Exploring the Mechanisms of Implementation Intentions: A Preschool Intervention

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Abstract

In childhood, the ability to exhibit self-control, or to adapt behavior to promote goal achievement, is an essential predictor for general life outcomes. Children with strong control abilities develop into adults who are more successful in domains such as health, wealth and academic achievement. One aspect of self-control is the ability to resist temptation in the face of attractive distractions. For this reason, interventions that target improvements in distraction avoidance in young, preschool-aged children may improve self-control. The present study tested the effectiveness of implementation intentions (IIs), or if-then plans used to facilitate goal achievement (Gollwitzer, 1999), to improve the performance on a categorization task by increasing the ability to resist distraction in school-aged and preschool-aged children. Additionally, by measuring the relationship between individual differences in categorization task performance and individual differences in proactive control, the cognitive control mechanisms supporting the effectiveness of IIs were tested. We found no evidence that IIs improved task performance in either age group; thus, the mechanisms underlying IIs remain unresolved. Future projects will be necessary for making strong conclusions about the effectiveness of II interventions in young children and the potential cognitive control mechanisms on which IIs operate.

Keywords: Implementation Intentions, Self Control, Cognitive Control, Proactive Control, Reactive Control, Children, Preschool
Self-control, or the deliberate altering of behavior in order to better support goal achievement (Baumeister, Vohs, & Tice, 2007), is centrally important in everyday life. Self-control develops gradually across childhood, but even adults occasionally continue to struggle with self-control in the face of temptations and distractions. Early indices of self-control predict general success in later life (Casey et al., 2011; Mischel, Shoda, & Rodriguez, 1989; Moffitt et al., 2011; Tangney, Baumeister, & Boone 2004). Two-year-olds who exhibit high self-control grow up to be more emotionally and socially developed three-year-olds (Kochanska, Murray & Harlan, 2000), and preschoolers who exhibit greater self-control have higher social competence and SAT scores in adolescence (Mischel, Shoda, & Rodriguez, 1989), greater health and wealth, and less criminality and substance use in adulthood (Arneklev, Grasmick, Tittle, & Bursik 1993; Moffitt et al., 2011). Moreover, impaired self-control is implicated in clinical disorders in which patients struggle in everyday life, such as major depression, bipolar disorder, and attention hyperactivity disorder (ADHD) (Corruble, Damy, & Guelfi, 1998; Swann, Steinberg, Lijffijt, & Moeller, 2007; Barkley, 1997). Thus, given the importance of self-control in life outcomes and the implications of self-control for clinical populations, the ability to alter one’s behavior in order to support goal achievement is an important skill to cultivate early in life.

Preschoolers notoriously struggle with self-control relative to older children and adults. For example, in a delay of gratification task, many young children find it challenging to exert self-control in order to resist the temptation of an immediately available reward (such as eating piece of candy) in favor of a larger future reward (such as eating multiple candies) and often fail to wait for the more desirable outcome (Mischel
& Ebbesen, 1970). The difficulty children face in exhibiting control and achieving goals (such as waiting for more candy or completing a task) may result from preschoolers’ inability to resist temptation created by the presence of attractive distractions (such as the candy in front of them or a distracting toy). When children need to exhibit control in order to complete a task in the presence of a tempting distraction, interventions that target task-oriented behaviors (such as increasing focus on the task) are more effective in improving self-control than are interventions that target temptation resistance (such as reminders not to focus on the temptation) (Miller, Weinstein, & Karinol, 1978).

Moreover, some evidence suggests that age-related improvements in self-control may relate to the tendency of older children to create task-focused, rather than reward-focused, strategies for self-control tasks (Mischel & Mischel, 1983). The problems children face with self-control and the implications of distractions in self-control support interest in early interventions that cultivate self-control by improving how children respond to the presence of distractions.

The success of early interventions depends on the capacity of preschoolers to improve their self-control. Some evidence from intervention studies suggests that children’s self-control can be improved. In the classic delay of gratification task, reframing the marshmallow as a “cool” stimulus – for example, a fluffy white cloud – improved delay of gratification relative to children who focused on the “hot” aspects of the marshmallow – for example, as a tasty treat (Mischel & Mischel, 1983; Metcalfe & Mischel, 1999). Exposure to live and symbolic modeling of delaying rewards also improves children’s delay of gratification performance (Bandura & Mischel, 1965). Interventions such as computerized and classroom training, aerobic exercise, and mindfulness training improve executive functioning and self-control in 4- to 12-year-old
children (Diamond & Lee, 2011). Finally, self-control in 7- to 10-year-olds for specific tasks involving the inhibition of a prepotent response can be improved with practice on that task (Simonds, Kieras, Rueda, & Rothbart, 2007). Further, younger children may benefit from such interventions more than older children: practice on an interference task yielded greater improvements for younger children (i.e., 4-year-olds) with less developed executive functioning than for older children (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). Taken together, this body of work demonstrates that self-control can be improved in children through a wide variety of laboratory-based methodologies. However, identifying relevant interventions that can be flexibly applied to a wide variety of real-world goal-achievement scenarios remains a needed area of research.

One promising area of focus for improving self-control, and one that has been particularly effective for all ages tested thus far, is the use of implementation intentions. Implementation intentions (IIs) are if-then plans that are designed to facilitate goal achievement in the face of obstacles (Gollwitzer, 1999). The plans usually follow the format: “If situation X is encountered, then I will perform behavior Y in order to reach goal Z” (Gollwitzer, 1993, 1999). Such if-then plans are established in addition to a goal in order to prepare individuals for possible obstacles that may arise and that could disrupt goal achievement. Relative to goal intention (GI) interventions (e.g., “I will perform behavior Y in order to reach goal Z”), II interventions have been more effective in helping adults fight addiction (Armitage, 2007), improve dieting and health (Sheeran, Milne, Webb, & Gollwitzer, 2005; Adriaanse, Vinkers, Ridder, Hox & Wit, 2011) improve test scores (Bayer & Gollwitzer, 2007), and better make and remember plans (Gollwitzer, 1999). Understanding the effectiveness of II interventions is of broad interest
to many researchers concerned with improving self-control because IIs are simple yet successful strategies for goal achievement.

Although the majority of implementation intentions studies focus on adult populations, some evidence suggests that IIs can also improve goal achievement in children. For example, IIs have been effective in improving delay of gratification for monetary rewards in 10- to 11-year-olds (Gawrilow, Gollwitzer, & Oettingen, 2011), increasing daily exercise in 8-year-olds (Armitage & Sprigg, 2010), improving response inhibition performance in 11-year-olds with and without ADHD (Gawrilow & Gollwitzer, 2008), and avoiding distraction while performing an effortful categorization task in 5- to 8-year-olds (Wieber, von Suchodoletz, Heikamp, Trommsdorff, & Gollwitzer, 2011). However, existing research with children has focused on either older children (middle-schoolers and adolescents) or clinical populations (such as children with attentional deficits like ADHD). One important open question concerns the effectiveness of IIs with younger, preschool-aged children. Given that preschoolers demonstrate particular struggles with impulsive behavior, this population may especially benefit from relatively simple interventions such as IIs. Because IIs are short, easy to remember, and can be reframed to address a variety of goal-achievement scenarios, learning to effectively employ such interventions at a relatively young age may help to cultivate general purpose strategies to improve behavior, and could ultimately lead to improved later life outcomes in adulthood.

The mechanisms underlying the effectiveness of IIs may determine whether or not this type of intervention is amenable to use in preschoolers. Specifically, it is unclear whether IIs operate via “reactive” (engaged in-the-moment, as needed) or “proactive” (engaged in advance) cognitive control mechanisms (Braver, 2012). Research examining
the mechanisms underlying IIs has utilized cognitive load manipulations in an attempt to disrupt proactive control. Tasks that induce high cognitive load, such as dual tasks, disrupt the ability to plan ahead to control behavior, and thus cause participants to resort to reactive control. For example, in one study, IIs were less effective in improving prospective memory in participants when they were placed under high cognitive load, presumably disrupting proactive control (McDaniel & Scullin, 2010). This result is consistent with the idea that IIs rely on proactive control to operate effectively. However, in another study, cognitive load did not influence the effectiveness of IIs in improving reaction time (RT), consistent with the idea that these interventions may act reactively (Brandstätter, Lengfelder, & Gollwitzer, 2001). Some have argued that these contradictory results were driven by differences in the difficulty of the cognitive load manipulations, which were not equally effective in disrupting proactive control. In any case, the mechanisms supporting the effectiveness of IIs is still debated and represents an important area for further investigation (Meiran, Cole, & Braver, 2012). Moreover, identifying the possible mechanisms through which IIs operate could provide additional information regarding the feasibility and appropriateness of using IIs with young children, who are notoriously impulsive.

In order to address the mechanism through which IIs are successful, a key developmental transition in childhood can be utilized. Preschoolers engage primarily reactive cognitive control, but undergo a developmental transition between the ages of 5 and 6 years in which they switch to employing primarily proactive control (Chatham, Frank, & Munakata, 2009; Munakata, Snyder, & Chatham, 2012). Therefore, if IIs rely on proactive control, preschoolers may not be able to utilize them effectively. To provide
a natural manipulation to tap the mechanisms underlying IIs, the present study will focus on children of two age groups that surround this transitional period.

Thus, the goals of the present study are twofold: 1) to explore the effectiveness of implementation intentions in preschoolers relative to older, school-aged children, where IIs have already been found to be effective and 2) to investigate the cognitive control mechanisms through which IIs operate. Proactive and reactive control mechanisms can be examined in relation to the success of IIs by comparing the effectiveness of IIs in primarily reactive (preschool-aged) and primarily proactive (elementary school-aged) children. We will also test whether individual differences in proactive control predict the effectiveness of IIs within each age group. If school-aged children, but not preschoolers, benefit from IIs, this would be consistent with the possibility that IIs operate through proactive control mechanisms, which only school-aged children are able to utilize. If so, we further predict that individual differences in proactive control will predict the extent to which II improves behavior: more proactive children would show the greatest benefits from IIs. Alternatively, if both school-aged children and preschool-aged children benefit from IIs, this finding would be consistent with the possibility that IIs are able to operate through either proactive and reactive control mechanisms, or just reactive mechanisms, which both age groups are able to employ. This result would also suggest that IIs can be used with preschoolers to improve behavior and may lead to long-term benefits in these children.

Methods

Participants and Research Design

Participants included 42 preschool-aged children, ages 42-48 months ($M_{age} = 45.23$ months, 21 females) and 42 school-aged children, ages 76-84 months ($M_{age} = 80.41$ months, 21 females).
months, 21 females), recruited from the University of Colorado Cognitive Development Center database. The sample size of 84 participants was determined based on an a priori power analysis calculated using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) for 90% power to detect a predicted effect size of .47 (the average effect size from a meta-analysis of II interventions with children; Gollwitzer & Sherran, 2006). Children with the diagnoses of ADHD or ADD were excluded from participation, given evidence that the effectiveness of IIs may be different for children with attentional deficits (e.g., Gawrilow, Gollwitzer & Oettingen 2011, Gawrilow & Gollwitzer 2008). Parental consent and child assent was obtained prior to participation in the experiment. At the conclusion of the session, all children received small prizes (e.g., book, ball) and a certificate for participation and parents received $5 compensation to cover travel expenses. The present study used a 2 (between: preschool vs. school-aged) x 2 (between; implementation intention vs. goal intention) x 3 (within; high vs. medium vs. low distraction level) design. Children within each age group were randomly assigned to II or GI intervention conditions, balancing for age and gender. All children completed the tasks with one of two female experimenters in a single session that lasted approximately 60 minutes.

_Categorization Task_

First, children completed a categorization task (adapted from Wieber et al., 2011) measuring goal-oriented behavior in the face of varying levels of distractions. After the presentation of a 500ms fixation cross, images depicting vehicles and animals appeared one at a time on the bottom half of a computer screen, and children were instructed to categorize each image by pressing the left or right key labeled with pictures of a car or a cat, denoting the vehicle or animal categories respectively as quickly and accurately as
possible. During each test trial, upon presentation of the animal or vehicle image, a distraction simultaneously appeared in the top half of the computer screen. Each child completed three blocks with varying levels of distraction. The three levels of distraction, pretested for attractiveness of distraction type (Wieber et al., 2011), were low distractor (black and white cartoon smiley faces), moderate distractor (still, full-color images from the movie *Shrek*), and high distractor (4 second, full-color video clips from the movie *Ice Age*)(Figure 1).

![Diagram](image)

*Figure 1*: The categorization task. The categorization task began with 12 practice trials before continuing to a 30-trial baseline block of animals and vehicles without distractions (A). Then children learned the intervention (the II or GI) and rehearsed the intervention nine times before continuing on the three experimental blocks of varying levels of distraction (B).

The categorization task began with 12 practice trials. Prior to the start of the practice trials, the experimenter ensured that children adequately understood task rules, and then warned children about the possible presence of distractions (“something that is not an animal or vehicle that could appear on the top of the screen”). Next, children completed six categorization trials without distractions followed by two trials of each level of distraction.

After completion of the practice trials, children were asked two questions to assess pre-test motivation to perform well in the categorization task (as in Wieber et al.,
Motivation was measured because it has been shown to interact with the effectiveness of II interventions (Gollwitzer 1999). The questions were “How important is it for you to decide as quickly as possible if you see an animal or a vehicle?” and “How important is it for you to get a lot right in the animal or vehicle game?” These questions were administered with a child-adapted 5-pt Likert scale in the form of circles of ascending size (as in Wieber et al. 2011).

Following these questions, children completed 30 trials of the categorization task without distractions. This block served to provide a baseline measure of response time for each participant for the categorization trials. Next, children were introduced to the distraction interventions (II or GI), which were described to children as a “plan” to help ignore the distractions in the game they were about to play. The plan for children in the II condition was: “If there is a distraction, then I will ignore it.” The plan for children in the GI condition was: “I will ignore distractions.” Wording for each intervention was the same across both age groups and exactly matched that of the II and GI conditions in Wieber et al. (2011). To ensure the children comprehended the terminology used in the plan, the experimenter defined the term “ignore” (“When you ignore something, you don’t pay any attention to it. You don’t even look at it!”). Children were told to remember the plan “word-for-word” and were informed that they would be asked to repeat the plan again at the end of the game.

After the initial description of the plan by the experimenter, children’s memory of the plan was tested in a series of nine repetitions: three in which children recited the strategy out loud with the experimenter, three in which children recited the strategy out loud by themselves, and three in which children were instructed to recite the strategy to themselves (in their heads). After this series of nine repetitions, children were asked to
recite the plan out loud a final time by the experimenter. If the plan was produced verbatim, children moved on to the three experimental blocks of the categorization task. If the plan was incorrectly produced, repetitions were redone as needed until children were able to reproduce the plan word-for-word. This check was used to ensure our manipulation was effective as intended.

After the specific plan was memorized, children moved on to the testing phase of the categorization task. This phase consisted of 90 testing trials (30 trials with low distractions, 30 trials with moderate distractions, 30 trials with high distractions). Breaks were provided as needed (e.g., if the child requested a break or refused to continue playing).

Following completion of the categorization task, children were given a post-test of the distraction plan to ensure they could reproduce it verbatim, and were also given a post-test of the motivation questions. All children were then given a small break and a prize before moving on to the Track-it task.

**Track-it Task**

After the categorization task, children completed the Track-it task (Fisher, Thiessen, Godwin, & Dickerson, 2013) to index proactive control. This task was selected because performance correlates with other established measures of proactive control (Chevalier, Fisher, & Munakata, in prep), and it is appropriate for use across both age groups tested in the present study.

In this task, the experimenter instructed children to visually track a target shape (e.g., a yellow star) with their eyes as it moves randomly around on a 3x3 or 4x4 grid (adapted for preschool-aged children and school-aged children respectively) on the computer screen amongst other moving shapes (e.g., a blue heart, a pink triangle, a green
circle, etc.) that served as distractors (Figure 2; Fisher et al., 2013). After 10 sec of tracking the target shape, all of the shapes on the screen disappeared and the child was asked to point to the square on the grid where the target shape last appeared. After choosing a grid square, both the preschoolers and school-aged children saw a grid of shapes (four or six respectively) from which they were asked to choose which was the shape they had been following (to evaluate memory for the target shape). Task difficulty varied slightly between age groups to ensure children were not at floor or ceiling. The following parameters differed between age groups: for the preschool-aged children, object speed was 500pps and two non-target distractor shapes were present, and for the school-aged children, object speed was 800pps and six non-target distractor shapes were present.

The task was modified during overall data collection in order to address an issue in which some preschool aged children demonstrated difficulty with the task instructions. This change involved the use of the first trial of the task as a practice trial with experimenter help, in which the experimenter traced the path of the followed shape with her finger. The modification occurred after 53 participants.

Figure 2: The Track-it task. (A) preschool children were presented with a 3x3 grid containing three different shapes including a target shape denoted by a red circle, and (B) elementary school children were presented with a 4x4 grid containing eight different shapes including a target shape. Then, (C) the shapes randomly moved across the screen before disappearing. Children were asked to select the box where the target shape was last seen (D), before seeing a smiley face denoting the end of the trial.
While the child completed the experimental tasks, parents completed the Child Behavior Checklist (CBCL). The CBCL is a questionnaire designed to measure patterns in a child’s behavior that occurred within the two months prior to survey completion (Achenbach, Rescorla, McConaughey, Pecora, Wetherbee, & Ruffle, 2009). For preschool-aged children, parents completed the CBCL for ages 1.5-5 years (with 100 questionnaire items). For school-aged children, parents completed the CBCL for ages 6-18 years (with 112 questionnaire items). Parents were asked to score the presence of specific traits of their child’s behavior between 0 and 2 for each component of the questionnaire. For each question, ‘0’ signifies ‘not true,’ 1 ‘somewhat true,’ and 2 ‘very true’. Behavioral scores are generated by summing across all responses of ‘1’s and ‘2’s in the checklist. This survey allows researchers to screen for clinically relevant behaviors such as ADHD that may affect the effectiveness of IIs (Gollwitzer, 2008), and follows the procedures of Wieber et al., 2011.

*Preliminary data trimming*

RTs of practice trials and inaccurate trials were excluded for data analysis (as in Wieber et al, 2011). Removal of inaccurate trials resulted in the exclusion of 781 trials (517 trials cut from those completed by preschool-aged children) out of 10,080 total trials. Further, trials in which RTs < 200ms were removed in order to remove trials in which responses may have been accidental (as in Cepeda & Munakata, 2007), resulting in the exclusion of 8 additional trials. Given that some children had interruptions during the game (e.g., to talk with their parent or the experimenter), we established an upper threshold for RT trimming based on visual inspection separately for each age group (for preschool children, trials > 25000ms; for school-aged children, trials > 17000ms), resulting in the exclusion of 17 additional trials.
Results

Preliminary analyses and control variables

Within each age group, intervention conditions did not significantly differ in age ($ps > .3$), and the ratio of boys to girls was held constant. Children in both conditions successfully learned the task instructions and interventions as indicated by their performance on retention and memory checks.

Baseline measurements for the categorization task revealed no differences between intervention conditions in terms of response times (RTs; see Table 1 and Figure 3) for either age group, all $Fs (1, 40) < 2.2$, and $ps > .15$, and no gender differences, all $Fs (1, 40) < 1.1$, $ps > .3$. As predicted, school-aged children were faster than preschool-aged children on baseline trials, $F (1, 82) = 34.9$, $p < .001$; however, this age difference did not interact with condition, $F(1, 80) < 1$, $p > .8$. CBCL scores did not differ between intervention conditions for school-aged children, $F(1, 40) < 1$, $p > .6$, or preschool-aged children, $F(1, 40) = 2.8$, $p > .1$. Finally, baseline RTs did not differ between the two experimenters, $F(1, 82) < 1$, $p > .3$.

Table 1

Means and Standard Deviations of RTs at Each Level of Distraction

<table>
<thead>
<tr>
<th>Distraction Level</th>
<th>3.5 year olds</th>
<th>6.5 year olds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implementation Intention</td>
<td>Goal Intention</td>
</tr>
<tr>
<td>None (Baseline)</td>
<td>1922.27 (1565.384) 1882.565 (1824.662)</td>
<td>927.3826 (336.2269) 878.9476 (317.3379)</td>
</tr>
<tr>
<td>Low attractiveness</td>
<td>2261.203 (2096.217) 2076.843 (1853.766)</td>
<td>1060.234 (791.1883) 961.6093 (442.6745)</td>
</tr>
<tr>
<td>Moderate attractiveness</td>
<td>3337.425 (2874.173) 3371.544 (3227.504)</td>
<td>1253.088 (727.3987) 1229.584 (808.2876)</td>
</tr>
<tr>
<td>High attractiveness</td>
<td>7194.982 (4385.333) 6412.742 (3800.967)</td>
<td>1558.744 (1249.227) 1828.404 (1934.189)</td>
</tr>
</tbody>
</table>

*Note:* Mean response times for each level of distraction attractiveness in ms (SD), ($N = 84$).
As predicted, we observed a linear effect of distraction level on RTs for each age group, such that RTs increased significantly as distractions became more difficult, $F(3, 123) = 11.19, p < .001$ for school-aged children, $F(3, 123) = 35.62, p < .001$ for preschool-aged children (Figure 3). To test the predicted differential effects of IIs vs. GIs on task performance in the face of varying levels of distraction, we first modeled RT means of correct categorizations in the baseline trials subtracted from RT means of correct categorizations in the critical trials with distraction (hereafter, RT differences) in an Intervention x Distraction Attractiveness repeated-measures ANOVA separately for preschool and school-aged children. For school-aged children, we saw a main effect of distraction attractiveness on RT differences, $F(2, 80) = 5.81, p = .004$, but no main effect of intervention, $F(1, 40) < 1, p > .4$, and no two-way interaction, $F(2, 80) < 1, p < .7$.

Similarly, for preschool-aged children, we saw a main effect of distraction attractiveness, $F(2, 80) = 22.70, p < .001$, but saw no main effect of intervention, $F(1, 40) < 1, p > .8$. 
and no two-way interaction, \( F(2, 80) < 1, p > .5 \). Thus, we did not observe the predicted benefit of II over GI in either age group.

To test whether differential effects of IIs vs. GIs on task performance at varying levels of distraction interact with age group, we included Age Group in the above repeated measures ANOVA and tested for a three-way interaction. We saw a main effect of age group \( F(1, 80) = 12.88, p < .001 \), a main effect of distraction level on RT difference scores, \( F(2, 160) = 27.559, p < .001 \), and a two-way interaction between age group and distraction level, \( F(2, 160) = 5.42, p < .01 \), such that the effect of distraction level on RT was stronger for preschool-aged children than for school-aged children. Intervention had no main effects or interactions in this model, all \( F_s < 1, p_s > .4 \).

As an exploratory analysis, given evidence that IIs work most effectively when tasks are difficult (Gollwitzer & Brandstatter, 1997), we modeled average RTs in an Intervention x Age Group linear model focusing specifically on RTs in the high distraction level. We again found a main effect of age group, \( F(3, 80) = 6.85, p = .01 \), but no main effect of intervention or interaction between age group and intervention, \( F_s < 1, p_s > .3 \).

**Relationship between II effectiveness and proactive control**

To test the hypothesis that IIs are most effective for individuals high in proactive control, we next tested a series of models examining the relationship between proactive control and RT differences looking specifically at individuals who had been given an II. Track-it scores were computed as the proportion of correct tracking trials excluding trials in which the child did not correctly identify the shape in the memory portion of the trial. First, as predicted, we observed a difference in proactive control between age groups \( F(1, 82) = 43.21, p < .001 \). School-aged children (\( M = .79, SD = .179 \)) completed a higher
proportion of the trials correctly compared to preschool-aged children (M = .44, SD = .295) on the Track-it task. Proactive control did not significantly differ between the GI and II conditions for either age group $F < 1, p > .9$.

To test the critical question of whether proactive control predicts RT differences, we tested a model predicting RT differences from Distraction Attractiveness x Track-it scores in a repeated-measures-ANOVA separately for each age group. For school-aged children in the II condition, there was no main effect of proactive control on RT differences and no interaction between proactive control and distraction level, $F$s < 1, $p$s > .5. However, when controlling for proactive control, the effect of distraction level on RT differences was only marginal, $F(2, 38) = 2.76, p = .08$. That is, for older children, the effect of increasing levels of distraction on RTs was partially driven by differences in proactive control. For preschool-aged children in the II condition, there was no main effect of proactive control on RT differences and no interactions with distraction level, $F$s < 1, $p$s > .5, but the main effect of distraction level persisted, $F(2, 38) = 13.75, p < .001$.

To test the possibility that the relationship between proactive control and RT differences only emerges at a given level of distraction for children in the II condition, we tested the correlation between Track-it scores and RT differences separately for each distraction level. We observed no relationships between Track-it scores and RT differences across the low, moderate, or high distraction levels for either age group, all $p$s > .2.

As we failed to observe any relationship between proactive control and RT differences for children in the II conditions, we decided to test for this relationship across both intervention groups, separately for each age group (given age-related differences in proactive control), and separately for each level of distraction. We found no evidence for
a relationship between proactive control and RT differences in any of these models, all $F$s < 2.8, all $p$s > .1.

**Discussion**

In the present study, we found no evidence for benefits of IIs over GIs in either school-aged or preschool-aged children. Further, proactive control did not predict performance of the intervention on the categorization game, which is not surprising given that the effect of proactive control on performance may depend on the initial success of IIs, which in the present study did not differ from GI performance. Given our failure to replicate the beneficial effects of IIs on avoiding distractions in school-aged children, we cannot draw firm conclusions about the mechanisms underlying the effectiveness of IIs or about the effectiveness of IIs in preschoolers.

In the categorization task, increased levels of distraction led to slower RTs and larger differences between means of critical trial RTs and mean baseline trial RTs. Therefore, the task was successful – as predicted, the task became more difficult with each subsequent block. Further, the differences in RT were more pronounced for preschool children than elementary school children – the younger age group was more affected by the increasing levels of distraction than the older age group. This is consistent with evidence that younger children have a decreased ability to employ self-control compared to older children, and thus may be more impaired by the presence of distractions. Further, as predicted, school-aged children, who can employ proactive control, had higher overall Track-it accuracy scores than younger children. Moreover, Track-it scores were less variable for school-aged children than for preschool-aged children. Because some have speculated that the effectiveness of IIs depends on proactive control abilities (McDaniel & Scullin, 2010), we hypothesized that Track-it scores would
predict the extent to which IIs benefited children. However, without evidence
demonstrating any effect of IIs, it is difficult to draw conclusions about whether proactive
control supports IIs in conditions where they are effective.

Further considerations

There are multiple possible explanations for why we failed to replicate prior work
in which IIs benefit performance over GIs in school-aged children. One possibility is that
II interventions do have real benefits to goal achievement, but the present study was not
able to detect differences between the II and GI conditions. This is supported by the
interesting trend of RTs at high levels of distraction (as seen in Figure 3), in which IIs
seem to help older, school-aged children, but hurt younger, preschool-aged children, in
comparison to GIs. Although this trend is not significant, it lends support to the idea that
IIs do work, and may work through proactive mechanisms that cannot be employed by
preschoolers who are not able to use proactive control. However, as this trend was not
statistically significant in any of the models seen, it is useful to speculate about why
stronger results were not generated. As the study involved two age groups at different
points in development, there may be many possible reasons why the null result was
generated.

First, the interventions used in the present study were very well matched, so each
may have increased self-control in participants, regardless of condition. The GI, “I will
ignore distractions,” acted as an active control for the II “If there is a distraction, then I
will ignore it,” as both specified a particular obstacle to performing well on the
categorization task, and only differed in the presentation of clauses. Although this
wording was employed because it exactly matched that of prior studies demonstrating II benefits (Wieber et al., 2011), having such a well-matched control condition is not typical for II research. In the majority of research testing the effectiveness of IIs, the GI comparison acts as a passive, non-specific control that simply reinforces the goal at hand (as in Gawrilow, Gollwitzer, & Oettingen, 2011). For instance, a passive GI for the present study may be, “I will do my best on the Animal and Vehicle game.” It is possible that intervention conditions that are well matched are not as sensitive as less well matched interventions for demonstrating that IIs are more effective than GIs. Further, previous discussion has stated that IIs are effective because they provide plans that address specific obstacles to goal achievement, thus enabling individuals to react to environmental cues rather than relying on proactive planning to overcome obstacles (Gollwitzer, 1999). Thus, as both interventions used in the present study referred to a specific obstacle to goal achievement, (e.g., distractions), they may have had equivalent benefits on task performance. If the II and GI used in the present study were indeed equivalent, a third control condition that better matches the GIs traditionally used in II literature may lead to stronger conclusions about the mechanisms of IIs and the usefulness of IIs in preschoolers.

Conversely, the difficulty of the present study in distinguishing the effectiveness of GIs and IIs may lie in the fact that neither intervention was effective in increasing self-control. The interventions in the present study may have been too subtle to generate significant effects on task performance, especially for young children who may require more obvious interventions to improve self-control. Many successful II studies involve long training programs to teach participants how to use IIs in daily life (as in Stadler, Oettingen, & Gollwitzer, 2010, in which a two-hour session was used), and they may
even promote habit formation with IIs (Gollwitzer, 1999). However, in the present study, the intervention was relatively shorter (only approximately 3 min). Therefore, it is possible that for IIs to be successful, more time and energy is required than is used for the II intervention in the present study.

Lastly, the interventions in the present study may not have offered clear results due to potential moderator variables that differed for each age group. For school-aged children, the lack of differences on self-control in the presence of distractions between intervention conditions may have occurred because the task was not challenging enough. According to previous research, IIs are only more beneficial than GIs when the task is adequately difficult to cause GIs to fail (Gollwitzer & Brandstatter, 1997). The Boulder demographic used in the present study may include a biased sample of children, who have higher self-control than the general population of children as the Boulder demographic typically is highly educated. As a result, the categorization task may not have been sensitive to the differences in ability between the different populations tested, and therefore may not have been difficult enough to require the II instead of the GI for effective distraction avoidance. This may account for the failure to replicate Wieber et al. 2011. The present task, even at high levels of distraction may not have been difficult enough to disrupt GIs in the school-aged children. On the other hand, for preschool-aged children, it is possible that differences were not seen between conditions because of the structure of the interventions used. Children under four years old may have difficulty producing and understanding conditional statements, such as an “if-then” plan (McCabe, Evely, Abramovitch, Corter, & Pepler, 1983). The structure of IIs may be too difficult for preschoolers to understand, and therefore may not be effective in this age group.
**Limitations**

Various limitations of the present study may have affected the results. First, the RT data was highly variable, especially for the preschool subjects. Therefore, even if the II was effective in increasing self-control, the effect may not have been large enough to be detected. This may have resulted from the hour-long length of the study, which was difficult for some participants to remain engaged in throughout. Further, the vocabulary used in the wording of each intervention condition may have been too advanced for preschool populations to understand. Although the words “distraction” and “ignore” were defined to every participant regardless of age, preschool children may still have had trouble understanding the meaning of either intention. This possible lack of comprehension may partially explain why IIs were no better than GIs specifically in the preschool age group (i.e., our manipulation was not effective as intended because children didn’t understand the wording). Further, the Track-it task was used in the present study as an index of proactive control. However, this measure may not be adequate for rating individual cognitive control differences. For each age group, Track-it accuracy scores did not have much variability, so it is possible that the task is not sensitive. Although it has been demonstrated that Track-it performance correlates with other indices of proactive control, this task is not a well-established proactive control measure (Chatham, Frank, & Munakata, 2009).

**Future Directions**

First and foremost, future directions include plans to analyze potential moderator variables—such as CBCL, motivation, and intervention memory at the end of the tasks—to address the possibility that intervention effects only occur when controlling for such
variables. Adequate motivation and goal commitment are essential for the effectiveness of IIs, thus if children were not motivated to play the categorization game, this may have prevented IIs from being effective.

Second, examining measures of RT variability, instead of RT differences, may reveal significant effects of intervention on RT. It is possible that although the II intervention did not seem to improve RTs overall, it may decrease the variability in RT as compared to the GI intervention. The presence of this relationship may show that IIs work by increasing overall focus on the task, as much of the variability in the data arises from the inability of some children to stay engaged throughout the tasks.

Further, running a third, passive control condition may provide a better GI comparison to IIs. For the task used in the present study, a GI that follows more closely with GIs used in the bulk of previous literature might be “I will do my best in the Animal and Vehicle game” (Such as in Gawrilow, Gollwitzer, and Oettingen, 2011). Including this third condition may allow us to analyze why we did not replicate Wieber et al. 2011 by demonstrating whether or not the intentions in the present study were equivalent or not. The running of this third, passive GI condition is currently planned and underway.

Concluding remarks

Improving a child’s self-control may set him or her up to be more successful in adulthood. For this reason, interventions that effectively increase a child’s ability to exhibit control are often explored in research. Further, interventions that target preschool children may be more effective than later-life interventions, as children of this age are particularly bad at self-control, and self-control follows a predictive trajectory throughout life. IIs are a promising type of intervention that are exceptionally easy to employ, so they may be particularly well suited to preschool-aged children. However, the present
study, the first to test the effectiveness of IIs in preschoolers, was unable to replicate
previous findings for benefits of IIs over GIs, and was unable to determine which
mechanisms underlie IIs, and was therefore unable to conclude if IIs can benefit
preschoolers. Future extensions of this project may enable stronger conclusions to be
drawn about the way IIs work, and therefore, establish if they are an adequate
intervention for young children.
References


