as Asian, and 24.0% as Multiracial.[1] Within each ethnic group, 35.7% - 41.3% of families resided below the poverty line (U.S. Census Bureau Housing and Household Economics Statistics Division, 2007), and 63.9% - 73.9% of families were eligible to receive some type of government aid (e.g., food stamps). At age five, 215 families participated in the assessment (mean age at Time 2 = 61.93 months, *SD* = 2.45; 48.8% female). At age six, 215 families participated in the assessment (mean age at Time 3 = 73.30 months, *SD* = 2.51; 49.3% female). At age seven, 181 families had participated in the assessment at the time of the study (mean age at Time 4 = 85.34 months, *SD* = 2.37; 50.7% female). Although several families had difficulty scheduling an appointment within the appropriate age window for one or more time points, 233 families contributed at least two data points to the current analyses.

Procedures

Families were recruited via flyers and advertisements distributed to local child care centers, including those that target economically disadvantaged and ethnically under-represented families (e.g., Head Start, Family Services Association). Flyers invited families to participate in a “study of children’s learning and development” in exchange for $25 per hour and a small gift for the child. Potential participants were screened by phone to ensure that the child was 1) between 3.9 and 4.6 months of age, 2) proficient in English, and 3) not diagnosed with developmental disabilities or delays. There were no other exclusionary criteria.

[1] Previous published reports on this sample utilized data based on Time 1 parent report of child’s race. This differs slightly from the more specific information gathered at later time points which revealed a larger percentage of children to be multiracial, resulting in the final racial breakdown determined above.

At each time point, child-caregiver dyads completed a three to four hour laboratory assessment and teachers completed questionnaire data by mail approximately three months later, for a small honorarium. Teacher questionnaires were sent a minimum of one month following the child's entry into the classroom, so that the teacher had sufficient time to become familiar with the child's behavior. Laboratory assessments consisted of measures with the child, the caregiver, and the caregiver and child interacting. All procedures were approved by the University's Human Research Review Board. Informed consent was obtained from the child's legal guardian at the time of each laboratory visit.

Measures

Regulation. Assessments of emotion and behavior regulation were obtained at each time using age-appropriate and well-validated laboratory tasks. The scoring of emotion and behavior regulation at each time point involved observational coding done by a team of trained coders. Groups of two or more coders independently rated each participant and then met to agree upon a set of consensus codes. Coding groups were rotated every 20 cases to minimize drift.

***Emotion regulation*.** Assessment of emotion regulation at age four involved a disappointment task (P. M. Cole, Zahn-Waxler, & Smith, 1994), in which the child was shown a bag of attractive toys s/he would receive, but was then given an empty bag to open instead. This task lasted for two minutes: one with the examiner absent from the room, after delivering the empty bag, and one with the examiner present but non-responsive to the child. Assessment of emotion regulation during the age five visit involved a five-minute frustration task (Rubin, Cheah, & Fox, 2001), in which the child was asked to build an extremely difficult Tinkertoy© model with the caregiver present but non-responsive to the child. Assessment of emotion regulation at age six paralleled the disappointing gift task at age four, with the exception that the disappointing gift was a broken toy, rather than an empty bag.

Coding. Emotion regulation was indicated by coding the presence of any type of negative affect (sadness, anger, fear, disgust) in each 10 second interval, and calculating the duration of negative affect during the task (i.e., how many intervals contained negative affect) (age four $\alpha = .861$; age five $\alpha = .925$; age six $\alpha = .881$). Discrete emotions were identified by both facial expression and vocalizations using indicators detailed in the original disappointment paradigm, which defined emotion dysregulation as the duration of expressed negative affect (P. M. Cole, Zahn-Waxler, et al., 1994). See Appendix A for an excerpt from the emotion regulation coding sheets.

To account for the differences in length of emotion regulation tasks at different ages, durations of negative affect were converted into proportions of the total task time. Further, to facilitate comparisons to behavior regulation, emotion regulation was reverse scored such that higher scores indicated better emotion regulation. Thus, emotion regulation scores used in these analyses represented the proportion of task time during which the child was *not* expressing negative emotion, with larger proportions indicating better emotion regulation.

Methodological considerations. In defining and measuring emotion regulation, it is important not to confuse emotion regulation with several related constructs. First, research has demonstrated that emotionality and emotion regulation are distinct, each with unique effects on adjustment (Eisenberg, Fabes, et al., 2000). Emotionality refers to the degree/intensity of one's typical emotional responses. It does not imply response to a particular challenge, or the change or modulation of a response. In contrast, regulation refers to the way in which one adjusts her/his emotion in response to situational demands, and is less dependent on general modes and intensity of expression (i.e., personality). In this investigation, emotion regulation was defined according to duration, regardless of intensity. In this way, emotion regulation also differed from emotional reactivity, which would have been characterized by the latency to an emotional response, rather than the duration of that response. Finally, it is important to keep emotion regulation strategy use (e.g., distraction, self-soothing) distinct from the actual occurrence of emotion regulation. While strategies represent *attempts* to regulate emotion, observation of negative affect following a challenge is a better indicator of the success or failure of these strategies, that is, the amount of emotion regulation that has actually occurred (Bridges, Denham, & Ganiban, 2004; Campos et al., 2004; P. M. Cole et al., 2004).

Behavior regulation. At age four, behavior regulation was assessed during a two-minute delay of gratification task (Bennett, Bendersky, & Lewis, 2005), in which the examiner played with an enticing remote control car in front of the child, telling the child s/he was not allowed to touch it. At age five, behavior regulation was assessed during a one-minute delay of gratification task (Arend, Gove, & Sroufe, 1979) in which the child was asked to wait to look at a gift while the examiner wrapped it behind the child's back, telling the child not to peek. Assessment of behavior regulation at age six paralleled the age four task, with the examiner playing with an attractive remote control robot in front of the child for two minutes, telling the child s/he was not allowed to touch it.

Coding. Behavior regulation was coded by first counting the number of times the prohibited behavior was committed (i.e., child touched toy car/robot, child peeked at gift). The number of times the child reached for the toy/gift and the distribution of these behaviors were also coded. A global rating of inhibitory control was rendered based on these behaviors, on a scale from one (*very poor inhibitory control*) to five (*excellent inhibitory control*) (age four $\alpha = .938$; age five $\alpha = .831$; age six $\alpha = .948$). See Appendix B for an excerpt from the behavior regulation coding sheets.

Methodological considerations. Consistent with the assessment and scoring of emotion regulation, behavior regulation was operationalized so that it was not confounded with behavioral reactivity (Rothbart et al., 2001; Schachar, Tannock, & Logan, 1993). Specifically, behavior regulation was conceptualized as inhibitory control, or the ability to suppress a dominant response (i.e., regulation), rather than impulsivity, or the latency to a response (i.e., reactivity). Similarly, care was taken to differentiate behavior regulation from emotion regulation, by including tasks which isolated these capabilities such that behavior regulation tasks were relatively free from emotion regulation demands, and vice versa.

Adversity. Adversity was assessed during the age four visit via caregiver reports on demographic information (e.g., socioeconomic status, residential mobility) and caregiver reports of the child's relational adversity (e.g., child's maltreatment history, excessive discipline) on Briere's (1992) Child Maltreatment Interview and on the

Conflict Tactics Scales: Parent to Child – Short Form (CTSPC-SF; Straus & Mattingly, 2007). The Child Maltreatment Interview probes for the child's past experiences of child abuse and neglect. The CTSPC-SF is a 10-item questionnaire assessing the frequency of specific disciplinary practices and child neglect in the past year on a seven point scale from zero (*never*) to six (*twenty times or more*). Based on these measures, several indicators of adversity were coded present or absent, and composited to yield cumulative measures of environmental, relational, and total adversity.

Environmental adversity. Environmental adversity (M = .98, SD = .79, range 0-3) represented the sum of dichotomous indicators, including 1) receiving public assistance (58%): TANF, food stamps, or any other form of government subsidized financial assistance; 2) low maternal education (19.8%): less than a high school degree; 3) high residential mobility (19.7%): more than three moves in the child's first four years of life.

Relational adversity. Relational adversity (M = .62, SD = .73, range 0-3) represented the sum of dichotomous indicators, including 1) psychological aggression (31.2%): yelling or cursing at the child more than 20 times in the last year (Straus & Mattingly, 2007); 2) physical abuse or excessive physical punishment (13.8%): child physical abuse leaving marks or bruises (Briere, 1992), caregiver having ever thrown/knocked child down, ever hitting child with an object on a part of the body besides the bottom, or hitting child on the bottom with an object more than 20 times in the last year (Straus & Mattingly, 2007); 3) child neglect or parental substance use (15.8%): child lacking appropriate care (Briere, 1992), caregiver having to leave child home alone, caregiver inability to provide food for child (Straus & Mattingly, 2007), someone in the home using alcohol four or more days per week, caregiver using marijuana in the last week, or caregiver using any hard drugs (such as cocaine or methamphetamines) since child was born.

Total adversity. A total cumulative adversity index was created summing the indicators of environmental and relational adversity, yielding a total score from zero to six (M = 1.60, SD = 1.09, range 0-5). Of note, environmental adversity was not correlated with relational adversity (r = .03, p =.60).

Adjustment. Given its documented links to the development of regulatory capabilities (Aldao, Nolen-Hoeksema, & Schweizer, 2010), child psychopathology (specifically internalizing problems) was examined as one key domain of adjustment. To further investigate the broader impact of self-regulation during the early childhood period, conduct, social competence, and academic achievement were also examined. These three particular domains of adjustment have been previously identified as the key important areas of functioning in childhood (Masten et al., 1995). As teacher-reported adjustment data was collected approximately three months following the laboratory assessment, the ages corresponding to these measures are listed as age 4.3, 5.3, and 6.3.

Psychopathology. Internalizing problems were indicated by the widely-used, well-validated Teacher Report Form of the Child Behavior Checklist (Achenbach, 1991; Achenbach & Rescorla, 2001). This measure consists of 118 items rated by teachers as zero (*not true*), one (*somewhat/sometimes true*), or two (*very true*). The internalizing problems subscale contains items such as “Unhappy, sad, or depressed” and “Withdrawn, doesn’t get involved with others;” (age 4.3 α = .936; age 5.3 α = .860; age 6.3 α = .912).

Conduct. Externalizing problems were also indicated by the Teacher Report Form of the Child Behavior Checklist (Achenbach, 1991; Achenbach & Rescorla, 2001). The externalizing problems subscale contains items such as “Explosive or unpredictable behavior” and “Doesn’t sit still, restless, or hyperactive;” (age 4.3 α = .951; age 5.3 α = .953; age 6.3 α = .955).

Social competence. Social competence was indicated by the Peer Acceptance subscale of the MacArthur Health and Behavior Questionnaire (Armstrong & Goldstein, 2003). This subscale contains 10 items, including “Has lots of friends at school” and “Liked by other children who seek child out for play” which were rated by teachers on a four point scale from one (*not at all*) to four (*very much*)*;* (age 4.3 α = .890; age 5.3 α = .932; age 6.3 α = .947).

Academic achievement. Academic achievement was indicated by scaled scores on the Woodcock-Johnson III Tests of Achievement (Woodcock, 1989), Letter Word subtest (reading) and Applied Problems subtest (math). Administration of each subtest involved establishing a six item basal level and continuing administration until six consecutive items were missed. This assessment was completed at ages six and seven only.

Covariates. Sex, IQ, and family socioeconomic status (SES) were included as covariates in all models. These variables were selected based on previously documented effects of sex on regulation (Bjorklund & Kipp, 1996), and of sex, IQ, and SES on adjustment (e.g., Leadbeater, Kuperminc, Blatt, & Hertzog, 1999; Oakland, 1983). Covariates were modeled to account for direct effects on endogenous variables at each age point, given evidence that these factors may exert differential effects as children develop over time and as the context in which they are functioning (e.g., home, school) changes. For example, sex effects may take on particular relevance as gender identity becomes more solidified in development, and effects of SES may become more or less salient for adjustment with increasing exposure to peers and other extrafamilial influences (Bradley & Corwyn, 2002; Slaby & Frey, 1975).

Full scale IQ. Full scale IQ was assessed with the Wechsler Preschool and Primary Scale of Intelligence – III (Wechsler, 2002), by compositing verbal IQ and performance IQ subscales according to published scoring guidelines (M_{FSIQ} = 94.76, *SD* = 13.55). The verbal subtest consisted of a receptive vocabulary test (i.e., pointing at pictures to identify words) for children under 48 months, and an expressive vocabulary test (i.e., verbally explaining words) for children 48 months or older. The age-appropriate measure was used to compute a pro-rated verbal IQ score for each child (M_{VIQ} = 96.89, *SD* = 15.55). The performance IQ subtest consisted of the block design subtest, used to create a pro-rated performance IQ score for each child (M_{PIQ} = 92.33, *SD* = 17.67).

Family socioeconomic status (SES). Family SES was scored using the Hollingshead (1975) Four-Factor Index of Social Status, based on a composite of caregivers' education and occupational statuses. Education codes ranged from one (*less than 7th grade*) to seven (*graduate or professional training*). Occupational scores ranged from one (*farm laborers and unskilled service workers*) to nine (*executives and major professionals*). Education codes were multiplied by three and occupation codes were multiplied by five. Scores were summed within caregiver and then averaged across caregivers (in cases with two caregivers in the home) to yield a total SES score. Scores in the sample ranged from 9 to 66 with higher scores connoting higher SES (M_{SES} = 33.22, *SD* = 13.07, e.g., a licensed vocational nurse with a trade degree).

Data Preparation

Missing data. Missing data was missing completely at random; Little's (1988) MCAR test: $\chi^2(1747) = 1654.944$, $p = .942$. All models were estimated in MPlus v.6.12 (Muthen & Muthen, 1998-2011) using Maximum Likelihood Estimation. Initial bivariate correlations and mean differences reported for descriptive purposes were estimated in SPSS v.20 (IBM Corporation, 2011) using pairwise deletion.

All 250 participants had complete data on sex, IQ, and SES. At age four, four children were missing behavior regulation data (one due to non-compliance, one due to examiner error, one due to video recording failure, and one due to equipment malfunction), and three children were missing emotion regulation data (two due to noncompliance, and one due to video recording failure). Environmental adversity information was not available for two participants. Further, 78 participants were missing all teacher reported data (44 children were not yet in school, 27 teachers did not return questionnaires, and accurate school information could not be obtained for seven children), and an additional two participants were missing just social competence data, due to teachers' partial completion of forms.

At age five, as noted earlier, 35 participants did not complete the visit. Additionally, eight children were missing behavior regulation data (seven due to video recording failure, and one due to examiner error), and six children were missing emotion regulation data (three due to video recording failure, and three due to misunderstanding the task). Further, 85 of the 215 eligible participants were missing all teacher reported data (24 children were not yet in school, 44 teachers did not return questionnaires, accurate school information could not be obtained for 16 children, and one caregiver refused teacher data collection), an additional two participants were missing just social competence data, and eight participants were missing just internalizing and externalizing problems data, due to teachers' partial completion of forms.

At age six, 35 participants did not complete the visit. Additionally, three children were missing behavior regulation data due to caregivers not being able to complete the entire visit because of time or distance considerations (incomplete assessment), and four children were missing emotion regulation data (two due to misunderstanding the task, and two due to incomplete assessment). Two children were missing reading achievement data due to incomplete assessment, and an additional seven children were also missing math achievement data (one due to incomplete assessment, and six due to administration errors). Further, 57 of the 215 eligible participants were missing all teacher reported data (54 teachers did not return questionnaires, accurate school information was unable to be collected for one participant, and two caregivers refused teacher data collection), an additional seven participants were missing just social competence data, and 11 participants were missing just internalizing and externalizing problems data, due to teachers' partial completion of forms.

At age seven, 42 participants did not complete the visit, and 27 participants were still pending at the time of this study. In addition, one participant was missing reading achievement data and two were missing math achievement data, due to administration errors.

Model assumptions. In the path analytic framework, four study variables had to be transformed so as to be sufficiently normally distributed to render parametric statistics appropriate (Afifi, Kotlerman, Ettner, & Cowan, 2007). Specifically, the internalizing problems variable at age six, and the externalizing problems variables at ages six and seven were square root transformed. The emotion regulation variable at age five was arc sine square root transformed, because this transformation is considered the most appropriate way to handle proportion data derived from counts (Christensen, 1996; Osborne, 2002). Variables used in the cross-lagged path analyses to predict each endogenous variable met assumptions for multivariate normality (i.e., normality of residuals, independence of residuals, and homoscedasticity; Cohen, Cohen, West, & Aiken, 2003). In addition, residuals were held equivalent across time points when fitting all models so as to further preserve the assumption of homoscedasticity. All predictor variables were standardized for path analyses. In the latent change model framework, variables were left untransformed and unstandardized, so as to accurately model changes in raw levels of constructs across time and obtain interpretable parameters.

Model fit. The fit of each model tested in the analyses was evaluated considering several indices. Chi square tests of model fit evaluated the extent to which the model produced data differed from the observed data, with significant chi square tests indicating poor model fit. However, given that considering this index alone can potentially be misleading, several other indicators were also evaluated. The root mean square error of approximation (RMSEA) and comparative fit index (CFI) give indications of the degree of improvement of the proposed model compared to a model positing no relations between variables. Generally accepted values for these metrics are RMSEA < .05 and CFI > .90 (Hu & Bentler, 1999; Marsh, Hau, & Wen, 2004; Raykov & Marcoulides, 2006). When appropriate, nested model comparisons were conducted using a chi square difference test, to indicate the degree to which model fit improved or declined with the removal of parameters (Satorra, 2000). Given nested models with equivalent fit, both parsimony and theoretical concerns were considered to determine final model selections.

Study 1 Results

Descriptive Results

Table 1 displays the means, standard deviations, and bivariate correlations between predictor variables and adjustment variables. Higher IQ was related to fewer internalizing and externalizing problems across time points, better social competence across time points, and higher achievement in reading and math. Higher SES was associated with fewer internalizing and externalizing problems and better social competence at age 6.3, as well as higher achievement in reading and math. Better emotion regulation at age four was associated with fewer internalizing and externalizing problems, but emotion regulation was not associated with adjustment in any other domain. Better behavior regulation at several time points was associated with fewer externalizing problems, better social competence, and better achievement in reading (but not in math).

Table 2 displays interrelations among regulation measurements as well as relations between covariates and regulation indices. Behavior regulation was moderately, though inconsistently, stable across time points, such that better behavior regulation at age four was associated with marginally better behavior regulation at age five and significantly better behavior regulation at age six. Behavior regulation at ages five and six were not related. Emotion regulation was also moderately, but more consistently, stable across time points such that better emotion regulation at age four was related to better emotion regulation at age five and marginally better emotion regulation at age six. Further, better emotion regulation at age five was related to better emotion regulation at age six. Higher IQ was related to worse emotion regulation at age six, and marginally better behavior regulation at age six. SES was not related to either type of regulation at any time point.

Within time correlations demonstrated that behavior and emotion regulation were positively associated at age four, marginally negatively associated at age five, and positively associated at age six. Across time, behavior regulation at age four was positively associated with emotion regulation at age six, and emotion regulation at age four and age five were each positively associated with behavior regulation at age six.

Sex differences in predictors were tested with independent samples *t* tests (Table 3). A sex difference in emotion regulation emerged at age six, such that girls had better emotion regulation than boys. A sex difference in behavior regulation emerged at ages five and six, such that girls had better behavior regulation than boys. Sex differences in externalizing problems were significant at age four and marginal at age six, such that boys were higher than girls. There were no significant sex differences in social competence or academic achievement. Given relations among sex, IQ, and SES and several endogenous variables, these covariates were included in all models.

Cross-Lagged Path Analysis

The initial transactional model tested is pictured in Figure 1. This model represents a traditional cross-lagged panel analysis, testing directional links between emotion and behavior regulation across three time points. Several significant paths emerged in this model, including 1) significant stability of emotion regulation from age four to age five and age five to age six, 2) within time correlations between emotion and behavior regulation at ages four and six, and, importantly, 3) better emotion regulation at age five predicting better behavior regulation at age six. However, the fit of this initial model was relatively poor; $\chi^2(8) = 23.536$, $p = .003$, RMSEA = .088, 90% C.I. [.048, .130], CFI = .765.

Model modification indices produced by the statistical software suggested adding an additional stability path from behavior regulation at age four to behavior regulation at age six. After considering the merit of this suggestion, it was deemed theoretically justifiable that there could be additional long term stability in these capabilities in the form of direct effects, beyond the indirect effects from one year to another. In particular, this seemed viable considering the similarity of tasks at ages four and six. Although not suggested by the statistical software, the most appropriate course of action in light of theoretical and methodological considerations was to add all direct long term paths (from age four directly to age six) to the model. In other words, there was no theoretical justification for expecting long term effects in one domain but not in another. The final path model is pictured in Figure 2, consisting of both the original cross-lagged panel analysis, as well as paths from age four predicting directly to age six. This model fit very well, and was a significant improvement over the original model; $\chi^2(4) = 2.737$, $p = .603$, RMSEA = .000, 90% C.I. [.000, .080], CFI = 1.000, χ^2 difference $p < .001$.

Stability. In the final model, the stability of behavior regulation from age four to age five was marginally significant ($\gamma = .112$, $p = .084$), but stability was not significant from age five to age six. Further, behavior regulation at age four predicted behavior regulation at age six ($\gamma = .239$, $p < .001$). The stability of emotion regulation was significant from age four to age five ($\gamma = .189$, $p = .005$), and from age five to age six ($\gamma = .151$, $p = .022$), but stability was not significant from age four to age six. Therefore, hypothesis one was partially supported. Emotion and behavior regulation were both modestly stable across time. Although behavior regulation was expected to evidence greater stability than emotion regulation, it remains to be seen whether there are meaningful differences in the magnitude of emotion versus behavior regulation stability. Although emotion regulation was more consistently stable across all three time points, the largest single effect size was found in the behavior regulation domain, from age four to age six.

Concurrent relations. The within time correlation between behavior and emotion regulation was significant at age four ($\gamma = .137$, $p = .019$), but not at ages five or six. Therefore hypothesis two, which posited that behavior and emotion regulation would be associated concurrently, was partially supported.

Covariates. Examining the effects of covariates on the model, sex effects emerged on behavior regulation at age five (γ = -.241, p < .001) and on emotion regulation at age six (γ = -.211, p = .001), such that girls were better regulated than boys. Higher IQ was associated with worse emotion regulation at age six (γ = -.153, p = .020) and marginally better behavior regulation at age six (γ = .120, p = .065). There were no effects of SES on emotion or behavior regulation at any time point.

Transactional effects. Considering hypothesis three, which pertained to the directionality of cross-lagged paths between emotion and behavior regulation, the model supported both directions of effects. Emotion regulation at age five predicted behavior regulation at age six (γ = .179, p = .009), however, the path between emotion regulation at age four and behavior regulation at age six, which was significant at the bivariate level, dropped to nonsignificance in the full model. In the other direction, behavior regulation at age four predicted emotion regulation at age six (γ = .125, p = .047). The obtained model therefore provided support for both competing hypotheses: that early emotion regulation would contribute to later behavior regulation, and that early behavior regulation would contribute to later emotion regulation. Importantly, these cross-lagged paths were significant beyond within-domain stability and cross-domain concurrent associations.

To evaluate the strength of these associations more directly, the final model was compared against a model in which each set of directional cross lagged paths was fixed to zero. The model in which paths from emotion to behavior regulation were fixed to zero had significantly worse fit than the original model; $\chi^2(7)$= 14.282, p = .046, RMSEA = .065, 90% C.I. [.008, .113], CFI = .890, χ^2 difference p = .009. However, the decrease in model fit from the original model to the model in which paths from behavior to emotion regulation were fixed to zero was not significant; $\chi^2(7) = 7.068$, $p = .422$, RMSEA = .006, 90% C.I. [.000, .078], CFI = .999, χ^2 difference $p = .228$. This comparison suggests that the paths from early emotion regulation to later behavior regulation may be more substantively important (as their removal more markedly affected the model), but does not negate the importance of finding a significant cross-lagged path from behavior to emotion regulation. Given the relevance of each path for the evaluation of directional effects, it would be misleading to conclude that there is only an effect in one direction. Thus, the original model was retained, such that both directional effects were used to predict adjustment in subsequent analyses. The final model explained 7.4% of the variance in age five behavior regulation ($p = .028$), 13.9% of the variance in age six behavior regulation ($p = .001$), 4.1% of the variance in age five emotion regulation ($p = .130$), and 11.2% of the variance in age six emotion regulation ($p = .004$).

Adjustment

Internalizing problems. The model predicting internalizing problems consisted of the final transactional path model determined above, with regulation at each time point predicting teacher reported internalizing problems at the subsequent time point, controlling for internalizing problems at the prior time point (Figure 3a). The model fit well; $\chi^2(17) = 21.105$, $p = .222$, RMSEA = .031, 90% C.I. [.000, .069], CFI = .957. Internalizing problems evidenced stability from age 4.3 to age 5.3 but were not significantly stable from age 5.3 to age 6.3. Further, better emotion regulation at age four predicted fewer internalizing problems at age 4.3 (γ = -.187, p = .007). As regulation at age six did not predict later adjustment, no indirect paths were tested in this model.

Externalizing problems. The model predicting externalizing problems (Figure 3b) had adequate fit; $\chi^2(17) = 26.140$, p = .072, RMSEA = .046, 90% C.I. [.000, .080], CFI = .958. Externalizing problems were highly stable across ages. Better emotion regulation at age four predicted marginally fewer externalizing problems at age 4.3 (γ = -.127, p = .056). Predictive relations from behavior regulation to fewer externalizing problems were evident from age 4 to age 4.3 (γ = -.222, p = .001), marginally from age 5 to age 5.3 (γ = -.131, p = .082), and significant from age 6 to age 6.3 (γ = -.291, p < .001). An indirect effect of emotion regulation at age five on externalizing problems at age 6.3 through behavior regulation at age six was significant (γ = -.053, p = .026). As noted, these associations were significant beyond the effects of sex, IQ, and SES, as well as the stability of externalizing problems at prior time points.

Social competence. The model predicting social competence from emotion and behavior regulation (Figure 3c) fit well; $\chi^2(17) = 21.918$, p = .188, RMSEA = .034, 90% C.I. [.000, .071], CFI = .960. Social competence was stable across time points. Better behavior regulation at age four predicted better social competence at age 4.3 (γ = .153, p = .033). In addition, better behavior regulation at age six predicted better social competence at age 6.3 (γ = .256, p < .001). The indirect effect of emotion regulation at age five on social competence at age 6.3 through behavior regulation at age six was significant (γ = .046, p = .037). Again, these associations were significant beyond the effects of sex, IQ, and SES, and the stability of social competence from prior time points.

Reading achievement. The model predicting reading achievement from emotion and behavior regulation (Figure 3d) fit very well; $\chi^2(10) = 9.806$, $p = .458$, RMSEA = .000, 90% C.I. [.000, .068], CFI = 1.000. Because achievement was measured in the laboratory, it was concurrent with each time point, rather than longitudinal, which affected the number of testable paths modeled. Reading achievement was highly stable from age six to seven. Better behavior regulation at age four predicted higher reading achievement at age six ($\gamma = .164$, $p = .004$). As regulation at age six did not predict subsequent achievement, no indirect effects were tested in this model. Once again, this association was significant beyond the effects of sex, IQ, and SES.

Math achievement. The model predicting math achievement from emotion and behavior regulation (Figure 3e) fit very well; $\chi^2(10) = 9.266$, $p = .507$, RMSEA = .000, 90% C.I. [.000, .065], CFI = 1.000. Math achievement was highly stable from age six to age seven. No significant direct or indirect effects of regulation emerged in this model, beyond the effect of IQ and the stability of math achievement across time.

Overall, hypothesis four was largely supported. Both emotion and behavior regulation evidenced effects on later adjustment, controlling for prior levels of adjustment and relevant covariates. Furthermore, emotion regulation indirectly affected adjustment in multiple domains through its developmental influence on behavior regulation.

Study 2 Results

Descriptive Results

Table 4 displays the means and standard deviations for emotion regulation and behavior regulation across ages four, five, and six. Emotion regulation improved over time, with the proportion of time spent *not* displaying negative affect represented in the table. Specifically, emotion regulation increased from age four to five, and then remained relatively constant from age five to six. In addition, the variability of emotion regulation decreased from age four to five, and remained constant at age six. A repeated measures ANOVA on emotion regulation was significant ($F[2, 372] = 14.868$, $p < .001$), and also produced both significant linear ($F[1, 186] = 19.984$, $p < .001$) and quadratic ($F[1, 186] = 7.715$, $p = .006$) contrast tests. Figure 4a displays a plot of the individual linear emotion regulation trajectories for the entire sample.

Behavior regulation also improved across time, with the mean inhibitory control score (1-5 scale) represented in the table. Specifically, behavior regulation increased from age four to age five, and then increased by an even larger margin from age five to age six. The variability of behavior regulation was fairly constant from age four to five, and then decreased markedly at age six. A repeated measures ANOVA on behavior regulation was significant ($F[2, 372] = 11.223$, $p < .001$), and produced a significant linear contrast test ($F[1, 186] = 31.096$, $p < .001$), with no significant quadratic effect. Figure 4b displays a plot of the individual linear behavior regulation trajectories for the entire sample. Thus, hypothesis one was supported, both emotion and behavior regulation were discontinuous and improved across time.

Latent Change Models

Emotion regulation. A latent change model was used to model the change in emotion regulation across ages four through six, and to identify possible predictors of and outcomes of observed change in emotion regulation. Given the dearth of empirical knowledge about the development of emotion regulation at specific ages in early childhood, along with the suggestion from the descriptive statistics and repeated measures ANOVA that the change in emotion regulation was not necessarily linear, a level and shape model was fit to the data. This type of model allows the nature of the change to vary freely across time, and was achieved by fixing the weight of the slope (or shape of change) at age four to zero, modeling an unrestricted parameter at age five, and fixing the weight of the slope at age six to one (Raykov & Marcoulides, 2006). Therefore, the resulting weight at age five represented the proportional change associated with the first year of measurement as compared to the final year. As mentioned, the residual variance for the indicators was held equivalent across time to preserve the assumption of homoscedasticity.

The unconditional growth model (Figure 5) fit well; $\chi^2(2) = 1.040$, $p = .595$, RMSEA = .000, 90% C.I. [.000, .103], CFI =1 .000. The intercept parameter ($\mu_{\alpha y} = .772$, $SE = .016$, $p < .001$) indicated that at age four, participants spent on average 77.2% of the task not displaying negative affect. The shape parameter ($\mu_{\beta y} = .092$, $SE = .018$, $p < .001$) represented the overall change in emotion regulation over the course of the model, such that from age four to age six, the model predicted percent of time spent not displaying negative emotion increased by 9.2%, to 86.4% at age six. Furthermore, the weight of the shape parameter applied to the second time point was .929 ($SE = .112$, $p < .001$), indicating that 92.9% of the predicted overall increase in emotion regulation occurred by age five. Finally, the level and shape parameters were correlated at -.028, $p < .001$, indicating that those individuals who started at a higher level of emotion regulation increased less over time.

The variances for the level and shape parameters were also estimated. The variance estimate for the level (intercept) parameter was .034 ($p < .001$), and the variance estimate for the shape (slope) parameter was .028 ($p = .002$). These significant variance estimates indicate that individual differences in both the initial level of emotion regulation and the shape of change in emotion regulation persisted after accounting for the group level growth function. Therefore, predictors that might distinguish among individual levels and growth trajectories were examined.

Predicting emotion regulation trajectory. First, the covariates sex, IQ, and SES were tested as predictors of level and shape of emotion regulation. The model including covariates evidenced a significantly poorer fit than the unconditional growth model; $\chi^2(5) = 9.398$, $p = .094$, RMSEA = .059, 90% C.I. [.000, .117], CFI = .764, χ^2 difference $p = .039$, and none of the covariates had a significant effect on either the level or shape of emotion regulation. Therefore, these covariates were excluded from subsequent models.

Next, adversity was examined for its influence on the development of emotion regulation. Table 5 displays relations between types of adversity and study variables. First, a model was tested in which environmental and relational adversity were examined as separate predictors. The fit of this model was equivalent to the fit of the unconditional growth model; $\chi^2(4) = 1.209$, $p = .877$, RMSEA = .000, 90% C.I. [.000, .047], CFI = 1.000, χ^2 difference $p = .919$. Neither environmental nor relational adversity had an effect on initial levels of emotion regulation. There was a marginal effect of environmental adversity on the growth of emotion regulation ($\gamma = -.029$, $p = .098$), and a nonsignificant effect of relational adversity on the growth of emotion regulation ($\gamma = -.027$, $p = .116$). The comparable magnitude of these parameters suggested that there was no difference in effects based on particular type of adversity. Therefore, the total cumulative adversity model was examined next.

The fit of the total cumulative adversity model was also equivalent to the fit of the unconditional growth model; $\chi^2(3) = 1.120$, $p = .772$, RMSEA = .000, 90% C.I. [.000, .071], CFI = 1.000, χ^2 difference $p = .777$. Cumulative adversity did not have an effect on initial levels of emotion regulation ($\gamma = .017$, $p = .277$). However, there was a significant effect of cumulative adversity on the growth of emotion regulation ($\gamma = -.041$, $p = .020$), such that increased levels of adversity related to slower growth of emotion regulation. Specifically, for every one standard deviation increase in cumulative adversity, individuals gained 4.1% less in emotion regulation proportion from age four to six. The difference in these trajectories is represented in Figure 6. Although a significant amount of residual variance in level ($p < .001$) and shape ($p =.003$) of emotion regulation remained after accounting for cumulative adversity, adversity represented an important element in the conceptual model of the development of emotion regulation. As the inclusion of this significant predictor did not decrease the overall fit of the model, it was retained in subsequent models. In sum, hypothesis four was partially supported. There was an effect of cumulative adversity on the growth of emotion regulation, but there were no differential effects of environmental and relational adversity.

Predicting adjustment from emotion regulation level and trajectory. The final emotion regulation level and shape model, as predicted by cumulative adversity, was used to predict each adjustment indicator at subsequent time points (i.e., teacher reported outcomes at age 6.3 and laboratory outcomes at age seven). There were no significant effects of initial levels of emotion regulation or the shape of emotion regulation growth on any adjustment measures. There was a marginally significant effect of cumulative adversity on math achievement at age seven ($\gamma = 4.185$, $p = .087$), which was not mediated by an indirect effect through emotion regulation growth. Thus hypothesis three was not supported; there were no effects of level or shape of emotion regulation on adjustment.

Behavior regulation. A latent change model was used to model the change in behavior regulation across ages four through six, and to identify possible predictors of and outcomes of the change in behavior regulation. As with emotion regulation, a level and shape model was fit to the data, allowing the nature of the change to vary freely across time. This was achieved by fixing the weight of the slope at age four to zero, modeling an unrestricted parameter at age five, and fixing the weight at age six to one. The residual variance for the indicators was held equivalent across time to preserve the assumption of homoscedasticity.

The latent change model for behavior regulation was problematic, and the results suggested there were serious specification issues which precluded the ability to reliably fit a model. These issues will be discussed at length following the description of the intended model. The proposed model fit only modestly; $\chi^2(2) = 3.610$, $p = .164$, RMSEA

= .057, 90% C.I. [.000, .150], CFI = .905. The intercept parameter ($\mu_{\alpha y}$ = 3.765, *SE* = .066, $p < .001$) indicated that at age four, participants performed the prohibited behavior on average 1-2 times. The shape parameter ($\mu_{\beta y}$ = .452, *SE* = .080, $p < .001$) represented the overall change in behavior regulation over the course of the model, such that from age four to six, behavior regulation scores were predicted to increase, up to 4.217 (performing the prohibited behavior 0-1 times) at age six. Furthermore, the weight of the shape parameter applied to the second time point was .363 (*SE* = .085, $p < .001$), indicating that less than half the change in behavior regulation had occurred by age five. Finally, the level and shape parameters were correlated at .368 ($p = .034$), indicating that those individuals who started at a higher level of behavior regulation increased more over time, such that skill in early behavior regulation capabilities conferred a subsequent developmental advantage.

The variances for the level and shape parameters were also estimated. Although there was a nonsignificant amount of variance estimated for initial levels of behavior regulation, the variance estimate for the shape of growth in behavior regulation was significant at -1.240 ($p < .001$). Importantly, however, this negative value for the variance of the growth parameter indicates a serious misspecification in the model.

There are several potential determinants of this problem. First, the nature of the model may be misspecified, such that, for example, a linear model has been posited where a quadratic model exists. In this case, a level and shape model was specified such that any potential shape could be fit. Following identification of this issue, strictly linear and strictly quadratic models were also attempted, with similarly poor results. Another potential specification error may be that a moderator needs to be specified, such that a model could be fit for one group differently than for another group. Given the apparent sex differences in behavior regulation at the group mean level, a post-hoc analysis evaluated a potential multi-group model by sex, which was similarly misspecified (i.e., resulted in a negative slope variance in each group). Additional research is needed to evaluate other putative moderators that could account for specification errors. Second, a negative variance problem can arise with very small sample sizes or large amounts of missing data. However, the current sample included over 200 participants at each time point, and evidenced adequate power when fitting the model for emotion regulation. In addition, the model was also tested with an imputed data set so that the total sample size was 250, without improvement, suggesting that sample size and missing data are not likely to account for the obtained findings. Third, a negative variance error can occur when a variable has a strong floor or ceiling effect. This is a likely factor in the case of the behavior regulation model because there was a strong potential for a ceiling effect by age six, despite efforts to enhance the challenge with an enticing, age-appropriate toy. That is, at ages five and six, many children were already committing the prohibited behavior only zero to one times. Given that this is the nature of the variable, there is little corrective action that can be taken, however, model estimation was tested with more robust estimators such as MLR (maximum likelihood with robust standard errors), to no avail. Finally, with regard to model specification, it may be that the lack of stability observed in behavior regulation across these ages means it is not tenable to estimate an overall group growth model in early childhood. In other words, there may be no model of average growth that applies to the whole sample, individual differences notwithstanding. Individual differences in growth patterns that do occur may happen within such a restricted range of the variable that it is difficult to estimate robust group level patterns. Additional time points of measurement could help to stabilize the model in the future. However, in comparing the individual trajectory plots for emotion and behavior regulation, it also became clear that the way in which the behavior regulation variable was scored meant there was inherently less variability in individual scores given the 5-point scoring range, relative to the proportional score for emotional regulation, which yielded continuous values from zero to one. Regardless of the cause, this statistical issue presented an insurmountable obstacle to producing trustworthy estimates of growth parameters, and as such the unconditional growth model produced could not be accepted.

Given that the unconditional growth model for behavior regulation could not be successfully estimated, level and shape parameters could not be subsequently explained by other predictors (e.g., adversity), and could not be used to predict early childhood adjustment indicators.

Emotion and behavior regulation parallel latent change model. In the absence of an acceptable unconditional growth model for behavior regulation, the parallel latent change model with emotion regulation could not be estimated. Thus, hypothesis two, that levels and changes in one type of regulation would influence the changes in the other type of regulation, remains to be evaluated at a later date, after further data collection has occurred.

Study 1 Discussion

This study makes a unique contribution to the understanding of relations among the integrated processes of emotion and behavior regulation across early childhood, and facilitates ongoing and future efforts to develop targeted applied and empirical paradigms to support and understand early childhood adjustment.

Stability of Regulation across Early Childhood

Both emotion and behavior regulation evidenced moderate rank order stability across ages four through six. With regard to emotion regulation, the extant literature is sparse with regard to longitudinal investigations, and particularly with respect to observational measurement. The strongest support for stability has come from studies using parent report of children's emotion regulation (Raffaelli et al., 2005; Rydell et al., 2003). It is not surprising that parent report of a child's functioning might evidence greater stability than observational measurement, given the stability of parent characteristics that influence their reporting (e.g., degree of awareness of their child's development, positive or negative reporting biases). Furthermore, even if prompted to think about their child's functioning in specific situations or at a particular stage of development, it may be that parents' reports naturally integrate more dispositional elements of emotionality into their assessments of their child's regulation. In contrast, this study was careful to separate emotionality from actual modulation of emotion during a challenging situation. Therefore, it is not unexpected that the stability of emotion regulation found in this study was modest, though consistent over time. This estimate is congruent with theoretical conceptualizations of stability that account for considerable variation in a wide range of both intrinsic and extrinsic influences on emotion regulation development (Thompson et al., 2008).

Relative to the literature on emotion regulation, prior research on the stability of behavior regulation in longitudinal samples is more prevalent and consistent. Evidence suggests that behavior regulation capabilities are highly stable across childhood (Kochanska et al., 2001; Kochanska et al., 1997; Murphy et al., 1999; Raffaelli et al., 2005). The present findings are consistent with this literature in terms of the stable rank order differences in behavior regulation from age four to age six. Consistent with prior literature, behavior regulation evidenced greater stability than emotion regulation from age four to six, though this difference was not statistically significant. However, the present study did not find consistent behavior regulation stability, with regard to age five. As discussed below, the changing nature of the regulatory tasks over time constitutes both a strength and a vulnerability of the current study. The greater similarity of the challenge task at ages four and six relative to age five may have contributed to the observed lack of stability at age five. Unfortunately, it is not possible to tease apart whether the apparent differences in behavior regulation obscured a truly stable relationship that exists across each age point (i.e., there may have been an implicit problem with the task administered at age five such that it wasn't tapping behavior regulation in an accurate way), or whether the stability between age four and age six was actually inflated due to the similarity of the tasks rather than the construct itself. Given that all the tasks were delay of gratification paradigms that were coded and scored in the same way, detecting stability should theoretically transcend more nuanced task differences if it is really tapping a broader construct of behavior regulation, rather than stable task-specific differences. These conflicting interpretations will be further evaluated when additional data are available across a broader range of tasks and time points in this sample.

While the variability of specific tasks represents an inherent confound in the observational measurement of emotion and behavior regulation, it is encouraging that consistent stability, though modest, was found across ages four through six in this study. The current stability estimates should be interpreted as conservative given the potential for greater observational stability if the assessments had been even more similar across time points. Further, it is possible that even greater stability will emerge in later childhood. Nevertheless, it remains important to note that, even if this is a conservative estimate, this study suggests emotion and behavior regulation across early childhood may be only modestly stable.

Another potential influence on observed stability across time may have been the nature of this sample. Relative to prior studies, the present findings were drawn from a more diverse sample with more variable and higher levels of adversity exposure. Although more representative of the general population, these sample features may have contributed to more variability between individuals in the current study than is typical in the more homogenous samples used in prior research. Moreover, the relatively greater likelihood of acute adversity exposure during the course of the study (e.g., home foreclosure, child maltreatment, parental separation) may have introduced more opportunities for adversity-induced dysregulation at any given time point, thereby reducing the apparent stability of emotion and behavior regulation over time.

Importantly, the modest stability of emotion and behavior regulation observed in this study does not undermine the importance of potential effects of early levels of emotion or behavior regulation on later cross-domain capabilities and/or later adjustment. Regardless of whether early advantages or deficits in regulation persist, the potential for cascading influences from regulation to other capabilities remains robust. Early regulation may set the stage for later development, despite later instability, in much the same way early caregiving can have a lasting impact on later development even if the quality of caregiving in later childhood dramatically changes (Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). Therefore, the question of stability is an important one, but distinct from efforts to understand if and how early regulation influences later development.

Concurrent Relations between Emotion and Behavior Regulation

The transactional model examined here partially supported the second hypothesis in Study 1, which posited the presence of concurrent relations between emotion and behavior regulation. Significant concurrent relations between domains of self-regulation were observed at age four, but not at later time points. One explanation for this pattern is that a domain general process, such as physiological regulation or executive functioning, may underlie both emotion and behavior regulation early in childhood, thereby accounting for concurrent relations early in development. Over time, however, this shared mechanism may weaken in influence as regulatory capabilities become more differentiated and responsive to context.

Alternately, it may be that the bivariate relation between emotion and behavior regulation in early childhood reflects the operation of developmental influences that are more fully addressed in the complete transactional model. In this view, concurrent relations between emotion and behavior regulation at ages five and six would be weaker than at age four because the relations at later time points control for both the within-domain stability of each construct and earlier cross-domain effects. Importantly, the modest nature of these within-time associations reinforces the idea that emotion and behavior regulation are related, but distinct, constructs.

Effects of Covariates

The current investigation is strengthened by its careful consideration of covariates known to influence regulatory development, including sex, IQ, and SES. While controlling for any initial effects of sex on early emotion regulation acting indirectly on later capabilities, there was a unique direct effect of sex on emotion regulation that specifically emerged at age six. There are several reasons why this effect may have emerged later in development. First, given the modest stability observed in emotion regulation, it may be that indirect effects of any type are unlikely across early childhood. That is, if emotion regulation capabilities at age six are not driven in large part by emotion regulation at earlier ages, then other influences will be unlikely to exert their effects through this developmental process alone. Instead, as individual differences begin to canalize later in development, other intrinsic and extrinsic effects may have more impact. Second, decades of research have established that gender identity develops well into childhood, and is not complete before age six (Slaby & Frey, 1975). Gender identity can change over early childhood as a function of development of cognitive capabilities that influence the ability to think of gender as a stable characteristic. In addition, as children enter formal schooling, they increasingly come into contact with peers and teachers who expose them to more gender norms and broader socializing influences. In this context, biological sex differences can increasingly manifest as socialized gender differences.

A review of the emotion and behavior regulation literature revealed that the preponderance of studies have found gender differences in emotion regulation, such that girls regulate better than boys. However, most studies have included children who ranged widely in age, and were age six or older (with two exceptions where children ranged from four to nine, and five to twelve) (Bjorklund & Kipp, 1996). A separate study on emotion regulation in infancy found that boys and girls displayed similar patterns of responding (Mangelsdorf, Shapiro, & Marzolf, 1995), indicating that gender differences may not emerge until later in development.

In addition to socializing influences, in later childhood and adulthood there may be differences in emotion related processes, such as coping strategies (Eschenbeck, Kohlmann, & Lohaus, 2007), as well as differences in attention paid to emotions (Thayer, Rossy, Ruiz-Padial, & Johnsen, 2003), which in turn may impact the degree to which emotions are consciously regulated. In addition, Saarni (1979) found that girls invoke display rules in the service of pleasing others more than boys, and that display rule knowledge is just coming online in later childhood. Thus, it is likely a sex effect based on display rule differences would not emerge during the preschool period. Importantly, other research has found specifically that early sex differences in emotion expression at age four became more pronounced by age six, with girls eventually expressing fewer 'disharmonious' emotions (primarily characterized by anger) than boys, and more 'submissive' emotions (primarily sadness/anxiety) than boys (Chaplin, Cole, & Zahn-Waxler, 2005).

In terms of behavior regulation, girls in the present study were better at regulating than boys, but only at age five. Given that this difference was specific to age five, there are two possible explanations for this finding. First, it may be that the sex difference in behavior regulation emerges at age five, and then indirectly affects behavior regulation as it develops over time, without additional direct effects in later childhood. Some research has identified differences in inhibitory control that are already present at age five and persist across short term development (Matthews, Ponitz, & Morrison, 2009). Furthermore, when examining mean levels of behavior regulation over time in this study, it became apparent that boys' behavior regulation was constant from age four to five, and increased at age six, whereas girls had a large increase at age five. This lag in development may explain the gender effect at age five that was apparent in the path model.

Bjorklund and Kipp's (1996) review, discussed earlier, found that only two of eight studies published using delay of gratification paradigms, such as those employed in the present study, found a gender effect, with an advantage for females in those cases.

Those studies had participants ranging in age from three to thirteen. Based on these findings, Bjorklund & Kipp (1996) suggested that sex differences in emotion regulation may be substantially more pronounced than differences in behavior regulation. It may be that gender differences in behavior regulation do exist, but only briefly, at a particular age when the development of behavior regulation lags between boys and girls. However, if, as the literature review suggests, there is not a substantial sex difference in behavior regulation, the current finding may reflect something specific to the task used at age five that precipitated gender differentiated responding. Perhaps the age five task lent itself to a greater desire to please the examiner, a feature more salient for girls (Saarni, 1979), than the task at ages four and six. If this were the case, a true gender difference in behavior regulation more broadly may not be present, or may not have emerged in this sample yet, even at age six.

Finally, an effect of IQ was present on emotion regulation at age six, such that more intelligent children showed worse emotion regulation. No specific research has identified direct links between IQ and emotion regulation. If anything, prior research points to indirect effects of higher IQ through ability to use particular coping strategies (Wilson, 1999), which would serve to enhance emotion regulation abilities. The effect found here may have been a task-specific anomaly, perhaps indicating greater understanding of the task or perception of the gift as reward-based, which would have produced more emotional distress for higher IQ children.

Transactional Effects of Emotion and Behavior Regulation

In evaluating competing hypotheses regarding the direction of cross-lagged developmental effects, present study findings suggest that both directions of effects may be important. First, there was a significant effect of emotion regulation capabilities at age five on behavior regulation capabilities at age six, controlling for the stability of behavior regulation as well as concurrent relations with emotion regulation. This effect is consistent with the temporal sequence of emotional experiences, in which feeling states precede actions. In developmental terms, early abilities to control emotion may subsequently reduce contextual demands for behavior regulation, such that these children are better able to focus on improving their behavior regulation once their emotions are under control. This idea holds particular relevance in childhood, when emotions are often activated in behaviorally challenging situations (Calkins & Hill, 2007). This finding suggests that acquiring the ability to regulate emotion confers an advantage upon children during the development of behavior regulation.

There was also a significant effect of behavior regulation at age four on emotion regulation at age six. This effect of early behavioral control on the development of emotion regulation is consistent with the idea that the act of managing emotions involves a broader capacity for effortful control. Effortful control may be important with regard to controlling facial expressions and vocalizations, as well as to engaging attentional control as a potential emotion regulatory strategy (Eisenberg et al., 2007; Schweizer et al., 2013; Tronick et al., 1977). This finding suggests that children who were better able to control their behavior early on were able to generalize this ability to the behaviors relevant to controlling emotion in later development. It remains to be seen whether this benefit of behavioral control abilities extends to both felt and expressed emotions, as well as whether it is specific to individuals who use particular emotion regulation strategies (e.g., attention shifting).

The finding that both directional effects were present in the model casts doubt on the idea that these capabilities develop in a temporal, definitive, sequence. If the model had suggested emotion regulation at multiple time points predicted gains in behavior regulation at each subsequent time point, and not the other way around, one could infer that emotion regulation was a necessary developmental precursor for behavior regulation. However, given the bidirectional effects, it seems that there is no temporal contiguity. Rather, there are multiple important inputs to both regulatory processes, which may themselves be developing in concert. Additional research is needed to evaluate whether one directional process is stronger than the other. For example, emotion regulation may exert a stronger effect on behavior regulation because it influences the context in which behavior regulation is exercised and develops, whereas behavior regulation may only influence particular aspects and strategies of emotion regulation.

It is important to note that not every cross-lagged path was significant in the model. Additional research is needed to determine whether the particular age at which these specific effects occurred is meaningful, or whether (more likely) the current study was better able to detect these broader effects with particular tasks or at particular ages. For example, the absence of a significant prediction from emotion regulation at age four to behavior regulation at age five may reflect that emotion regulation has not adequately developed at age four to confer a subsequent developmental advantage, or that there was a methodological issue with the age five behavior regulation task. A methodological issue would be consistent with the lack of stability in behavior regulation from age four to five as well, however these findings alone do not conclusively disentangle the methodological, developmental, and conceptual issues that may be at play here. The most appropriate interpretation of the model at this juncture is simply that there appear to be bidirectional effects of both emotion and behavior regulation capabilities on later cross-domain development, above and beyond within-domain stability and concurrent relations, but the extent to which these effects persist across multiple time points and tasks remains to be assessed.

Effects of Emotion and Behavior Regulation on Adjustment

Higher levels of internalizing problems were predicted by early deficits in emotion regulation, but only at age four. This is consistent with work that finds relations between emotion regulation and later psychopathology, including depression (e.g., Zeman et al., 2006). However, it may have been difficult to detect meaningful differences in internalizing problems during early childhood. Given that internalizing problems appeared to stabilize with increasing age in this sample, the dearth of findings in later childhood should be interpreted with caution.

The model predicting externalizing problems revealed that behavior regulation evidenced predictive effects across time points. Furthermore, a potential effect of emotion regulation on externalizing problems at age six was observed in an indirect effect through behavior regulation at age five. This finding is consistent with a robust literature connecting externalizing problems with behavior regulation (e.g., Eisenberg, Guthrie, et al., 2000), rather than directly with emotion regulation.

Social competence was also predicted by behavior regulation across time points. The effects of behavior regulation rather than emotion regulation in this domain are a bit surprising, given the considerable links between emotion regulation and social competence in the literature (e.g., Eisenberg et al., 1993; English et al., 2012). However, most studies do not compare both emotion and behavior regulation in the same sample, and certainly not longitudinally. The results of the present study suggest that the documented connection between emotion regulation and social competence may be mediated by behavior regulation, such that the more direct and proximal link may be found with behavior. However, given the robust literature on emotion regulation and social competence, it is likely that both direct and indirect processes explain their substantial connection. Therefore, it will be important to evaluate these effects using additional reporters and indicators of adjustment in this domain.

In terms of achievement, better behavior regulation at age four predicted higher reading achievement at age six, beyond the strong effect of IQ. It is not unexpected that behavior regulation difficulty in particular (compared to emotion regulation) predicted achievement, given the importance of inhibitory control (i.e., sitting still) in the classroom during learning situations. Furthermore, it is notable that the long term effects of early behavior regulation proved more important than later effects, considering the importance of mastering the building blocks of reading in preschool, followed by the considerable stability of achievement across time.

In sum, these models strongly suggest that behavior regulation deficits may be the most proximal source of adjustment difficulties across domains. Further, they demonstrate that behavior regulation across ages remains important and adds variance to outcomes beyond the stability of adjustment difficulties from prior time points. However, in more than one domain, early regulatory capacities were uniquely important, even beyond later abilities. As for the influence of emotion regulation, it was significant with regard to early internalizing problems, but for the most part exerted indirect effects on later adjustment through its influence on behavior regulation. Future work is needed to ascertain if and how emotion regulation may influence adjustment in other domains, at other ages (earlier or later in development), or as indicated by other reporters of children's functioning (e.g., caregiver reports, child self-reports).

Study 2 Discussion

This study investigated the development of emotion and behavior regulation across early childhood, predictors of individual differences in the development of each, and the importance of these trajectories in predicting later adjustment. This study is unique for its longitudinal measurement of regulatory capacities with focused attention to development in early childhood.

Growth in Emotion Regulation

Both the descriptive statistics and the latent change model demonstrated that emotion regulation improved from ages four to five, and then remained constant from ages five to six. It is difficult to fully interpret this growth trajectory with only three time points, given that emotion regulation may go on to grow further or may remain constant with increasing age. The literature does not suggest that emotion regulation has reached adult levels by age six (Raffaelli et al., 2005), and thus the lack of growth between age five and six is surprising. It may be that a ceiling effect is beginning to emerge by age six, given that children only expressed negative emotion an average of 15% of the time by this point. Alternatively, children may have experienced moderate levels of negative emotion, but have improved and reached ceiling effects in the degree to which this emotion is actually expressed and thus measurable via observation. Further, it may be that improvements in emotion regulation past this age manifest in other ways, such as in the efficiency and differentiation of strategy use. Importantly, management of negative emotion did improve significantly from initial levels at age four, so development of this capability over the measured time period was observed, as expected. Finally, the level and shape parameters for emotion regulation were negatively associated, indicating that children who started out better in emotion regulation improved less. This is potentially consistent with a ceiling effect, given that individuals who started at high levels of emotion regulation simply didn't have the ability, given this measurement, to improve to as high a level as those who started out lower.

Influences of Adversity on Emotion Regulation

Relational and environmental adversity evidenced similar effects on the development of emotion regulation. This is somewhat unexpected given the type-specific effects of adversity that have been identified in prior work in other domains (e.g., S. A. Cole, 2005). However, these findings are also consistent with prior research demonstrating that multiple forms of adversity influence emotion regulation (H. Chang et al., 2012; L. Chang et al., 2003; Krause et al., 2003; Raver, 2004).

A cumulative composite of environmental and relational adversity exposure predicted decreased growth in emotion regulation over time. This finding emphasizes the extent to which emotion regulation growth is a multiply determined, contextually influenced, developmental process. Adversity did not affect initial levels of emotion regulation, suggesting that, regardless of where children began at age four, exposure to harsh parenting/child maltreatment and/or poverty/residential mobility interfered with the typical developmental trajectory of emotion regulation across early childhood. This deficit may be due to decreased effective parental emotion socialization, persistent activation of regulation in the context of excessive challenge, and/or limited access to emotion regulation strategies, among other influences. Importantly, this finding represents the effect of a continuous predictor, such that increased amounts of adversity were increasingly detrimental to emotion regulation development, which is consistent with cumulative risk models (Masten & Wright, 1998).

Neither the initial level nor shape of emotion regulation growth predicted adjustment in any domain in later childhood. This is somewhat surprising, given the preponderance of literature suggesting that emotion regulation has an impact on adjustment (e.g., Aldao et al., 2010; Eisenberg et al., 1993). However, research has yet to fully investigate the influence of the *rate* of growth in emotion regulation on adjustment, so it is difficult to contextualize the lack of findings for this particular construct. It may also be that the short period of development over which this growth was modeled yielded an unstable shape parameter, and limited the ability to detect significant relations with subsequent adjustment.

Growth in Behavior Regulation

Descriptive statistics and repeated measures ANOVA indicated that behavior regulation improved over time, and that this trend in growth was basically linear across ages four to six. This is consistent with prior literature, which suggests that behavior regulation capabilities increase across development. However, the latent change model for behavior regulation (and by extension, prediction of this model by adversity or by parameters describing levels and growth in emotion regulation) could not be reliably estimated. It may be that ceiling effects in the behavior regulation variable or limited variability in the way it was scored precluded the ability to estimate change parameters in this variable. Alternatively, it may be that the lack of stability in behavior regulation rendered individual trajectories and group mean averages across trajectories unreasonable to estimate. While the descriptive findings are suggestive of linear growth across time, further data collection and perhaps adjustments in measurement will be necessary to truly model, and explain, the development of behavior regulation across early childhood, and, by extension, its relations with emotion regulation, adversity, and adjustment.

Integrated Discussion

Cross-Cutting Themes

Together, these studies provide an innovative examination of how the system of self-regulation, as assessed in multiple domains, and examined using multiple analytic frameworks, reflects multiple processes acting in concert across development. The information gained from these complementary analytic frameworks can be mutually informing in several ways.

First, the modest stability observed in individuals' rank order over time suggests that there is a great deal of individual variability in patterns of change, which was mirrored in the emotion regulation modeling results. Thus, it is important to document the extent to which these constructs are stable across particular periods of development before attempting to describe group and individual patterns of change. Given that this is still an emerging area of research, pursuing each of these lines of inquiry simultaneously in the future will be of critical importance.

Second, while it is clear from the path analysis that early capabilities in each domain influence later levels of those capabilities, it remains to be determined whether the mechanism by which early levels exert a cross-domain influence is through an effect on growth *trajectories*. High levels of one capability in early development (i.e., emotion or behavior regulation at age four) may confer an advantage such that the cross-domain capability can develop more efficiently and quickly. For example, if successful emotion regulation in early childhood means that contextual demands during challenging situations are reduced, the trajectory of behavior regulation growth should be altered. This pathway is particularly likely because the observed effects are developmental rather than concurrent. Strong concurrent effects would have suggested that development in either capability is the result of domain general growth processes, such as physiological regulation and attention, which contribute to gains in both emotion and behavior regulation at the same time. However, given that longitudinal cross-domain effects were stronger than concurrent, early regulatory capabilities may actually affect growth in self-regulation over time.

Third, given that the path effects were bidirectional, it is likely that any influence on growth processes is bidirectional. These processes may be explained by a feedback loop in which advantages in one domain influence growth in the other domain, which feeds back to influence growth in the original capability. While the present study lacked the ability to fully evaluate this recursive model using a parallel growth framework, the path model results suggest that this is a valuable area for future investigation.

Fourth, just as the path analyses can refine the interpretation of the latent change models, knowledge gained from the latent change framework can inform interpretations of the path analytic model. The growth results suggest that it is indeed important to examine specific ages in development. Thus, the ambiguous results from the path analysis wherein paths at certain ages were significant and others were not, may have some significance. Although it remains important to determine the extent to which the specific effects detected are a function of particular tasks rather than particular stages of development, there is a suggestion that age may indeed matter. That is, it may not be that emotion regulation at every earlier age influences behavior regulation at every later age, and vice versa. Instead, it may be that there is something particular to emotion regulation at age five, for example, that is more impactful on later development than emotion regulation at age four. Based on the results of the latent change modeling, it is clear that emotion regulation develops substantially between the ages of four and five, on an absolute level. Therefore, it may be that the higher levels of variability and dysfunction that exist in emotion regulation at age four render it a less stable predictor of later behavior regulation than emotion regulation at age five. Once development has progressed in emotion regulation, it may be that persistent deficits (and strengths) at age five are that much more meaningful in terms of their cross-domain effects. Both the path and latent change models will be more fully evaluated once additional time points are available. Yet to really address this question of directional effects across multiple ages, it remains important to investigate these capabilities via both perspectives – individual differences in rank order and actual raw levels of growth in these capabilities over time.

Finally, the inclusion of adversity in the latent change modeling framework is informative in that it reinforces the idea that these capabilities develop in context. Similarly, the importance of attending to contextual influences on development was apparent in the sex effects detected in the path model. Specifically, with regard to adversity, it is important to note that the detected effect was not of early adversity on initial levels of regulation, but actually on the growth process itself. Thus, to the extent adversity may continue to impact the context in which these capabilities develop, it may exert effects across development. With that in mind, it will also be important to assess and evaluate adversity exposure as a time-varying covariate in future research.

Strengths and Limitations

These studies feature several notable conceptual and methodological strengths. First, longitudinal assessment of emotion and behavior regulation across childhood is crucial for understanding both growth within and transactions between these capabilities, and yet is rarely found in the extant literature. Thus, this investigation makes a significant contribution to the descriptive understanding of the development of emotion and behavior regulation across early childhood, as well as to the dynamic understanding of the overall system of self-regulation during this time frame. While emotion and behavior regulation are conceptually related, the ability to compare and integrate these two domains of functioning is an extremely novel and important contribution of this data.

Second, the measurement of emotion and behavior regulation through observational indices represents a distinct methodological contribution of this research. Particularly in the longitudinal framework, it is rare to examine either of these capabilities observationally. Observation of regulation has the advantage of being free of parental bias in reporting, and offers an opportunity to meaningfully disentangle dispositional qualities from regulation, which cannot be accomplished effectively using caregiver report alone. Furthermore the present study represents an attempt to very specifically measure regulation, while separating this capability from related and often confounded capabilities, such as reactivity and intensity of response.

Third, the present studies utilized teacher and laboratory-based measures of adjustment. Thus, the current design mitigates the bias of using duplicate reporters of regulation and adjustment (such as often occurs with caregiver or observer reports of both) was avoided. Teacher reports of adjustment are often considered a gold standard, both because of their lower potential for biased reporting, as well as for their inherent practical validity in relating to children's real world functioning (Verhulst, Koot, & Ende, 1994).

Finally, the sample in which these studies were conducted represents a large community sample of ethnically and experientially (e.g., adversity exposure) diverse individuals. Thus, the generalizability of these findings is a major strength of the study above other investigations that have used small homogeneous groups of respondents. Moreover, these sample features offered ample opportunity to explore meaningful individual differences in this study.

Nevertheless, these findings are subject to several notable limitations. First, there was a significant confound between age of assessment and the specific task administered. Because there were several differences in the nature of the tasks used to assess emotion and behavior regulation at each time point, it is difficult to tell whether differential findings in either analytic framework were due to task differences or age differences. Specifically, tasks differed with respect to who was present in the room during the task, whether the tasks had an evaluative component (e.g., building a model), which discrete emotions may have been most likely to have been induced, and task length. Although the benefit of providing novel, age-appropriate tasks at each age point also constitutes a strength of this work, and several task-specific factors were attended to both methodologically and analytically, there remains the potential for one or more of these differences to have affected the results. This issue likely represents one of the reasons why longitudinal observational data is so infrequently obtained. That is, due to practice effects and memory of prior events, it is not advisable to repeat the same procedure with children three years in a row and expect to be able to compare reactions across time. In this study, the choice was made to make changes to tasks so as to preserve the likelihood of provoking novel, comparable, emotional responses at each time point, as well as to maximize construct validity within time point.

A second, related, limitation is that, because the length of certain tasks varied across time points, proportions of negative emotion experienced were used in analyses rather than raw durations of emotion. While this did not affect the standardized path analyses, this distinction was meaningful in the latent change analyses. Thus, as is problematic with proportion data, one cannot determine whether it is the ratio itself, the length of the task, or the duration of negative emotion experienced, that is driving the results. However, while a longer task gave children the opportunity to express longer durations of negative emotion, it also gave them the challenge of having to control and subdue emotions for a longer duration. These two effects may cancel each other out, such that the longer task is not biased in one particular direction. In this way, examining the proportion provides the most interpretable measure of emotion regulation. Similarly, for behavior regulation, the age five task was shorter than the tasks at ages four and six. While the coding of behavior regulation was based on an overall global rating of inhibitory control, the length of time during which children needed to control her/his behavior may have influenced these ratings. In future work, the ideal scenario would be for the length of administered tasks to be equivalent at the outset.

Third, the variables themselves provide a limitation, in that there may have been constraints on the variability of possible responses, particularly at the high end later in development. Potential ceiling effects in the assessment of either emotion or behavior regulation could have substantively influenced the latent change modeling results in particular. That said, mean levels of these capabilities at age six suggest there was still room for growth at the group mean level, though a subset of individuals may have reached a ceiling. It may be that measurement of emotion and behavior regulation at high levels requires more sensitive detection of differences in well-regulated individuals. Potentially this is an avenue that could be explored by recoding the already-collected data in one or more ways, or by administering more challenging tasks in the future.

Fourth, the subjective coding of emotion, rather than computerized detection of micro-expressions and subtle changes in affect, may have limited the assessment of emotion regulation. However, this assessment feature is of less concern given the use of global negative affect rather than discrete emotions, and of duration of emotion, rather than intensity.

Fifth, the study was limited to a relatively short age range: ages four through six. While this is likely a particularly important age range to study given the development of emotion and behavior regulation during this period, the study would benefit from additional information about emotion and behavior regulation at both earlier and later stages of development. This represents a clear area for future expansion of this research.

Finally, the study was limited by missing data in a few distinct areas. Although a subset of participants missed one or more of the two assessment points following initial data collection, the rate of attrition was consistent with other longitudinal data collection in community samples. Furthermore, data were determined to be missing completely at random, so it seems unlikely there was any biased attrition specific to the variables at issue in this study. In addition, a subsample of participants was missing teacher-reported adjustment data. Once again, because data were missing completely at random, and maximum likelihood estimation was used in both the path analytic and latent change analyses, it is unlikely that these missing data presented a significant problem. Ultimately the strength of including teacher informants outweighed the possible downside of the smaller sample size for these measures.

Empirical and Practical Implications

The results of this investigation have strong implications for both research and practice. With regard to research, moving forward, it is important to remember that the regulation of emotion and behavior reflect distinct processes. Often research on self-regulation collapses investigations across levels of analysis and/or domains of functioning. However, these findings suggest that, while integrated, these regulatory processes develop at distinct rates, with distinct individual profiles, and only modest concurrent associations, which may reflect cross-lagged developmental effects.

It is also important to consider the age at which these processes are evaluated in future research. Even within early childhood, as examined here, growth in both capabilities was observed, and differential effects on both adjustment and cross-domain functioning were revealed. Thus, researchers should be careful when combining broad age ranges of children into heterogeneous groups, as well as when generalizing findings across even brief periods of development. More longitudinal research studies are needed to specify these effects further through replication and extension in multiple samples.

The current results reinforce the idea that regulatory capabilities are multiply-influenced and thus research on their development demands consideration of environmental, interpersonal, and individual level factors. Specifying the contexts in which these capabilities develop is important to inform generalization across studies, and potentially to target future investigations of contextual influences on individual differences in these relations and trajectories of growth.

In addition to advancing the state of understanding of self-regulation as a dynamic system that develops in context, these findings have important implications for practice. While behavior is often the most easily observable and most attractive target of educational and clinical interventions, these results suggest that behavior develops in concert with, and in some cases as a result of, development in the emotional domain. Thus, it is important to attend to the child in a holistic manner. In applied settings, it is important to document strengths and deficits that may be building blocks for later behavioral functioning, as shown, for example, in the indirect effects of emotion regulation on social competence and externalizing problems, through behavior regulation, shown in this study.

As in research, attending to contextual influences is critically important in practice. The current findings highlight the importance of context in the development of self-regulation, with particular emphasis on early intervention and on targets that are likely to impact growth trajectories, such as adversity exposure and/or early levels of one or more of these regulation capabilities. Findings from the latent change modeling suggest that the period between ages four and five may be a particularly important moment in development, at least for emotion regulation, and potentially more so than the period between ages five and six. Regardless of the reliability of these specific levels of functioning at these ages, the key point is that there may well be particular ages that are more important than others if development does not proceed in a strictly linear fashion.

Finally, these findings suggest that development within and across systems of self-regulation may not proceed in a specific temporal sequence such that developing one skill is a prerequisite with temporal and/or functional primacy over the other. Thus, intervention efforts that target either early regulatory capability that is deficient may be beneficial in scaffolding subsequent growth in the other domain.

Future Directions

Despite the unique contributions of this investigation to understanding the development of the system of self-regulation, several opportunities present themselves for extensions of this work. First, now that initial relations have been proposed for an overall model of transactions between emotion and behavior regulation, an important next step will be to identify potential subgroups for whom these relations may act differently. Specifically, it is important to establish whether the directional paths in this model are relatively universal in development or whether certain paths may be differentially meaningful for particular sexes, ethnic groups, or subsets of individuals who have had specific experiences.

Additionally, it will be important to continue to pursue systems level investigations of these relations, such that particular combinations of emotion and behavior regulation capabilities may evidence interactive and/or synergistic effects on adjustment. For example, emotion regulation may be more or exclusively important for adjustment when levels of behavior regulation are low. Further, future studies will benefit from systematic examination of relations between regulation and adjustment, to evaluate whether optimal levels of emotion or behavior regulation may be moderate rather than extremely high or low. Relatedly, greater attention to the ways in which particular regulatory strategies are employed may mitigate or explain the effects of regulation on later adjustment. For example, while using avoidance as a regulatory strategy may lead to adaptive emotion regulation in the short term, that strategy may itself have detrimental effects on long term adjustment. Finally, it may be that these capabilities evidence effects on other domains of adjustment beyond the four main domains examined here (e.g., health, specific subcategories of psychopathology).

Further, emotion and behavior regulation represent only two specific domains of the system of self-regulation. An important area of expansion will be to integrate measures of physiological regulation across these ages into both path analytic and latent change models. Physiological regulation may transact with emotion and behavior in a similar manner to the cross-domain effects observed here, or it may be that physiology represents a domain general process that either provides an initial set point for these abilities, or supports their efficient development across time in a broad and non-specific way.

Finally, the clearest expansion of this work will be across additional time points. While the work presented here is significant and suggestive, examining these relations through middle childhood, or into adolescence, will enable a more comprehensive evaluation of bidirectional effects, as well as the opportunity to clarify whether there is a primacy of one direction over another, whether these effects are processes that act across development rather than at specific ages, and whether growth in levels of emotion or behavior regulation is ultimately linear or cyclical across periods of growth and periods of constancy.

Closing Comments

The current studies suggest that processes of emotion and behavior regulation comprise a complex multiply-influenced system of development. Relations between emotion and behavior regulation do not appear to proceed in a straightforward temporal sequence. While both capabilities improve over time, and evidence modest stability, they also develop in concert. The system of self-regulation likely does not represent overlapping manifestations of domain general growth, but rather separate and highly interrelated processes that affect both the context and specific capabilities which support and constrain development across domains. The finding that these effects transact in a bidirectional fashion is crucial to understanding this system of functioning. Further, the cross-domain, covariate, and adversity findings converge to demonstrate that the contexts in which these processes are developing influence their levels and trajectories across development. Nevertheless, individual differences in levels and growth persist and remain to be further explained by thorough exploration of both intrinsic and environmental factors that may influence development within and across domains of self-regulation. In sum, the present investigation represents an important step forward in understanding the dynamic system of self-regulation underlying development in early childhood.

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Table 1

Descriptive Statistics and Correlations between Predictors and Adjustment Variables

	IQ	SES	Emotion Regulation Age 4	Emotion Regulation Age 5	Emotion Regulation Age 6	Behavior Regulation Age 4	Behavior Regulation Age 5	Behavior Regulation Age 6	Mean	SD
Internalizing Problems										
Age 4.3	-.220**	-.139#	-.186*	--	--	-.095	--	--	6.413	7.243
Age 5.3	-.167#	-.069	-.117	-.009	--	-.057	-.005	--	5.250	6.230
Age 6.3	-.196*	-.189*	-.022	.035	-.030	-.132	-.205*	-.114	4.139	6.591
Externalizing Problems										
Age 4.3	-.207**	-.122	-.173*	--	--	-.221**	--	--	9.831	13.143
Age 5.3	-.239**	-.164#	-.157#	-.095	--	-.197*	-.177#	--	8.808	11.570
Age 6.3	-.150#	-.202*	-.076	-.129	-.081	-.240**	-.241**	-.416***	5.694	9.620
Social Competence										
Age 4.3	.150#	.088	-.082	--	--	.129#	--	--	32.910	5.570
Age 5.3	.231**	.049	.060	.029	--	.109	.102	--	33.637	6.137
Age 6.3	.180*	.287***	-.025	.081	-.033	.197*	.186*	.301***	32.499	7.185
Reading Achievement										
Age 6	.513***	.177*	-.001	.041	--	.143*	-.003	.162*	109.660	15.740
Age 7	.455***	.202**	-.009	-.039	-.068	.081	.089	.171*	111.422	15.036
Math Achievement										
Age 6	.480***	.189**	.035	-.012	--	.073	-.060	.042	98.068	12.215
Age 7	.518***	.176*	.035	-.068	-.110	.032	.108	.119	98.581	16.618

*** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Table 2
Interrelations among Predictors

	Emotion Regulation Age 4	Emotion Regulation Age 5	Emotion Regulation Age 6	Behavior Regulation Age 4	Behavior Regulation Age 5	Behavior Regulation Age 6
Emotion Regulation						
Age 4	--	--	--	--	--	--
Age 5	.180*	--	--	--	--	--
Age 6	.132#	.172*	--	--	--	--
Behavior Regulation						
Age 4	.146*	.033	.160*	--	--	--
Age 5	-.043	-.126#	-.023	.124#	--	--
Age 6	.176*	.206**	.179**	.277***	.058	--
Covariates						
IQ	-.067	.006	-.140*	-.057	.009	.117#
SES	-.036	.027	.018	.060	.012	.010

*** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Table 3

Sex Differences across Predictors and Adjustment Variables

	Girls	Boys		
	Mean (SD)	*Mean (SD)*	*t*	*p*
IQ	96.184 (14.106)	93.328 (12.863)	1.673	.096
SES	32.872 (12.262)	31.392 (12.012)	.964	.336
Emotion Regulation				
Age 4	.792 (.248)	.754 (.253)	1.174	.242
Age 5	.853 (.178)	.858 (.185)	-.191	.849
Age 6	.902 (.144)	.825 (.227)	2.925	.004
Behavior Regulation				
Age 4	3.836 (1.086)	3.677 (1.123)	1.126	.261
Age 5	4.272 (1.050)	3.635 (1.415)	3.683	< .001
Age 6	4.333 (.805)	4.084 (.972)	2.031	.044
Internalizing Problems				
Age 4.3	5.761 (6.920)	7.095 (7.547)	-1.209	.228
Age 5.3	4.862 (5.734)	5.613 (6.812)	-.658	.512
Age 6.3	3.813 (6.620)	4.493 (6.588)	-.617	.538
Externalizing Problems				
Age 4.3	7.170 (11.219)	12.619 (14.441)	-2.754	.007
Age 5.3	7.190 (11.508)	10.323 (11.513)	-1.490	.139
Age 6.3	4.227 (8.457)	7.290 (10.573)	-1.927	.056
Social Competence				
Age 4.3	32.905 (5.399)	32.912 (5.777)	-.007	.994
Age 5.3	33.550 (6.573)	33.724 (5.719)	-.159	.874
Age 6.3	33.136 (6.630)	31.792 (7.739)	1.160	.248
Reading Achievement				
Age 6	109.190 (15.736)	110.122 (15.804)	-.430	.668
Age 7	111.770 (14.671)	111.097 (15.442)	.299	.765
Math Achievement				
Age 6	98.020 (12.464)	98.113 (12.035)	-.055	.957
Age 7	97.791 (17.128)	99.312 (16.190)	-.611	.542

Table 4

Emotion and Behavior Regulation across Time

	Age 4	Age 5	Age 6	Overall		Linear Contrast		Quadratic Contrast	
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*F*	*p*	*F*	*p*	*F*	*p*
Emotion Regulation	.759 (.251)	.853 (.179)	.857 (.198)	14.868	<.001	19.984	<.001	7.715	.006
Behavior Regulation	3.759 (1.117)	3.909 (1.315)	4.251 (.846)	11.223	<.001	31.096	<.001	.830	.363

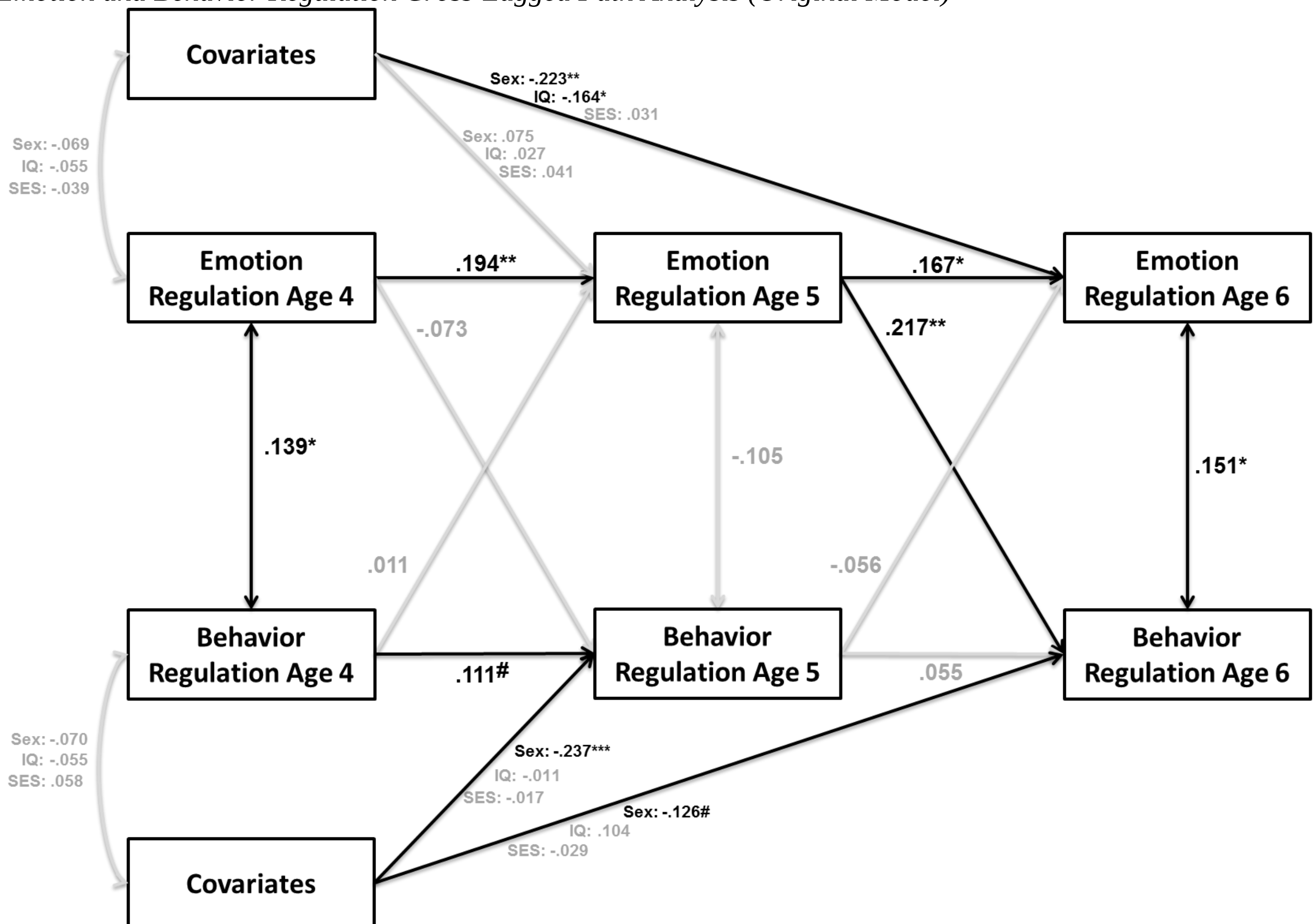
Table 5
Correlations between Adversity and Study Variables

	Environmental Adversity	*Relational Adversity*	*Cumulative Adversity*
Emotion Regulation			
Age 4	.058	.040	.069
Age 5	-.083	-.096	-.128#
Age 6	-.065	-.105	-.116#
Behavior Regulation			
Age 4	.035	-.084	-.030
Age 5	.057	.002	.045
Age 6	.038	.020	.037
Internalizing Problems			
Age 4.3	.088	-.090	.009
Age 5.3	-.100	-.056	-.109
Age 6.3	.151#	.066	.149#
Externalizing Problems			
Age 4.3	.082	.021	.074
Age 5.3	-.062	.037	-.016
Age 6.3	.088	.142#	.155#
Social Competence			
Age 4.3	-.105	-.015	-.094
Age 5.3	-.055	-.030	-.060
Age 6.3	-.116	-.036	-.103
Reading Achievement			
Age 6	-.186**	-.021	-.148*
Age 7	-.177*	.101	-.065
Math Achievement			
Age 6	-.170*	-.019	-.132#
Age 7	-.228**	.113	-.091

*** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 1

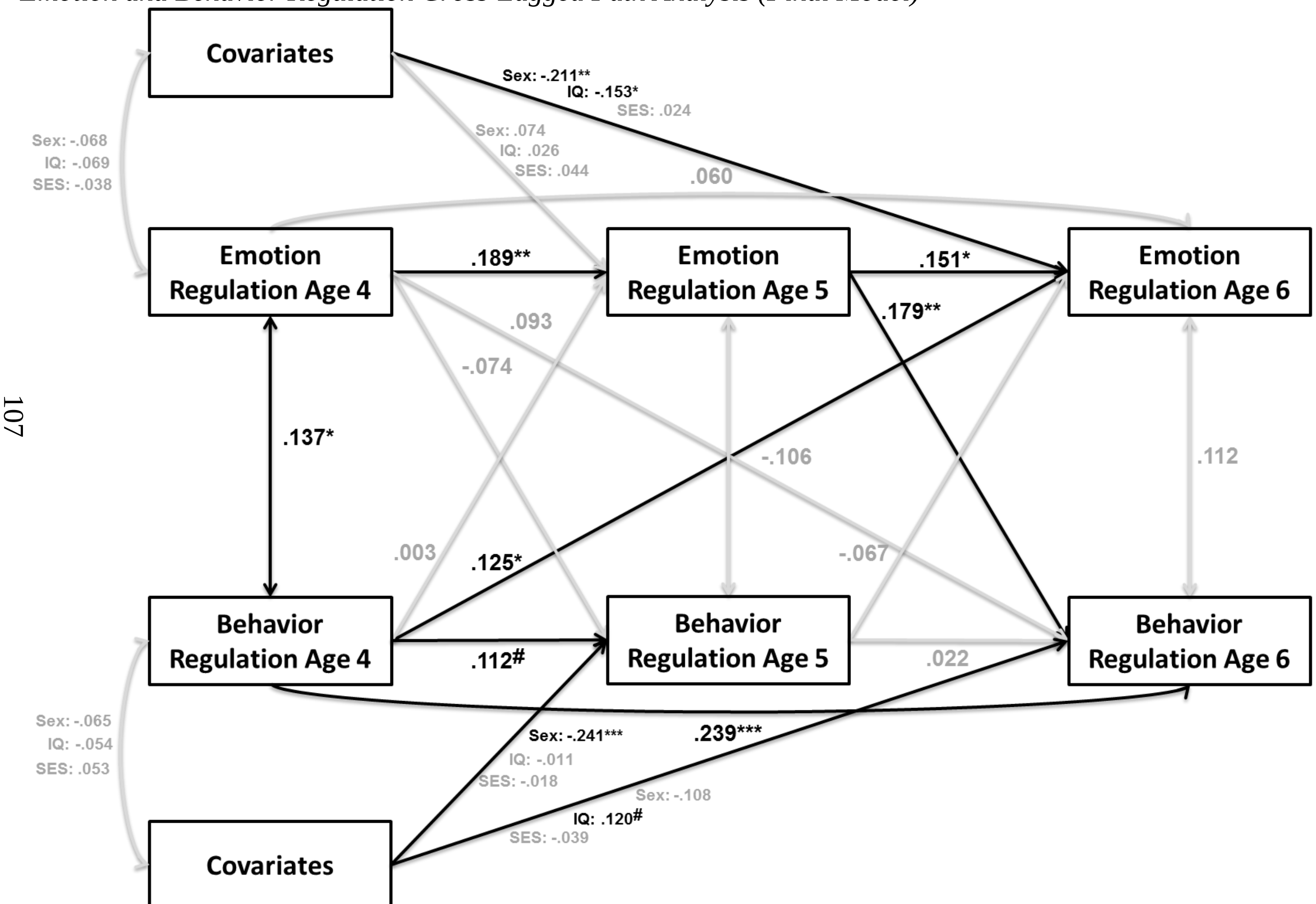
Emotion and Behavior Regulation Cross-Lagged Path Analysis (Original Model)



Note: $\chi^2(8) = 23.536$, $p = .003$, RMSEA = .088, 90% C.I. [.048, .130], CFI = .765. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 2

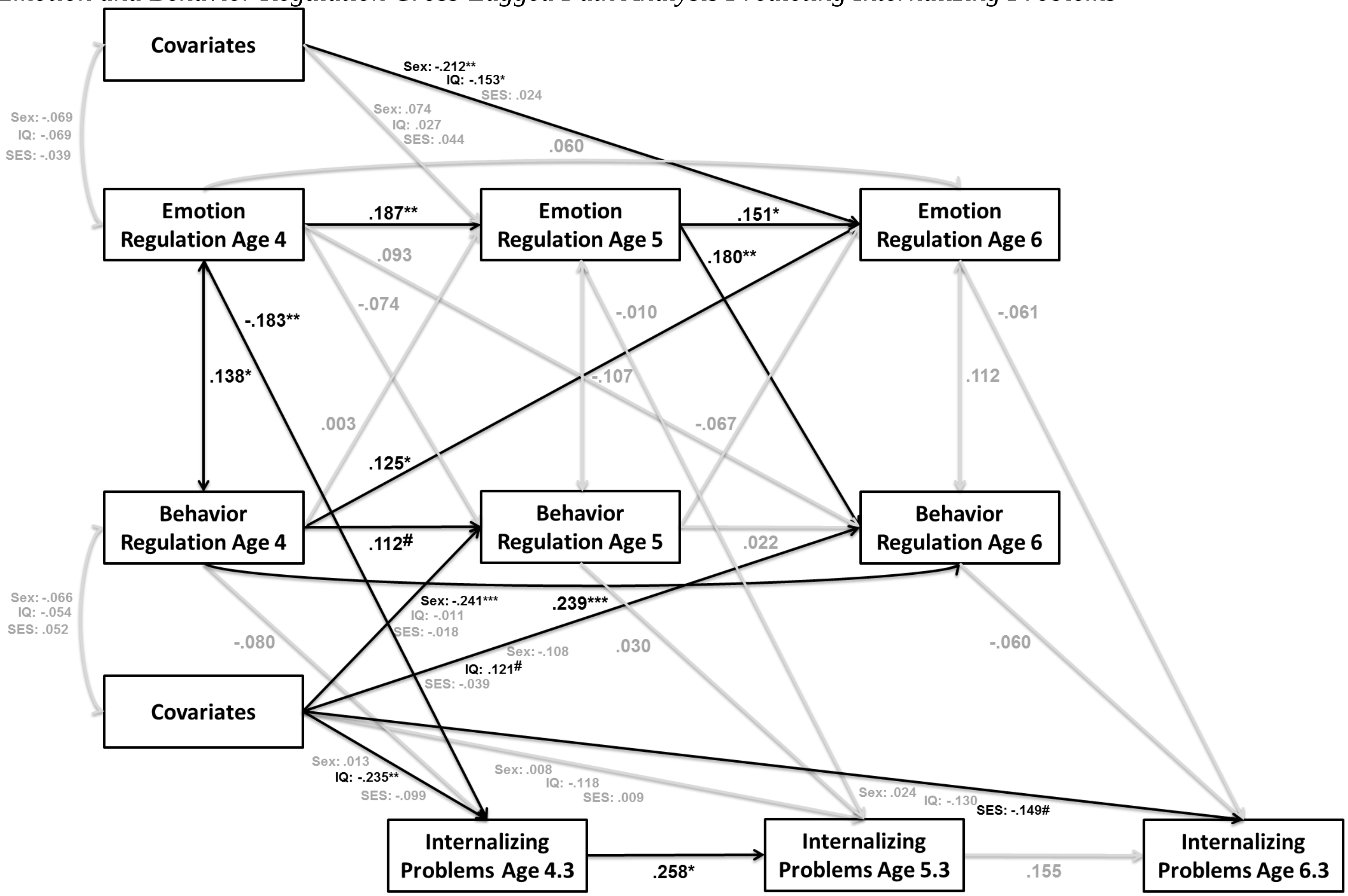
Emotion and Behavior Regulation Cross-Lagged Path Analysis (Final Model)



Note: $\chi^2(4) = 2.737$, $p = .603$, RMSEA = .000, 90% C.I. [.000, .080], CFI = 1.000. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 3a

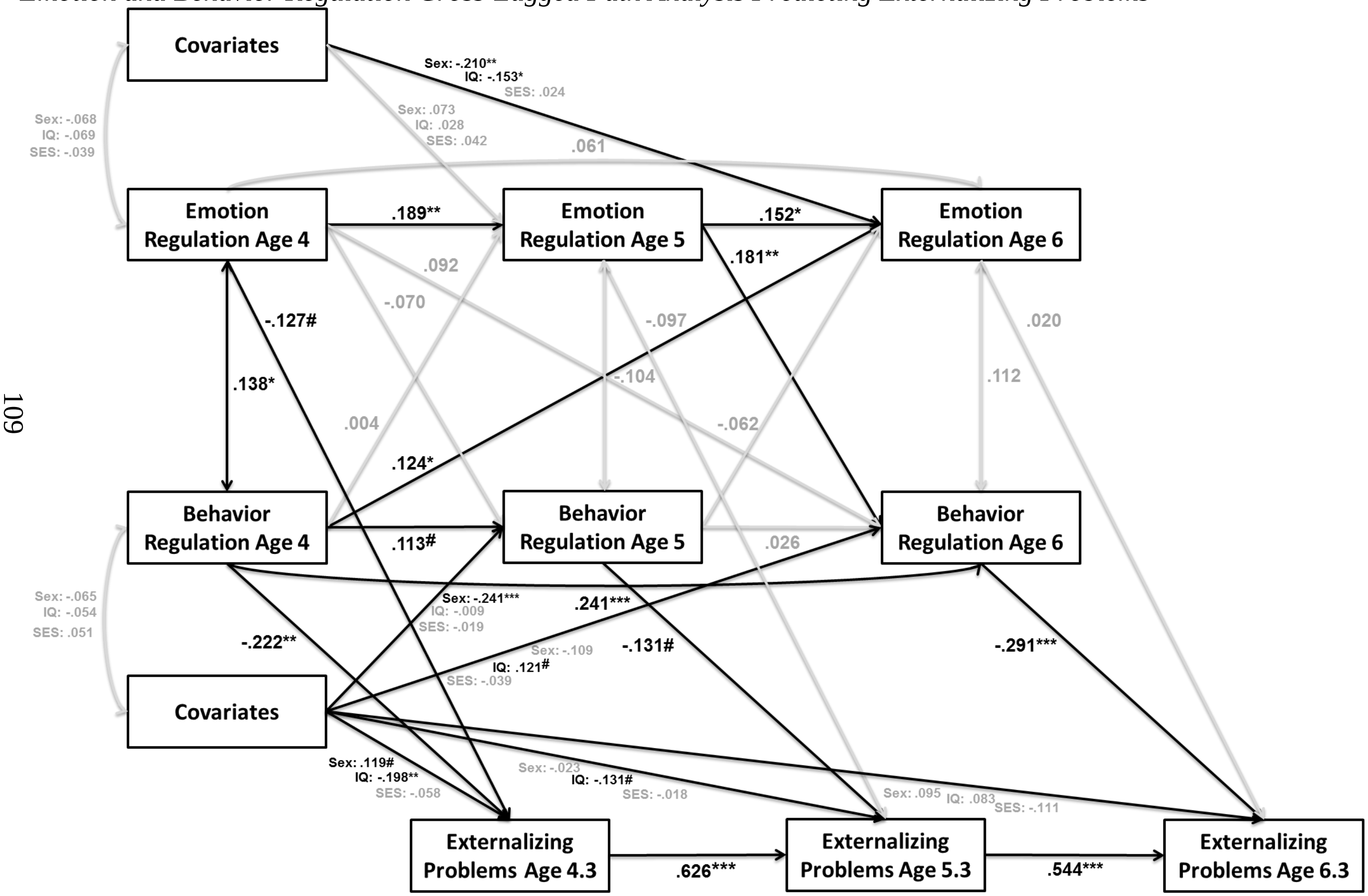
Emotion and Behavior Regulation Cross-Lagged Path Analysis Predicting Internalizing Problems



Note: $\chi^2(17) = 21.105$, $p = .222$, RMSEA = .031, 90% C.I. [.000, .069], CFI = .957.Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 3b

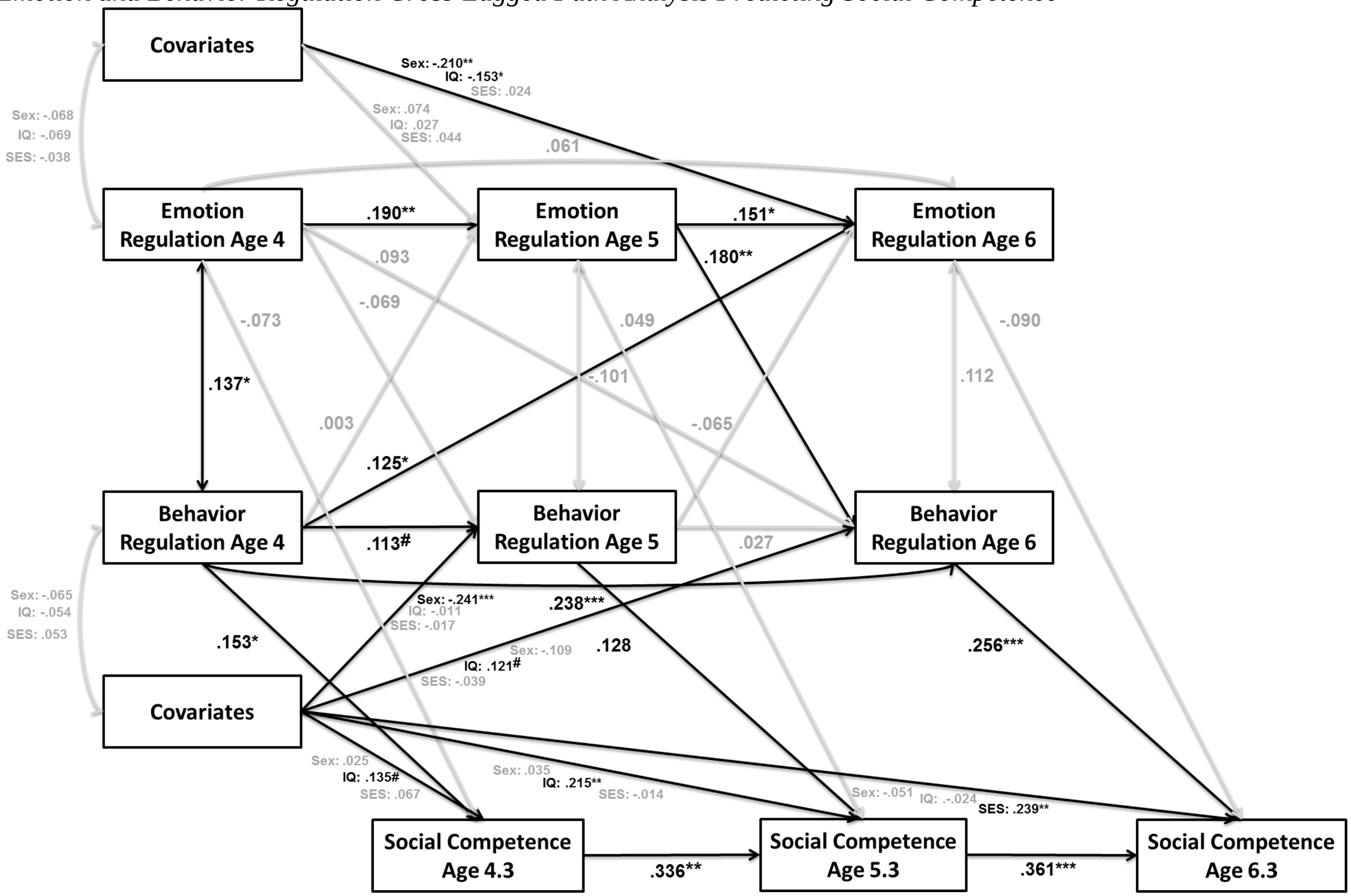
Emotion and Behavior Regulation Cross-Lagged Path Analysis Predicting Externalizing Problems



Note: $\chi^2(17) = 26.140$, $p = .072$, RMSEA = .046, 90% C.I. [.000, .080], CFI = .958. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106\#$, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228^{***}$. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 3c

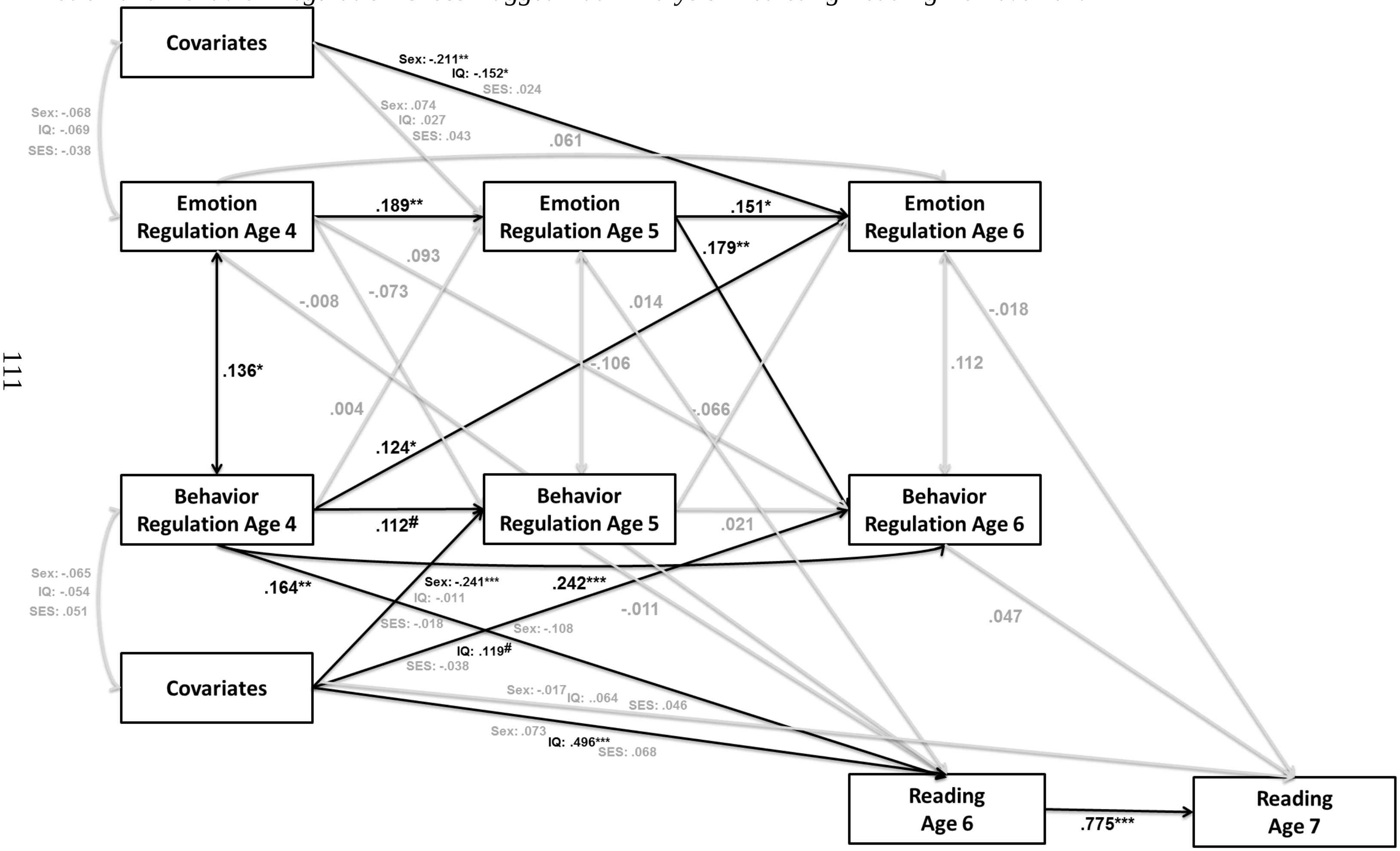
Emotion and Behavior Regulation Cross-Lagged Path Analysis Predicting Social Competence



Note: $\chi^2(17) = 21.918$, $p = .188$, RMSEA = .034, 90% C.I. [.000, .071], CFI = .960. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

Figure 3d

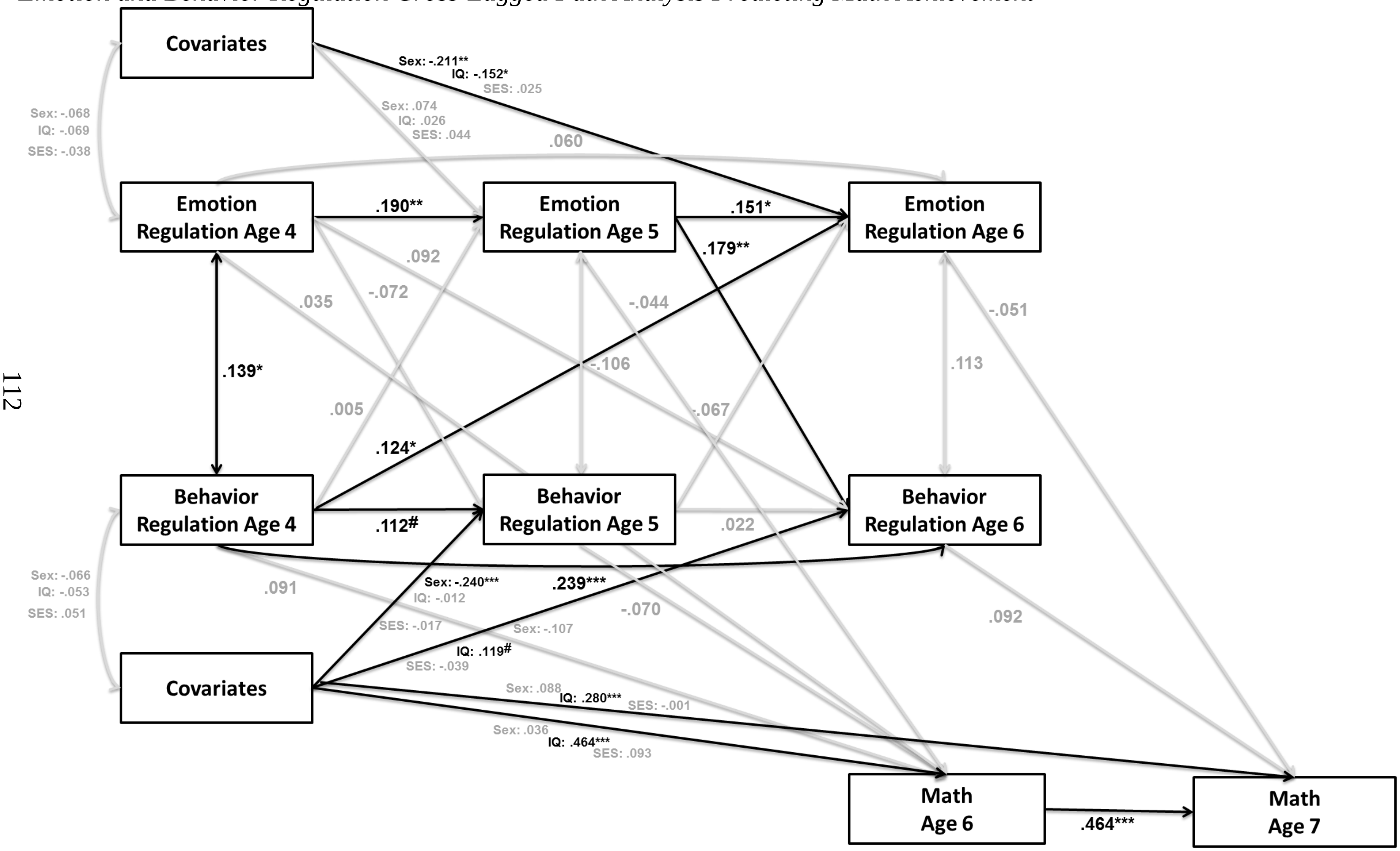
Emotion and Behavior Regulation Cross-Lagged Path Analysis Predicting Reading Achievement



Note: $\chi^2(10) = 9.806$, $p = .458$, RMSEA = .000, 90% C.I. [.000, .068], CFI = 1.000. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

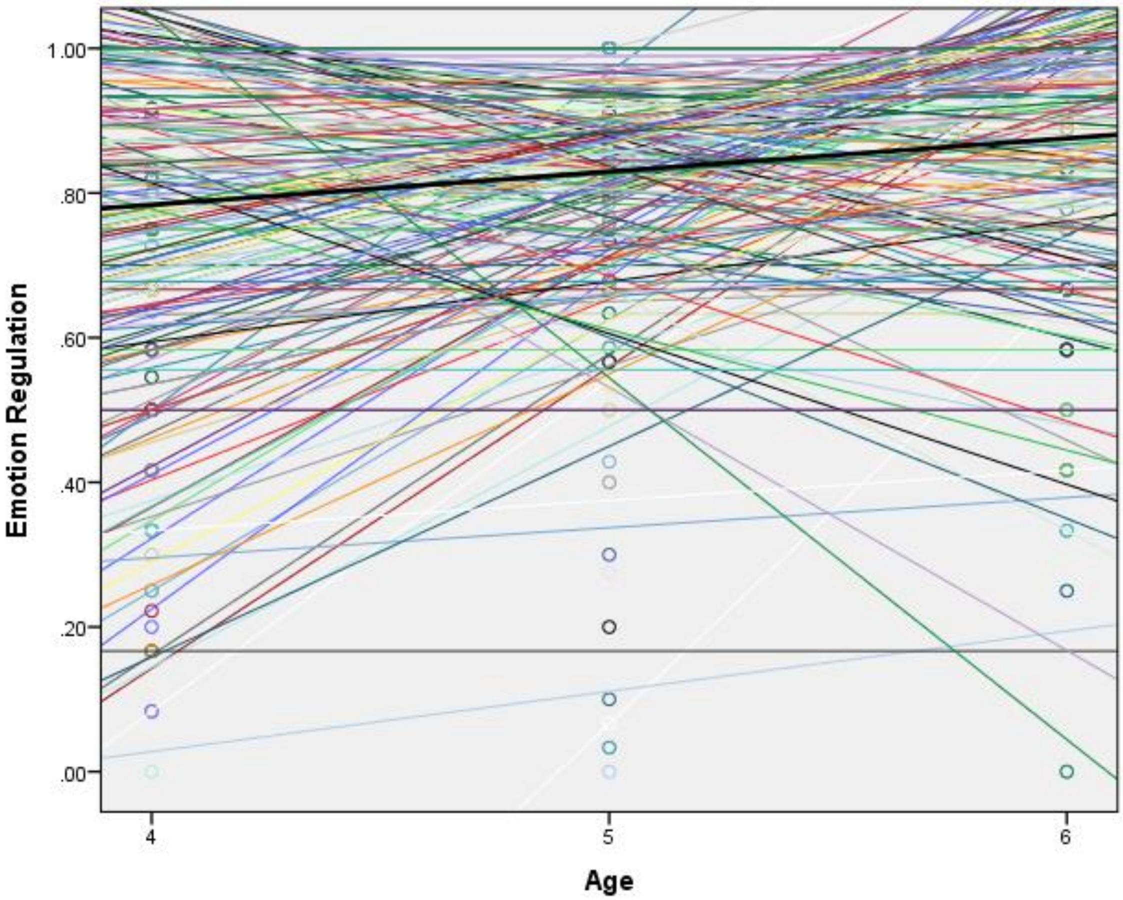
Figure 3e

Emotion and Behavior Regulation Cross-Lagged Path Analysis Predicting Math Achievement



Note: $\chi^2(10) = 9.266$, $p = .507$, RMSEA = .000, 90% C.I. [.000, .065], CFI = 1.000. Nonsignificant effects pictured in grey for clarity. $\gamma_{sex/IQ} = -.106$#, $\gamma_{sex/SES} = -.061$, $\gamma_{IQ/SES} = .228$***. Error variances modeled but not displayed. *** $p < .001$, ** $p < .01$, * $p < .05$, # $p < .10$

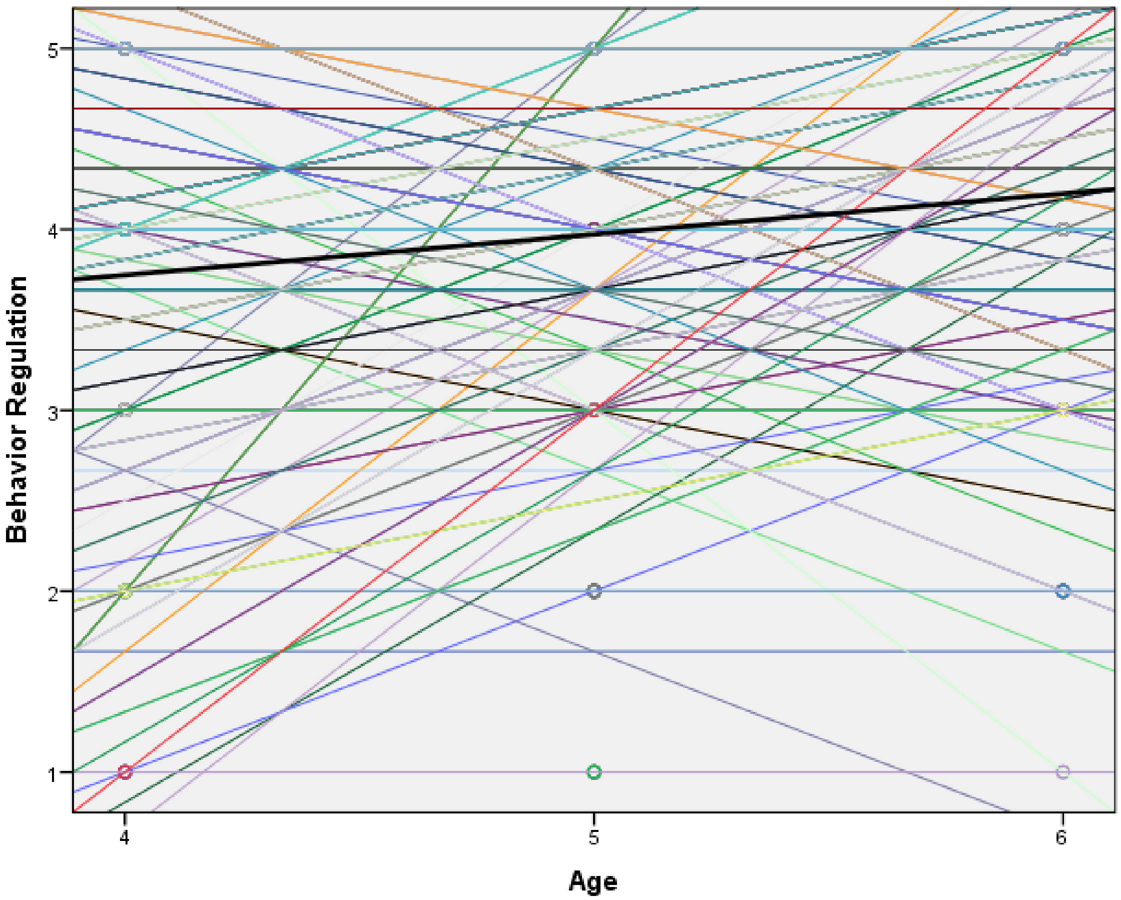
Figure 4a
Individual Linear Trajectories of Emotion Regulation



Note: Best fitting linear trajectory for the total sample depicted in black

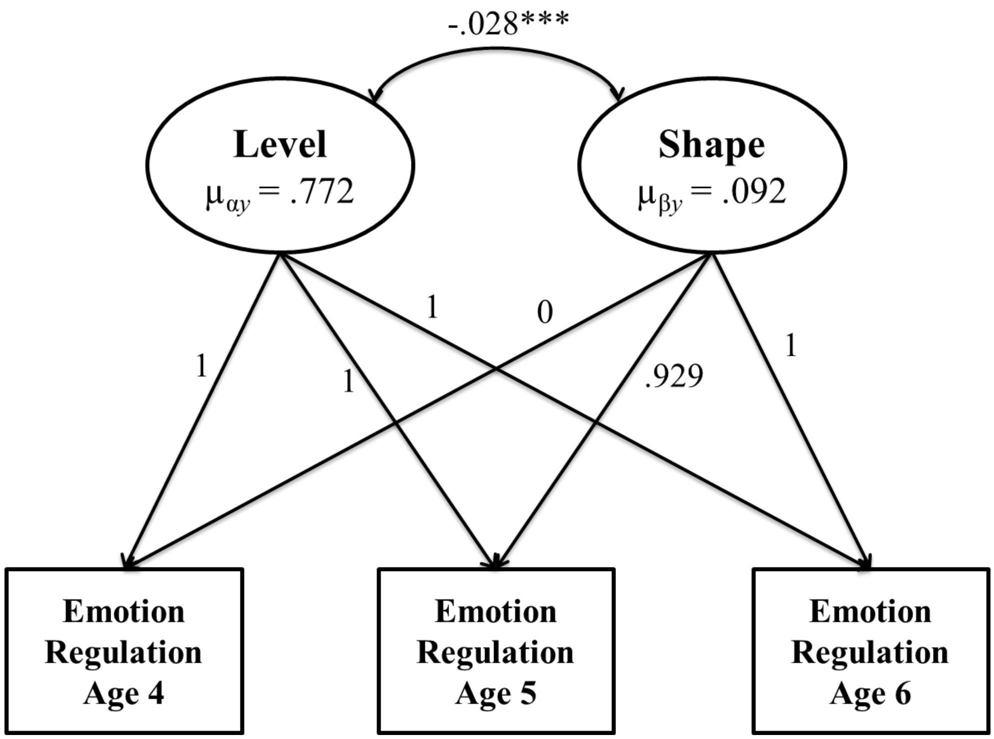
Figure 4b

Individual Linear Trajectories of Behavior Regulation



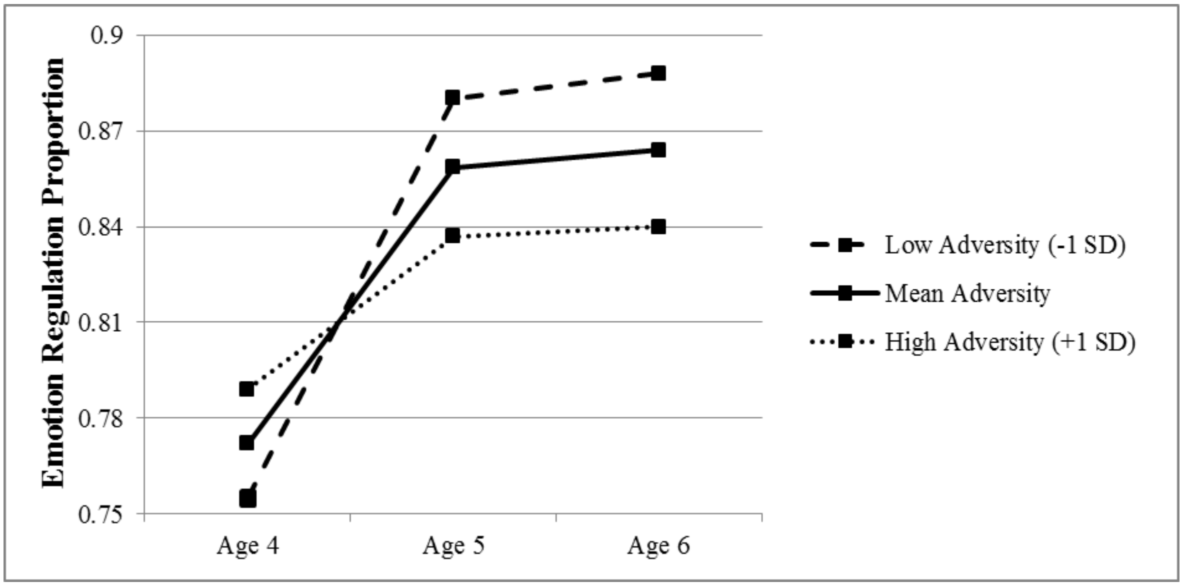
Note: Best fitting linear trajectory for the total sample depicted in black

Figure 5
Level and Shape Model of Latent Change in Emotion Regulation



Note: $\chi^2(2) = 1.040$, $p = .595$, RMSEA = .000, 90% C.I. [.000, .103], CFI =1 .000. Error variances modeled but not pictured, for clarity

Figure 6
Emotion Regulation Trajectories by Cumulative Adversity Experience



Appendix A

Emotion Regulation Coding Indicators:

0: Emotion not present

1: Mild or ambiguous display of emotion

2: Moderate or very clear, definite display of emotion (average intensity, not noticeably extreme)

3: Extreme display of emotion (much more expressive than an average display, may include exclamations of emotion or large movements)

Happiness:

Voice - light, lilting quality; higher pitch; laughing, giggling

Face - Lip corners pulled up, cheeks raised, crinkling around eyes; squinting eyes with open or closed smile, wide eyes with open or closed smile

Sadness:

Voice - Decreasing volume, soft voice, dropping off at end

Face - Lip corners turned down, lower lip depressed, inner brows raised and lowered in oblique shape, eyelids drooped; lower lip rolled in a non-smiling manner, pouting

Anger:

Voice - Harsh, insistent quality, pitch and/or volume increase, demanding

Face - Eyelids tighten or narrow, mouth or jaw set, lips pressed or tightened, open mouth is squarish, teeth clenched; knit, lowered brows, angular mouth, gritted teeth

Disgust:

Voice - As if trying to expel something from throat

Face - Upper lip raised, nose wrinkled; unilateral/bilateral movement of lip against cheek, grimace, tongue/lip out

Worry/Distress:

Voice - Strained, not smooth quality

Face - Brows lowered, eyes may shift frequently, facial twitching, hand twitching/fidgeting normally uncharacteristic of this child

Appendix B

Behavior Regulation Coding Indicators (Age 4):

Touch the car: Any touch of car or remote. A touch that lasts for longer than three seconds can be coded as multiple touches (counted in three section intervals).

Reach for the car: Extension of hand or arm in the direction of car or remote, when the car or remote is within reasonable reach (i.e. the reach could have come close to a touch), that is not clearly for another purpose (i.e. to steady oneself or reach for a different toy). Actual touches do not also count as reaches.

Ask for the car: Any request or demand for the car that is directed at the examiner (e.g. Can I play with it, Is it my turn, Let me play with it, I want to play with it [to examiner]. NOT I want to play with it, said to child her/himself to express frustration).

Inhibitory Control: *Capacity to plan and suppress inappropriate approach responses*

General examples: Can wait before entering new activities if asked to; Is good at following instructions; Can easily stop an activity when s/he is told 'no'.
Examples in this task: Does not touch the car.

1. Very poor inhibitory control: Touches the car 6 or more times, spread throughout the task.

2. Poor inhibitory control: Touches the car 3-5 times (can be more if all within a 30 second period).

3. Medium inhibitory control: Touches the car two separate times (i.e., is told not to touch the car at two separate points).

4. Good inhibitory control: Touches the car once or reaches for the car, but does not touch.

5. Excellent inhibitory control: Does not touch or reach for the car at all.