Individual Differences in Preschoolers' Self-Regulation and Theory of Mind
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Individual Differences in Preschoolers' Self-Regulation and Theory of Mind

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Self-regulation, or the ability to control one's actions and responses, is essential for healthy development across varied contexts. Self-regulation comes in several forms, including emotional, behavioral, and cognitive. The present study sought to examine whether individual differences in one form of self-regulation was related to children's regulation in another domain. In addition, we explored whether different forms of self-regulation were similar in their contribution to preschoolers' understanding of false belief. Findings revealed concurrent relations among emotional, behavioral, and cognitive self-regulation. When measures of children's self-regulation were related to their performance on false belief tasks one year later, executive function predicted false belief understanding, while emotional and behavioral self-regulation did not contribute significantly to the model. These findings support the theory that self-regulation may consist of different interrelated types, including emotional, behavioral, and cognitive. In addition, the study provides important discriminant validity for the types of properties by which inhibitory control processes may be distinguished.

Self-regulation, or the ability to control one’s actions and responses, is essential for healthy development across varied contexts. This ability comes in several forms, including emotional, behavioral, and cognitive. It

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has been proposed that individual differences in one form of self-regulation may be related to children’s regulation in another domain (Calkins & Howse, 2004). To date, there exists limited empirical work exploring a wide range of self-regulatory skills to address this issue. The first aim of the present study, therefore, was to examine individual differences in preschool children’s emotional, behavior, and cognitive self-regulation. Another important question is whether various forms of self-regulation are similar in their contributions to other developmental achievements. Specifically, recent work has identified an association among executive function, a cognitive form of self-regulation, and children’s understanding of false belief, a critical element in their development of theory of mind and significant to their social development (e.g., Carlson & Moses, 2001; Frye et al., 1995; Hughes, 1998). The second aim of the present study was to explore whether different forms of self-regulation are similar in their contribution to preschooler’s understanding of false belief.

Self-regulation is broadly defined as the control or organization of behavior, or the active suppression process engaged for the purposes of pursuing a goal (Fuster, 1997; Kopp, 1989; Posner & Rothbart, 2007), and involves control over a variety of processes, including emotion (i.e., emotion regulation), motor (i.e., behavioral control), and cognition (i.e., executive function). Theoretically, individual differences in one type of self-regulation might be expected to be related to regulation in another domain (Calkins & Howse, 2004). Blair (2002) hypothesized that children with difficulty regulating emotion may show poor behavioral and cognitive self-regulation or may have less practice than other children with more regulatory skills. On the role of executive function and behavioral control in aiding emotion regulation, Kopp (1989) highlights the importance of planfulness, organization, and monitoring in aiding children to identify sources of distress, reflect on how distress was alleviated in the past, and enlist the appropriate strategies for self-soothing. It may be that the underlying process of inhibitory control explains relations among various forms of self-regulation. Indeed, neuropsychological research points to correlations between dysfunctions of the frontal lobe and inhibitory deficits in action, cognition, emotion, and personality, suggesting that a common structure may govern these processes (Fuster, 1997; Luria, 1973). Developmentally, these skills appear in simpler forms across infancy but show the greatest maturation in the preschool years.

*Children’s Development of Self-Regulation*

Cognitive self-regulation, or executive function, entails flexible goal-directed behavior, the temporal organization of behavior, and flexibility of
complex and purposeful behavior (e.g., Fuster, 1997). Although cognitive self-regulation is present by around 12 months of age, the greatest developmental growth in this ability is thought to occur between about 3 and 6 years of age. During this time, children show significant improvement in their ability to inhibit perseverative and prepotent responses, to use rule-based reasoning skills, and to use overt speech to monitor their behavior (e.g., Diamond & Taylor, 1996; Frye, Zelazo, & Palfai, 1995; Gerstadt, Hong, & Diamond, 1994).

The self-regulation of emotion is an extrinsic and intrinsic process responsible for monitoring, evaluating, and modifying emotional reactions or expressions (Thompson, 1994). Rudimentary forms of this skill appear in early infancy (Stifter, 2002). With age, children become better able to express and self-regulate their emotions, as can be seen in their generation of emotional expressions in play and their modulation of emotional expressions during stressful events (e.g., Thompson, 1994). Studies have shown that children as young as 3 years of age are able to regulate their emotional expressions in accordance with social display rules, and this ability shows age-related changes in children from first through fifth grades (Saarni, 1984).

Behavioral self-regulation develops as children acquire greater motor capacities and an increasingly complex behavioral repertoire. The inhibition of some motor activity is necessary for the attainment of goals that do not call for physical activity (Maccoby, Dowley, Hagen, & Degerman, 1965). This ability begins to mature sometime after the first year, and by the preschool years children can more flexibly balance self-defined needs with social expectations (Kopp, 1989). Behavioral control includes the capacity to actively suppress or delay approach, to regulate the pace of one’s movement, to willingly inhibit forbidden impulses, to delay gratification, to suppress or initiate an activity, and to comply with others’ requests (Kochanska, Murray, and Harlan, 2000; Posner & Rothbart, 2007).

Although these skills may emerge and consolidate at different ages, there is empirical evidence to suggest some commonality. For example, several studies have demonstrated associations between traditional executive function measures and those requiring greater behavioral and attentional regulation (Carlson & Moses, 2001; Cole, Usher, and Cargo, 1993). Likewise, research has linked behavioral control to emotion regulation (Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Stifter, Spinrad, & Braungart, 1999) and to other measures of behavioral self-regulation (Kochanska et al., 1998). Finally, Carlson and Moses (2001) demonstrated that executive function tasks that require children to provide novel responses incompatible with prepotent responses (i.e., conflict tasks) can be distinguished from those that require the ability to delay, temper, or suppress an impulsive
response (i.e., delay tasks). It is possible to argue that measures of impulsivity and those assessing modulation of emotional responses can be more consistent with delay tasks than conflict tasks.

**Associations between Self-Regulatory Processes and Understanding of False Belief**

Important to our understanding of children’s self-regulatory processes is a consideration of whether various forms of regulation are similar in their contribution to other developmental achievements. There is an ever increasing body of work that implicates the role of executive function in children’s ability to understand false beliefs (e.g., Carlson & Moses, 2001; Frye et al., 1995; Hughes, 1998). Children’s comprehension of false belief indicates that they can distinguish between reality and the beliefs of others and can hold these multiple (and often contradictory) representations of events in their mind at once (Wellman, 1990; Wellman, Cross, & Watson, 2001). This ability emerges in the preschool years at around age 4, with some variation around the age of acquisition (Astington, 2003; Wellman et al., 2001). An understanding of false belief has been implicated in children’s development of social competence (Astington, 2003). While the specific mechanism underlying the connection between executive function and false belief understanding has yet to be confirmed, there is empirical support of both concurrent and longitudinal relations (e.g., Flynn, O’Malley, & Wood, 2004; Frye, Zelazo, & Palfai, 1995; Carlson, Mandel, & Williams, 2004; Carlson & Moses, 2001; Hughes, 1998; Perner, Lang, & Kloo, 2002).

With respect to the specific types of executive function, Carlson and Moses (2001) found relations between various measures of delay and theory of mind, but the conflict task battery was found to be a better predictor. In another study (Moore, Barresi, & Thompson, 1998), 4-year-olds who opted for a delayed reward showed better performance on a measure of theory of mind. Given that emotion-regulation and behavioral control are most consistent with delay executive function tasks, the findings suggest that such tasks should also be related to theory of mind, albeit to a lesser extent than true conflict executive function tasks.

The first goal of the present study was to examine individual differences in emotional, behavioral, and cognitive self-regulation. We hypothesized that the three forms of self-regulation would be related, at both the level of individual measures and composite batteries. Our second goal was to assess relations between self-regulation and theory of mind. We hypothesized that executive function would be a significant predictor of false belief understanding and speculated that both emotion-regulation and behavioral
control would also be significant predictors. Theoretically, these other forms of self-regulation could also moderate the relation between executive function and theory of mind in a linear fashion such that, overall, more self-regulation (e.g., greater behavioral regulation and executive function) would be a stronger predictor of theory of mind than executive function alone. Alternatively, executive function could act as a developmental link between other forms of self-regulation and theory of mind and thus mediate that relation. We explored both of these possible pathways.

Method

Participants

Participants were drawn from a longitudinal study of emotional development in healthy full-term infants and children. Child participants were from predominantly White, middle-class families and were originally recruited from a local community hospital. At 4.5 years ($M = 4$ years, 7 months), 92 participants were observed with their mothers (43 female), and 90 participants (43 female) returned to be observed with their fathers approximately two weeks later. At 5.5 years ($M = 5$ years, 8 months), 86 subjects (41 female) were observed.

Procedure

Laboratory visits were conducted in a quiet observation room with a one-way mirror and two video cameras. Children were seated at a small wooden table next to the experimenter for all tasks, with the exception of the second-order theory of mind task, which took place on the floor of the observation room. Table 1 lists the tasks completed at each laboratory visit.

- Emotional expressions and regulation. Two tasks were used to elicit children’s emotional responses and regulation strategies. In the Lab-TAB attractive toy in a transparent box task (Goldsmith, Reilly, Lemery, Longley, & Prescott, 1999), the child was prevented from playing with a desired toy because it was locked in a clear box that the child could not open. After a brief presentation of a handheld toy to the child, the experimenter took it away and told the child that she would lock it in the special box and that the child could use keys to open the lock and get the toy. After confirming that the child knew how to use keys and locks, the experimenter left the child to attempt to open the locked box for a total of 3 minutes (none of the keys worked). During the first 2 minutes of the task, the child’s parent remained in the room working on questionnaires. Parents were instructed not to help
Table 1. Tasks Completed at Each Laboratory Visit

<table>
<thead>
<tr>
<th>Measure</th>
<th>Construct</th>
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<tr>
<td>PPV</td>
<td>Receptive language</td>
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<td>Disappointment task</td>
<td>Emotion regulation</td>
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<tr>
<td>4.5-Year Lab Session #1</td>
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<tr>
<td>Three- pegs task</td>
<td>Executive function</td>
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<tr>
<td>Day/night task</td>
<td>Executive function</td>
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<td>Delay of gratification task</td>
<td>Behavioral control</td>
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<td>Continuous performance task</td>
<td>Executive function</td>
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<tr>
<td>Tapping task</td>
<td>Executive function</td>
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<tr>
<td>Dinky-toy task</td>
<td>Behavioral control</td>
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<tr>
<td>Attractive toy in transparent box</td>
<td>Emotion regulation</td>
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<tr>
<td>4.5-Year Lab Session #2</td>
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<tr>
<td>Theory of mind—false belief location</td>
<td>False belief understanding</td>
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<tr>
<td>Theory of mind—belief-desire reasoning</td>
<td>False belief understanding</td>
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<tr>
<td>Second-order false belief</td>
<td>False belief understanding</td>
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<tr>
<td>5.5-Year Lab Session</td>
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| their children open the lock and to respond to pleas for help with “I’m busy right now.” For the last minute of the task, the child was left alone in the room to continue trying to open the lock. In the disappointment task (Cole, 1986; Saarni, 1984), the child received an undesired toy. The child was shown a tray of 5 toys and asked to rank the toys that he or she liked the most and liked the least. After the child participated in a number of other tasks, the experimenter announced that she had a prize for the child. The experimenter left the room with the parent and returned alone with a wrapped prize, which consisted of the toy that the child had ranked as the least favorite. The experimenter sat across from the child while he or she unwrapped the gift but did not engage the child (experimenter-present condition; 30 seconds). Then the experimenter left the room for 60 seconds (experimenter-absent condition), after which a second experimenter interviewed the child about his or her feelings about the gift. Finally, the original experimenter returned to the room, apologized for accidentally giving the child the wrong prize, and gave the child the opportunity to exchange the unwanted gift for another prize.

Behavioral/motor self-regulation. Two tasks were used to assess children’s behavioral self-regulation. In the delay of gratification task (Mischel & Mischel, 1983), two small cups were placed on a table immediately in
front of the child, and a bell was placed between the two cups. One M&M candy was placed in one cup, and two candies were placed in the other cup. The experimenter informed the child that she and the child’s parent needed to leave the room. If the child waited for them to return, he or she would receive two M&M candies, but if he or she could not wait, then the child should ring the bell to summon their return and would then receive only one M&M candy. After ensuring that the child understood the rules, the experimenter and parent left the room for a period of 15 minutes, or until the child rang the bell.

In the dinky-toy task (Goldsmith et al., 1999), children were assessed on their ability to control impulsivity. Children were presented with a large container filled with small toys. As the experimenter opened the container of toys, children were told that they would have the opportunity to choose one toy to keep but that they had to be careful because the first toy that they touched would be the one that they would keep. The container was placed immediately in front of the children, and the experimenter waited while the children chose a toy.

**Cognitive self-regulation: Executive function.** Four tasks were used to assess executive function. The continuous performance task was a PsyScope computer-based go—no go task consisting of 16 trials (Cohen, MacWhinney, Flatt, & Provost, 1993). During each trial, children were presented with a black and white drawing of an animal on a computer screen. The stimuli consisted of rabbits (the target animal) and distracter animals (i.e., elephant, frog, deer, and polar bear). Children were instructed to press the space bar on the computer keyboard as fast as possible when a rabbit was presented (Rule 1) and to refrain from pressing the bar when any other animal was presented (Rule 2). The duration of the picture presentation began at 4 seconds, and decreased by an increment of 1 second at every fourth trial. The order of the stimuli presented was random without replacement. The picture disappeared from the screen either in response to a key press or when the duration of presentation time elapsed. The computer program recorded the child’s performance on each trial.

The day/night task (Gerstadt, Hong, & Diamond, 1994), a Stroop-like task, was used to assess children’s ability to follow two card-naming rules requiring inhibition of a prepotent response. Children were instructed to say “day” when shown a black card with a picture of a moon (Rule 1) and to say “night” when shown a white card with a picture of a sun (Rule 2). The task consisted of 2 practice trials, which were repeated if the child got them incorrect, followed by 16 test trials in a fixed random order.

The tapping task (Diamond & Taylor, 1996) was used to assess children’s ability to follow two stick-tapping rules requiring inhibition of a
prepotent response. Children were instructed to tap a stick on a table once if the experimenter tapped the stick twice (Rule 1) and to tap twice if the experimenter tapped once (Rule 2). The task consisted of 2 practice trials, which were repeated if the child got them incorrect, followed by 16 test trials in a fixed random order.

In the three-pegs task (Balamore & Wozniak, 1984), the child was required to tap colored pegs in a specified, novel sequence. The apparatus consisted of a wooden board with three colored pegs arranged in the order of red, yellow, and green and a small orange stick with which to tap the pegs. After a pretest of the child’s ability to correctly identify the three colored pegs, the experimenter asked the child to point to each colored peg in the order they appeared on the wooden board (i.e., red, yellow, green). Next, the experimenter instructed the child to use the stick to tap the pegs in an order that was inconsistent with their arranged order. A confirmation trial followed all correct responses. If the child was incorrect, the experimenter demonstrated how the pegs should be tapped and then let the child try again. If the child was again incorrect after demonstration, then the experimenter repeated the demonstration and asked the child to say the peg colors as he or she tapped them. If the child did not get this trial correct, the task was ended.

Theory of mind. To obtain a reliable estimate of children’s false belief understanding, three different false belief tasks were used. The location false belief task was a modified version of Wimmer and Perner’s (1983) standard unexpected location false belief task. Children watched a video of two young children placing a box of cookies in a specified location. After one of the characters left the room, the second character moved the cookies to a new location and left the room. Finally, the first character returned to the room and announced that she wanted another cookie. Following the end of the videotaped scene, children were asked one location false belief test question (Q1: “Where will Molly look for the cookies?”), one justification question (Q2: “Why will she look there?”), and two location reality control questions (Q3: “Where are the cookies really?” and Q4: “Where were the cookies put first of all?”).

The belief-desire reasoning task (see Harris, Johnson, Hutton, Andrews, & Cooke, 1989) required children to predict an emotion from an attributed false belief about the contents of a container. Children watched a video recording of two children acting out a scenario in which one character played a mean trick on the other character by replacing the contents of the first character’s can of Coke (his favorite drink) with milk (his least favorite drink). Midway through the video, children were asked two emotion questions, each one followed by an emotion reality control question.
(Q5: “How does Bradley feel when he gets a can of Coke?”; Q6: “Why does he feel that way?”; Q7: “How would Bradley feel if he got some milk?”; and Q8: “Why would he feel that way?”). At the end of the video, children were asked one emotion-contingent-on-false-belief question and justification (Q9: “When Bradley first comes back, how does he feel . . . Happy or not happy?” and Q10: “Why is he happy/not happy?”), a contents false belief question (Q11: “What does Bradley think is in the can?”), a contents reality control question (Q12: “What is in the can really?”), an emotion question (Q13: “How will Bradley feel after he has a drink from the can?”), and a follow-up emotion reality control question (Q14: “Why will he feel that way?”).

In the second-order false belief task (Perner & Wimmer, 1985), children were asked to attribute second-order beliefs to characters in a story enacted by the experimenter using Lego pieces for the characters (John and Mary) and a rug that depicted a neighborhood. “Mary wants to buy ice cream from the ice cream man at the park but must run home to get money. After she leaves, John witnesses the ice cream man leave the park to move his truck to another location (the library). The ice cream man passes Mary’s house on the way and informs her of his change of location. After going home, John goes to Mary’s house to find her. Her mother says she left to get ice cream. John runs to look for Mary.” Children were then asked one second-order false belief test question (Q15: “Where does John think that she has gone?”), one justification question (Q16: “Why does he think she has gone there?”), and three reality-control questions (Q17: “Does Mary know that the ice cream truck is at the library?”; Q18: “Does John know that the ice cream man has talked to Mary?”; and Q19: “Where did Mary go for her ice cream?”).

Measures and Coding

Verbal ability. The Peabody Picture Vocabulary Test-Third Edition (PPVT-III), developed by Dunn and Dunn (1981), was used as a measure of the child’s receptive language. The PPVT standardized score at 4.5 years of age was used to assess the degree of variation in other study variables that may be accounted for by the child’s language ability.

Emotion regulation. Children’s vocal and verbal expressions of affect were coded during the attractive toy in a transparent box and disappointment tasks. We focused only on the experimenter-present condition of the disappointment task as it represented a greater challenge to the emotion-regulation system than the experimenter-absent condition. From the videotapes, vocalizations and verbalizations were transcribed and then coded for
tone and content. Vocalizations suggestive of anger or frustration were
coded as negative, and those suggestive of happiness or cheerfulness were
coded as positive. Verbalizations and vocalizations were then categorized
as low or high positive and low or high negative, based on whether only
tone or content indicated that valence (coded as low) or both tone and con-
tent indicated that valence (coded as high). All other vocalizations were
coded as neutral. Reliability on 28% of the subjects was .91 (Cohen’s κ).

Children’s facial expressions were also coded during the experiment-
present condition of the disappointment task. Coders were trained to mark the
onset and offset of expressions reflecting low/moderate positive, high posi-
tive, low/moderate negative, and high negative affect. Positive expressions
included lip corner pull and cheek raise. Negative expressions included lip
corner depress, upper lip raise, chin raise, lip tighten, lip press, lip biting, nose
wrinkle, inner brow raise, and lowered brow (see Ekman & Friesen, 1978).
Coders were first trained to 89% agreement and maintained 84% agreement
on 24% of the subjects.

Children’s emotion-regulation strategies were coded from videotapes of
the attractive toy in a transparent box task. In line with previous work on regu-
laratory strategies used by young children in the context of frustration (e.g.,
Eisenberg et al., 1995), the presence/absence of the following nine behaviors
were coded in 10-second intervals: (1) goal-directed action (strategic or plan-
ful efforts to open the box), (2) alternative strategies (attempts to open the box
without using the keys), (3) distraction (when the child turned her or his atten-
tion away from trying to open the box), (4) self-speech (when the child talked
to herself or himself during the task), (5) vocal/internal venting (when the
child engaged in behaviors that released tension or frustration, such as raising
the volume of her or his voice or yelling), (6) physical venting (banging, kick-
ing, throwing, hitting the object), (7) social support-seeking (when the child
tried to get help from someone else), (8) self-soothing (when the child
engaged in behaviors such as thumb-sucking, hair-twirling, rocking, or other
auto-manipulative behaviors), and (9) disruptive behavior (when the child
acted in ways that were aggressive or disruptive). Reliability was assessed on
14% of the subjects; Cohen’s kappas for the nine categories of behaviors
ranged from .81 to 1.0.

Data reduction. In an effort to reduce the data on children’s emotional
expressions and regulation, we created summary scores by combining data
on vocal affect, facial affect, and regulatory behaviors as follows. First,
composite scores representing positive, negative, and neutral affective
expressions were created by summing the proportions of high and low posi-
tive and high and low negative affective expressions within the two con-
texts (attractive toy in a transparent box and disappointment tasks) and then
averaging the proportions of time that the children expressed positive, negative, and neutral affect, facially and vocally, across the tasks. Next, data on emotion-regulation strategies was aggregated based on theoretically driven categories of coping strategies (e.g., Eisenberg et al., 1995); constructive strategies consisted of goal-directed behaviors, alternative strategies, social support, and self-speech, and aggressive strategies consisted of vocal venting, physical venting, and disruptive behaviors. Finally, in order to determine whether the data on emotional expressions and emotion-regulation strategies could be combined to form coherent categories, a principal components analysis was conducted on positive, negative, and neutral affective expressions and on constructive and aggressive emotion-regulation strategies. Components with eigenvalues greater than 1 were selected to determine the factor model, and varimax rotation was used to interpret the factor matrix. Two factors were extracted that accounted for 62% of the variance. The first factor was defined by high loadings for negative expressions (.87) and aggressive strategies (.82). The second factor was defined by high loadings for positive expressions (.66), neutral expressions (.53), and constructive strategies (.82). Thus, two composite emotion expression-regulation variables were created: negative/aggressive and positive/constructive.

**Behavioral/motor self-regulation.** For the delay of gratification and dinky-toy tasks, latency scores were computed that consisted of the duration of time that the child waited without ringing the bell or eating an M&M (delay of gratification) or the time it took the child to touch a toy (dinky toy). Children who waited the entire period for delay of gratification were given a latency score of 900 seconds. Because the delay of gratification latency variable was negatively skewed, values were reverse-scored (i.e., reflected) prior to using a logarithmic transformation (Tabachnick & Fidell, 2001). Thus, lower values represented greater success at delay, and higher values indicated less success in delaying. The dinky-toy latency variable was positively skewed. Thus, a logarithmic transformation was used, and a constant of 1.0 was added to all values prior to the transformation to avoid obtaining negative values (Tabachnick & Fidell, 2001). Reliability was assessed for 20% of the sample, and the intrarater agreement on latencies was 1.0 and .96 (intraclass correlation coefficient) for the delay of gratification and dinky-toy tasks, respectively.

**Cognitive self-regulation: Executive function.** To assess inhibitory ability from children’s performance on the continuous performance task, scores for correct no key presses and errors of commission scores were calculated. For both the day/night and tapping tasks, composite scores were calculated that consisted of the percentage of correct responses across all test trials and the number of practice trials required (reverse-scored). For
the three-pegs task, scores consisted of the number of trials required to pass the task (reverse-scored), ranging from 0 (i.e., the child failed to pass the task) to 3 (i.e., the child passed the task on the first try).

Theory of mind. A total of 7 test questions were asked of the children across location false belief, belief-desire reasoning, and second-order false belief tasks (i.e., Q1, Q5, Q7, Q9, Q11, Q13, Q15). Children were rated as correct on each of the test questions if they also responded correctly to that question’s respective reality control question(s). The theory of mind composite score was created by adding the number of correct test questions for each child. The number of children who were correct on the test question but incorrect on reality control(s) were as follows: Q1 = 6, Q2 = 18, Q3 = 6, Q4 = 9, Q5 = 2, Q6 = 4, and Q7 = 11. Excluding these children from analyses did not alter any of the results.

Results

Table 2 provides descriptive data on the results. The sample size varied slightly across tasks because some children did not complete all tasks. The available data for such participants was included in the analyses whenever possible to increase the power of individual analyses.

Preliminary Analyses

We first tested for gender differences in all study measures using one-way analyses of variance (ANOVAs). No gender differences were found. It was expected that children’s verbal ability, as measured by the PPVT, would be related to a number of study measures, and these relations were confirmed. Children’s verbal ability was significantly positive related to their performance on executive function tasks, specifically the tapping task ($r[81] = .27, p < .05$) and the three-pegs task ($r[86] = .21, p < .05$) and marginally related to the day/night task ($r[85] = .21, p < .06$). There was also a negative relation between verbal ability and one measure of behavioral control (reverse-scored) latency to delay gratification score ($r[86] = -.26, p < .05$), indicating that higher verbal scores were related to a greater ability to delay gratification. Verbal ability was not related to either of the emotion-regulation variables (i.e., positive/constructive, negative/aggressive). Verbal ability was included as a covariate in subsequent analyses involving those variables with which it was significantly associated.

Intercorrelations among individual measures of self-regulation at 4.5 years. Partial correlations were conducted to assess relations among individual self-regulation measures, controlling for verbal ability (Table 3). Along
with the expected correlations within each self-regulation construct, several cross-construct relations were found. Specifically, children who had a greater proportion of correct trials on the continuous performance task (in which they inhibited pressing the space bar) showed better performance on the tapping and three-pegs tasks, longer latencies in the delay of gratification, and lower negative/aggressive emotion-regulation scores. Likewise, children with more errors of commission on the continuous performance task performed poorly on the tapping and three-pegs tasks, were less able to delay gratification, and had more negative/aggressive emotion-regulation behaviors. Children’s performance on the tapping task was related to longer delay of gratification latencies and fewer negative/aggressive emotion-regulation behaviors. Better performance on the three-pegs task was related to longer latency to choose a dinky toy. Finally, children’s negative/aggressive emotion-regulation behaviors were negatively related to their latency to delay gratification.

**Intercorrelations between individual measures of self-regulation at 4.5 years and measures of theory of mind at 5.5 years.** Partial correlations, controlling for children’s verbal ability, were conducted to assess the relation between measures of self-regulation and theory of mind. Only executive function showed a significant relation to the theory of mind composites. Children with better performance on the day/night task had higher theory of mind test scores ($r_{[78]} = .45, p < .001$).

**Primary Analyses**

The remaining analyses addressed the primary goals of the study: (1) to examine the relations among the constructs of emotional, behavioral, and cognitive self-regulation and (2) to examine whether each of the composite measures of self-regulation at 4.5 years predicted children’s theory of mind performance at 5.5 years. Prior to addressing our hypotheses, composite measures were created for behavioral control and executive function. The behavioral control composite was created by calculating the average of the two behavioral self-regulation tasks: latency to touch a dinky toy and (minus) latency to delay gratification (reverse-scored). The composite measure of executive function was created by averaging children’s performance across the following measures: continuous performance task proportion of correct no-press responses, (minus) continuous performance task proportion of errors of commission, tapping task, day/night task, and three-pegs task. We retained the two separate emotion-regulation variables.

**Relations among emotional, behavioral, and cognitive self-regulation.** To address our first goal of assessing relations among various forms of self-
Table 2. Descriptive Statistics of All Study Measures

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPVT</td>
<td>111.46</td>
<td>12.44</td>
<td>70-139</td>
<td>90</td>
</tr>
<tr>
<td>Delay of Gratification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latency to delay gratification (all children)</td>
<td>672.68</td>
<td>348.55</td>
<td>11.7-900.00</td>
<td>88</td>
</tr>
<tr>
<td>Latency of children who rang the bell</td>
<td>252.12</td>
<td>258.89</td>
<td>11.70-836.27</td>
<td>26</td>
</tr>
<tr>
<td>Latency of children who ate an M&amp;M</td>
<td>110.30</td>
<td>104.25</td>
<td>26.20-244.46</td>
<td>4</td>
</tr>
<tr>
<td>Dinky Toy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latency to choose dinky toy (all children)</td>
<td>32.12</td>
<td>46.68</td>
<td>.47-187.57</td>
<td>88</td>
</tr>
<tr>
<td>Latency of children who passed task</td>
<td>33.86</td>
<td>48.06</td>
<td>.47-187.57</td>
<td>81</td>
</tr>
<tr>
<td>Latency of children who failed task</td>
<td>11.90</td>
<td>16.84</td>
<td>3.03-49.56</td>
<td>7</td>
</tr>
<tr>
<td>Emotion Regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive/constructive behavior composite (z-score)</td>
<td>0.00</td>
<td>1.0</td>
<td>-2.3-2.9</td>
<td>91</td>
</tr>
<tr>
<td>Negative/aggressive behavior composite (z-score)</td>
<td>0.00</td>
<td>1.0</td>
<td>-.99-4.99</td>
<td>91</td>
</tr>
<tr>
<td>Continuous Performance Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of trials with correct inhibition</td>
<td>.48</td>
<td>.12</td>
<td>0-.72</td>
<td>82</td>
</tr>
<tr>
<td>Proportion of trials with errors of commission</td>
<td>.08</td>
<td>.13</td>
<td>0-.53</td>
<td>82</td>
</tr>
<tr>
<td>Day/Night Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of practice trials required</td>
<td>2.61</td>
<td>.89</td>
<td>2-5</td>
<td>87</td>
</tr>
<tr>
<td>Percent correct across the entire task</td>
<td>.66</td>
<td>.24</td>
<td>0-1.00</td>
<td>87</td>
</tr>
</tbody>
</table>
Tapping Task

Number of practice trials required  2.77  1.22  2–6  83
Percent correct across the entire task  .73  .26  .06–1.00  83

Three-Pegs Task

Average number of conditions required to pass  1.53  .71  1–3  72
Theory of mind test composite \( \text{FBL, BDR, SOFB} \)  4.20  1.70  0–7  85

<table>
<thead>
<tr>
<th>Task</th>
<th>Percentage of Children with Correct Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location False Belief (LFB)</td>
<td></td>
</tr>
<tr>
<td>Location false belief and all reality-control questions</td>
<td>69</td>
</tr>
<tr>
<td>Belief-Desire Reasoning (BDR)</td>
<td></td>
</tr>
<tr>
<td>Emotion 1 and emotion reality-control question</td>
<td>57</td>
</tr>
<tr>
<td>Emotion 2 and emotion reality-control question</td>
<td>73</td>
</tr>
<tr>
<td>Emotion 3 and emotion reality-control question</td>
<td>92</td>
</tr>
<tr>
<td>Contents false belief and contents reality-control question</td>
<td>75</td>
</tr>
<tr>
<td>False emotion/belief and false contents and contents reality-control question</td>
<td>42</td>
</tr>
<tr>
<td>Second-Order False Belief (SOFB)</td>
<td></td>
</tr>
<tr>
<td>Second-order false belief question and all reality-control questions</td>
<td>13</td>
</tr>
</tbody>
</table>

Note. PPVT = Peabody Picture Vocabulary Test; FBL = Theory of Mind False Belief Location; BDR = Theory of Mind Belief Desire Reasoning; SOFB = Theory of Mind Second-Order False Belief.
Table 3. Partial Correlations among Self-Regulation Measures, Controlling for Verbal Ability (PPVT)

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CPT proportion of correct no-press trials</td>
<td></td>
<td>-.92**</td>
<td>.30**</td>
<td>.15</td>
<td>.20†</td>
<td>-.31**</td>
<td>-.13</td>
<td>.01</td>
<td>-.26†</td>
</tr>
<tr>
<td>2. CPT proportion errors of commission</td>
<td></td>
<td>-.30**</td>
<td>-.16</td>
<td>-.23*</td>
<td>.26</td>
<td>.06</td>
<td>-.00</td>
<td>.21†</td>
<td></td>
</tr>
<tr>
<td>3. Tapping task</td>
<td></td>
<td>.23*</td>
<td>.21†</td>
<td>-.25*</td>
<td>-.07</td>
<td>-.05</td>
<td>-.28*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Day/night task</td>
<td></td>
<td></td>
<td>.15</td>
<td>-.10</td>
<td>.12</td>
<td>.05</td>
<td>-.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Three-pegs task</td>
<td></td>
<td></td>
<td></td>
<td>-.04</td>
<td>.21†</td>
<td>.03</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Latency to delay gratification (reverse-scored)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.13</td>
<td>.01</td>
<td>.20†</td>
<td></td>
</tr>
<tr>
<td>7. Latency to touch dinky toy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.06</td>
<td>-.07</td>
<td></td>
</tr>
<tr>
<td>8. Emotion regulation: Positive/constructive</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9. Emotion regulation: Negative/aggressive</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Number of participants ranged from 72 to 87 due to missing data.
† p < .10, * p < .05, ** p < .01.
regulation, partial correlations were conducted on the composite measures of emotional, behavioral, and cognitive self-regulation while controlling for children’s verbal ability. These analyses revealed that children with greater cognitive self-regulation (executive function) had greater behavioral control ($r[84] = .21, p < .05$) and fewer negative/aggressive emotion-regulation behaviors ($r[85] = -.21, p < .05$). Additionally, children with greater behavioral control also exhibited fewer negative/aggressive emotion-regulation behaviors, although this relation was marginally significant ($r[85] = -.18, p = .09$).

**Prediction of theory of mind at 5.5 years by executive function, emotional self-regulation, and behavioral control at 4.5 years.** The final goal of our study was to examine whether self-regulation at 4.5 years was a significant predictor of theory of mind at 5.5 years. To test the hypothesis that emotion regulation, behavioral control, and executive function at 4.5 years would each be independent predictors of theory of mind at 5.5 years, linear regressions were performed on the theory of mind composite, with children’s PPVT and each of the self-regulation variables as a predictor variable. Standardized values of all measures were used for these and subsequent regression analyses. Results revealed that consistent with our hypothesis, executive function significantly predicted theory of mind ($\beta = .27, t[81] = 2.71, p < .01 [R^2 = .21]$). However, behavioral control was only a marginal predictor of theory of mind, only before controlling for PPVT ($\beta = .19, t[82] = 1.77, p = .08 [R^2 = .04]$), after which the significance level fell to $p = .36$. Neither of the emotion-regulation composite variables significantly predicted theory of mind.

Next, we explored whether executive function mediated the relation among emotional self-regulation, behavioral self-regulation, and theory of mind. To test the mediation model, we first assessed the correlations between these variables and theory of mind. The results revealed that neither of the emotion-regulation composite variables was significantly related to theory of mind ($ps > .70$). The behavioral control composite showed a marginal relation to theory of mind ($p = .08$), but this relation fell below significance once we controlled for verbal ability. Because the relations between theory of mind and emotion-regulation and behavioral control were necessary in order to test for mediation (Baron & Kenny, 1986), we did not conduct these analyses.

Finally, we tested for the linear contribution of emotional and behavioral self-regulation to the prediction of theory of mind by executive function. In addition, we included interaction terms between executive function/emotion regulation and executive function/behavioral control to test whether higher values on both forms of self-regulation would increase the prediction to theory of mind. Two hierarchical regressions were conducted, and predictor
variables were entered into the equation using a series of steps. At the first step, children’s verbal ability scores (PPVT) were entered into the equation. The executive function composite variable was entered into the equations at the second step. For the first regression, the behavioral control and the interaction term for behavioral control and executive function were entered into the equation at the last step. The results of these analyses are presented in Table 4. While executive function remained a significant predictor of theory of mind, the inclusion of behavioral control and its interaction with executive function did not significantly contribute to the prediction of theory of mind.

For the second regression, the first two steps were similar to those in the first regression. On the third step, four emotion-regulation variables were entered: positive/constructive and its interaction term with executive function, and negative/aggressive and its interaction term with executive function. The results indicated that none of the emotion-regulation variables significantly contributed to the prediction of theory of mind over and
Individual Differences in Self-Regulation

above that of executive function. Together, these results indicate that children who performed better on measures of executive function at 4.5 years did better on assessments of theory of mind one year later, yet emotional and behavioral forms of self-regulation did not add to this prediction.

Discussion

The purpose of the present investigation was to examine relations among emotional, behavioral, and cognitive measures of self-regulation in preschool children and whether these measures predicted children’s understanding of false belief one year later. Consistent with our expectations, results revealed that different forms of self-regulation were related both at the individual level and the composite level. That is, children’s competence in each domain of self-regulation (emotional, behavioral, and cognitive) was related to performance in the other domains. With respect to emotion regulation, our findings indicated that children with poor emotion regulation (increased negative expressions and use of aggressive coping strategies) had poorer performance on executive function and behavioral-control tasks. This finding is consistent with Blair’s (2002) notion that difficulty regulating one’s emotions may negatively impact the ability to simultaneously engage in behavioral and cognitive self-regulation. Children are likely to experience frustration when told to refrain from touching toys in a basket or when they must wait patiently for a candy. To be successful at controlling their behaviors, they must regulate their negative emotional reactions to these situations (Thompson, 1994). Conversely, executive function and behavioral control may aid children’s intensive concentration, attention, or flexibility in selecting coping strategies (Matthews & Wells, 1999), which could facilitate the internal self-monitoring that is important for self-regulation of emotion. The present findings are consistent with the few studies that have found a relation between emotion regulation and various forms of inhibitory control (e.g., effortful attention and compliance) in infancy and childhood (e.g., Kochanska et al., 1998; Stifter, Spinrad, & Braungart-Rieker, 1999).

Also consistent with our hypotheses, we found measures of behavioral control and executive function to be interrelated. This pattern of findings is similar to those of Cole, Usher, and Cargo (1993), who found executive function to be associated with preschoolers’ ability to resist temptation in a forbidden-object paradigm. Additionally, Carlson and Moses (2001) found children’s executive function performance to be related to their ability to delay gratification, even after controlling for age, gender, and verbal ability. It may be that behavioral control directly influences children’s performance...
on measures of executive function such that children’s ability to inhibit impulsive movement during crucial points of executive function tasks contributes to success (Maccoby, Dowley, Hagen, & Degerman, 1965). Interestingly, our results indicated that children’s performance on one measure of behavioral control—the delay of gratification paradigm—was specifically related to those executive function tasks that required them to physically inhibit prepotent responses, including the continuous performance and tapping tasks. Thus, the relation between executive function and behavioral control may be bidirectional such that executive function abilities directly facilitate children’s behavioral control by aiding in planning and in the initiation, organization, and flexibility of behavioral activity (Cole, Usher, & Cargo, 1993; Kopp, 1989). A third possibility is that a common underlying ability (e.g., inhibitory control) explains the relations between these forms of self-regulation.

Together, these findings support the contention that self-regulation may be a broad construct that is observed at different interrelated levels (Calkins & Howse, 2004; Posner & Rothbart, 2007). Our findings provide a snapshot of one stage in the development of self-regulation, but because we measured these processes concurrently, we are unable to interpret the direction of effects. An important consideration for future research will be to determine the process by which each of these abilities influences the others across early childhood.

The second aim of the present study was to explore relations between indices of self-regulation at 4.5 years and children’s understanding of false belief one year later. In line with previous work, we hypothesized that measures of self-regulation, particularly executive function, would predict theory of mind. Our hypotheses were partially confirmed. Children with better performance on executive function had higher scores on false belief tasks, but emotional and behavioral self-regulation were unrelated to this outcome. This pattern of relations indicates that although emotion regulation, behavioral control, and executive function may be related forms of self-regulation at 4.5 years, the longitudinal prediction to false belief was specific to children’s ability to exert mental control over their responses.

Our results concerning the association between executive function and false belief are consistent with those found in previous literature (Carlson & Moses, 2001; Carlson et al., 2004; Flynn et al., 2004; Frye, Zelazo, & Palfai, 1995; Hughes, 1998), supporting the broader argument that children who perform better on a variety of cognitive measures of inhibitory control also perform better on theory of mind tasks. Notably, we found longitudinal relations between early executive function and later false belief, even after children have made considerable advances with respect to both skills.
Individual Differences in Self-Regulation

Because we tested these measures each at only one time point, we cannot offer confirmatory evidence of the direction of causality. However, our data do support those of Hughes (1998), who found that executive function skills at 3 years predicted theory of mind at 5 years; Carlson et al. (2004), who found that 2-year-olds’ executive function performance predicted theory of mind at age 3; and Flynn et al. (2004), whose microgenetic study of children between 3 and 4 years of age revealed that their performance on tests of inhibitory control preceded and predicted their understanding of false beliefs.

The fact that the current study found executive function, but not emotional and behavioral self-regulation, to be associated with theory of mind highlights possible features of the executive function—theory of mind relationship and provides discriminant validity for the notion that inhibitory control measures may not be unidimensional but rather are separable according to their delay and conflict demands (Carlson & Moses, 2001). Indeed, Carlson (2003) argues for the importance of incorporating measures of other forms of self-regulation, including emotion regulation, into the study of executive function and theory of mind in order to better explain how these processes are related. The present study’s measures of emotional and behavioral self-regulation may be considered delay forms of self-regulation such that they require control over affective expressions and motivation and primarily rely on inhibition of responses such as suppressing negative affect when receiving an undesirable gift. Although emotion regulation, particularly in the context of a disappointment task, may also include activation of positive expressions, our study arguably minimizes this property by combining data from the disappointment and locked-box tasks, combining proportions of neutral and positive affect, and compositing affective expressions with behavioral strategies in the locked-box task. In contrast, the traditional executive function and false belief tasks in the present study might reflect conflict self-regulation such that they require both inhibition of prepotent response and activation of alternative responses. This interpretation is partially supported by the studies of Carlson and colleagues, who found that delay tasks show weaker relations to theory of mind than conflict tasks (Carlson et al., 2004; Carlson and Moses, 2001). Similarly, Perner et al. (2002) found that a go–no go behavioral regulation task that relied primarily on inhibition showed little relation to false belief, whereas a conflict task was significantly related to false belief. In the present study, behavioral control was not related to false belief once we controlled for verbal ability, although there was a positive trend prior to including this control. If we assume that the need to both inhibit a prepotent response and initiate a subdominant one is what distinguishes the present
study’s measure of executive function from other forms of self-regulation, then our findings concerning relations to theory of mind suggest that simple inhibition may not be the most salient common thread linking executive function and theory of mind. Rather, it appears that control over both the information to be suppressed and that which needs to be activated may be an important link between these processes (Perner et al., 2002). Our data can be considered in terms of the cognitive complexity and control theory, which states that traditional executive function and theory of mind tasks are related because they both share a complex, embedded rule structure (e.g., Zelazo, Muller, Frye, & Marcovitch, 2003). Thus, both executive function and theory of mind are tapping children’s capacity to represent incompatible sets of rules (e.g., Zelazo et al., 2003). A slight variation to this approach is that measures of executive function reflect not the ability to represent incompatible sets but rather the ability to flexibly shift attention to that subdominant response set and to overcome a state of attentional inertia (i.e., when one’s focus of attention gets stuck) (Kirkham, Cruess, & Diamond, 2003). Thus, whether the emphasis is on representing subdominant responses or disengaging one’s attention from prepotent responses, these theories suggest that the association between executive function and theory of mind may involve something more than simple inhibition or suppression (Moses, Carlson, & Sabbagh, 2005). The pattern of findings from the present study, concerning relations between false belief and executive function but not other forms of self-regulation, is consistent with such theories.

Although we have hypothesized about the nature of the relations among the variables in the present study, our methodological design precludes us from being able to offer conclusive evidence regarding these relations. Specifically, because we measured various forms of self-regulation concurrently, the direction of the resulting relations cannot be confirmed. Additionally, we measured self-regulation at 4.5 years and false belief at 5.5 years, so we are unable to establish whether or not earlier theory of mind predicted later executive function. As our sample was homogenous in terms of socioeconomic status, our findings may not be generalizable to the greater population of children. Finally, previous research indicates that the strength of relation between executive function and theory of mind is related to age (Carlson et al., 2004); thus, our results may only generalize to preschool-aged children.

In summary, the present study supports the theory that self-regulation may consist of different interrelated types, including emotional, behavioral, and cognitive. Children who displayed poorer emotion regulation, as evidenced by greater negative affect and the use of aggressive strategies, performed with less success on executive function and behavioral control
Individual Differences in Self-Regulation

tasks, while the latter two types of self-regulation were positively related. The study also found that executive function, but not other forms of self-regulation, predicted false belief one year later. These findings offer an important contribution to our understanding of the inhibitory control construct and of the specificity of executive function—theory of mind relations.

References


Individual Differences in Self-Regulation


