Strategy Use and Executive Function in Young Homeless Children

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Julianna K. Sapienza

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Abstract

The development of executive function (EF) has garnered attention in recent years because of its association with many positive outcomes. Although evidence suggests these skills can be trained, little research has focused on the processes that promote strong EF skills in high-risk children. Study 1 sought to investigate spontaneous self-regulatory strategies in 138 4- to 7-year-old homeless children during an EF task and to understand the relation between verbal and physical strategies, performance on EF tasks, and school outcomes. As hypothesized, results indicated that physical strategy use was significantly related to general EF, and that EF mediated the relation between physical strategy use and academic achievement and peer competence at school. Study 2 sought to investigate whether similar strategies can be trained and are related to performance on a delay task. 106 4- to 7- year-old homeless children were randomly assigned to training and control groups, and performance on two delay tasks was examined. As expected, children in the training group displayed significantly more strategies on the training task than did children in the control group and that these strategies were significantly related to task performance. However, there were no overall group differences in performance. Exploratory analyses revealed some evidence for a significant relation between training and performance only for older children. Additionally, results demonstrated some transfer of trained strategies to a generalization task, although these were not related to performance. Overall, evidence indicates some potential benefit of training children to use strategies during delay tasks, with implications for interventions aimed at promoting EF development and long-term school success.

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1. Introduction

The development of executive function (EF) in children—the set of neurocognitive abilities that allow us to self-regulate, plan ahead and think flexibly—has received increasing attention in recent years because of its association with positive outcomes, including better school performance and social competence (Brock, Rimm-Kaufmann, Nathanson, & Grimm, 2009; Hughes & Ensor, 2011; McClelland et al., 2007; Raver et al., 2011; Razza & Blair, 2009; Willoughby et al., 2011), as well as lower levels of internalizing and externalizing symptoms (Hughes & Ensor, 2011; Riggs et al., 2006; Willoughby, Wirth, Blair, Greenberg, & Family Life Project, 2010). Additionally, EF has unique predictive significance for academic achievement and school adjustment in young homeless and highly mobile children (Masten et al., 2014; Obradović, 2010) and also mediates the link between parenting quality and school achievement in these children (Herbers et al., 2011). Moreover, evidence suggests that EF can be improved by preschool programs for high-risk children (Diamond, Barnett, Thomas & Munro, 2007) and that these skills can be trained (Diamond, 2012; Klingberg, 2010; Fernyhough & Fradley, 2005; Kendler & Kendler, 1961; Mischel & Patterson, 1976). Thus, EF appears to be fundamental to learning and behavioral adjustment, malleable in young children, and also promising as a target for promoting resilience in high-risk children. To date, however, processes that can be utilized to promote the development of EF in high-risk children are not well understood.

There is good reason to believe that verbal processes and strategies are important for scaffolding the development of EF skills in young children. Indeed, at a most basic level, there seems to be a close link between children's verbal skills and their performance on EF tasks. Children's verbal ability, measured by the Peabody Picture Vocabulary Test, is significantly related to performance on a host of EF tasks (e.g., Carlson, Mandell & Williams, 2004; Carlson & Moses, 2001). Moreover, there is evidence that EF performance may be boosted by children's use of self-regulatory private speech, which is self-directed but audible speech that children use to guide their actions. For example, Mischel and Patterson (1976) found that preschoolers who were taught to use self-instructional plans (i.e., talking aloud to themselves about focusing on the task) in the face of tempting distractions during a lengthy task spent much more time on the task and were much less distracted than children who had not been taught these techniques.

There is also emerging evidence that children's use of physical strategies may facilitate performance on EF tasks. Several studies examining the use of physical strategies, such as covering one's eyes or looking away from a reward during a delay of gratification task, found that these strategies are not only related to better performance on the task (Mischel & Mischel, 1983; Raver, Blackburn, Bancroft, & Torp, 1999), but they also generalize to better performance on other EF tasks (Carlson & Beck, 2009) and to peer competence at school (Raver et al., 1999).

Unfortunately, there is little research on the link between children's use of self-regulation strategies and EF performance in high-risk children. The present two-part study had three goals: (1) to investigate the use of spontaneous self-regulatory strategies in young homeless children during a delay task; (2) to understand the relation between verbal and physical strategies, performance on EF tasks, and teacher-reported academic and peer outcomes; and (3) to investigate whether strategies that children appear to use spontaneously can be trained and used to boost performance on delay tasks.

1.1 Risk and Adversity in Homeless and Highly Mobile Children

According to conservative estimates by the U.S. Department of Housing and Urban Development (2014), 138,149 children were homeless in 2013, representing about 23% of all homeless individuals that year. Despite efforts to address this problem, progress is slow, and homelessness in major US cities has increased in recent years (HUD, 2014). Thus, it is more important than ever to understand the problems faced by homeless people and how these can be addressed.

Homeless and highly mobile (HHM) children living in poverty experience many of the same chronic risks that other low-income children do, such as limited access to resources like food and health care, living in single-parent households, limited parental education, and much more (McLoyd, 1998; Rog & Buckner, 2007). Additionally, both homeless and low-income children are at higher risk for experiencing traumatic life events such as witnessing violence, experiencing the death of a close relative, or seeing a sibling arrested (Buckner, 2008). However, the past 20 years of research on homeless children suggests that homeless children experience greater chronic risk and more stressful life events than low-income children (e.g., Masten et al., 1993; Samuels, Shinn, & Buckner, 2010). Homeless children also face additional risks not experienced by low-income children due to residential instability and school mobility (Rafferty, Shinn, & Weitzman, 2004). These children have been shown to score consistently below average on standardized tests of math and reading, display higher levels of grade retention, lower school attendance, and have poorer overall school experiences than their low-income peers (Cutuli et al., 2013; Obradović et al., 2009; Rafferty et al., 2004). Additionally, in comparison to their low-income peers, homeless children are at higher risk for psychopathology (Masten et al., 1993) and are more likely to report having no close friends (Masten et al., 1997).

At the same time, however, there is significant variability in the adaptive functioning of HHM children, indicating differences in promotive and protective processes in their lives (Huntington, Buckner, & Bassuk, 2008; Samuels et al., 2010). Thus, research is beginning to focus on uncovering what these processes are in order to inform prevention/intervention efforts.

1.2 Executive Function as a Promotive or Protective Factor

One promising line of research has focused on the role of EF skills for positive adaptation. EF encompasses a host of abilities including working memory, inhibitory control, and cognitive flexibility, allowing individuals to direct their attention, thinking, and actions to reach their goals (for review see Carlson, Zelazo, & Faja, 2013).

In community samples, EF is related to positive outcomes in multiple domains. In preschool and kindergarten, EF is significantly related to reading and math achievement (Brock et al., 2009; Howse, Lange, Farran, & Boyles, 2003; McClelland et al., 2007; Senn, Espy, & Kaufmann, 2004). Strong EF skills are also related to lower levels of externalizing behavior problems in preschoolers (Kochanska & Knaack, 2003; Murray & Kochanska, 2002; Olson, Sameroff, Kerr, Lopez, & Wellman, 2005).

Improvements in EF skills lower internalizing and externalizing behavior problems in the short-term (Eisenberg, Zhou, Spinrad, Valiente, Fabes, & Liew, 2005; Riggs, Blair, & Greenberg, 2003). Finally, EF performance has been linked with social competence in preschool (Lengua, Honorado, & Bush, 2007) and in late elementary children (Lengua, 2002; Razza & Blair, 2009; Trentacosta & Shaw, 2009).

Good EF may be especially important for school success among high-risk children. In a study of 356 low-income children attending a Head Start preschool, Bierman et al. (2008) found that EF skills significantly predicted phonological awareness, vocabulary, print awareness, social competence, and aggression. In a similar sample of Head Start preschoolers, EF was positively related to teacher-rated academic achievement as well as lower levels of inattention and overactive behavior (Willoughby et al., 2011). In another study of school-aged homeless children, Buckner, Mezzacappa, and Beardslee (2003) found that self-regulation differentiated between groups of children showing poor versus good mental heath and emotional well-being. Obradović (2010) found that homeless children with higher levels of EF show higher levels of academic and peer competence and lower levels of externalizing symptoms, even after controlling for age, sex, IQ, and parenting quality. Moreover, after performing a person-centered analysis, Obradović (2010) found that although resilient and maladaptive groups of children did not differ in experience of socio-demographic risk or parenting quality, resilient children showed significantly higher levels of EF and IQ.

More recently, Masten et al. (2012) again found that EF skills had unique predictive significance for the school adjustment of young children assessed while they were staying in a shelter for homeless families just prior to entering kindergarten or first grade. Controlling for IQ, higher scores on a composite measure of EF were related to academic and social success at school in multiple domains, including achievement, good conduct, and getting along well with both peers and teachers. EF scores showed a broader pattern of associations with school function than did IQ scores.

Although EF is linked to many positive outcomes for low-income and HHM children, socio-economic disparities in children's EF are well-documented (e.g. Lengua et al., 2014; Hackman & Farah, 2009; Lupien, King, Meaney, & McEwen, 2001; Mezzacappa, 2004; Noble, Norman, & Farah, 2005). A study of 4- to 7-year-old found that in comparison to their socio-economically advantaged peers, socio-economically disadvantaged children performed significantly worse on a measure of executive attention and demonstrated significantly slower reaction times to incongruent trials (Mezzacappa, 2004). Similarly, Noble, Norman, & Farah (2005) found SES disparities in measures of working memory and inhibitory control in young children. At age 6, low SES children perform significantly worse on a measure of executive attention than their peers (Lupien, King, Meaney, & McEwen, 2001). Likewise, parent and teacher reports of attention in young homeless children demonstrate poorer attention than their housed peers (Bassuk & Rosenberg, 1988).

Importantly, while poverty and homelessness have been associated with lower EF (for a review, see Lawson et al., 2014), substantial evidence suggests that EF is responsive to intervention (for a review, see Diamond, 2012). Furthermore, several preschool programs have been developed for high-risk, low-income children that have been effective in boosting EF, mediating academic gains (e.g., Bierman et al., 2008; Raver et al., 2011). Additionally, several studies have shown intervention appears to be most effective at boosting EF in children who initially demonstrate the lowest EF (e.g., Bierman et al., 2008).

Taken together, these studies on EF in normative samples and in high-risk samples suggest that EF is an important predictor of positive outcomes across domains of development, could serve an important protective function for high-risk children, and is responsive to change. Still, it remains unclear why some children have strong EF skills despite high levels of risk while others do not. Additionally, those preschool programs that have been effective in promoting EF development are typically one- to two-year programs that involve many different components. Thus, it is unclear what the "active ingredients" of these programs are. For unstable families that move often throughout the year, such as those living in poverty or in homelessness, there is great need to understand which components of these large interventions are impacting EF development so that programs can be developed that are short-term and efficient to reach those most in need.

1.3 Private Speech and Executive Function

To date, there have been no published studies on EF interventions in HHM children and few studies on EF interventions in economically disadvantaged children. Studies on normative samples, however, have shown that private speech may be one key to improving EF in preschoolers (Kendler & Kendler, 1961; Patterson & Mischel, 1976; Diamond et al., 2007). According to Vygotsky (1962), private speech is audible speech directed toward the self that is used as a tool to direct, guide, and regulate the self.

Vygotsky hypothesized that private speech peaks in the preschool years, and then begins to decline after age five. Vygotsky suggested that as children age, private speech "goes underground" in the form of inner speech or verbal thoughts (Frauenglass & Diaz, 1985). Thus, teaching children to use speech to self-regulate may be a way of teaching them how to think.

Vygotsky further predicted that private speech should increase linearly with task difficulty because simple tasks do not require such conscious self-guidance. As tasks become more difficult, children begin engaging in private speech in order to better regulate their behavior. Interestingly, then, his theory predicts that private speech is likely to occur with task failure because those children using the most private speech are also those who are having the most difficulty with the task at hand (Frauenglass & Diaz, 1985). Other theorists have suggested a quadratic relationship, with private speech lower at both easy and difficult task levels—when a task is easy, private speech is not needed; when a task becomes moderately difficult, children use private speech strategies to regulate; when a task becomes too difficult, private speech decreases as children become overwhelmed and resort to other strategies. This pattern is consistent with a "cognitive congruency" model taking a nonlinear form. Evidence for the quadratic model was found by Fernyhough and Fradley (2004), who observed that tasks of moderate difficulty elicited the greatest amount of private speech in a study of 5- and 6-year-old children. Also, Luria (1959) found that speech helped younger children but hampered older children on a stop signal task. Research has shown that while the use of private speech in young children is beneficial for task performance, older children who use private speech actually exhibit lower task performance than those who do not (Berk, 1986). Thus, it seems that task difficulty and mental age, as opposed to chronological age, both show a curvilinear relation with the incidence of private speech, presumably because as children become more cognitively mature, tasks become easier and verbal strategy use may go underground (Kohlberg, Yaeger & Hjertholm, 1968).

Based on Vygotsky's ideas and studies showing the link between children's private speech and task performance, several studies have been conducted examining the effects of spontaneous use of private speech and private speech training on EF task performance. Preschoolers who spontaneously use self-regulatory private speech during delay tasks wait longer (Carlson & Beck, 2009; Mischel, Shoda & Rodriguez, 1989). Similarly, young preschoolers who spontaneously use labeling during a hot conflict task performed much better than those who did not label (Müller, Jacques, Brocki & Zelazo, 2009). In line with the curvilinear model of the relation between age and use of self-speech, 4-year-olds, but not 3- or 5-year-olds, who were trained to label the relevant dimension during a cognitive flexibility task, the Flexible Item Selection Task, performed much better on the task than children who were not trained to use labeling (Müller et al., 2009). In addition, children taught to use relevant verbalizations during a discrimination task were much more successful than children who were taught irrelevant verbalizations or no verbalizations (Doebel & Zelazo, 2013; Kendler & Kendler, 1961). Finally, as previously mentioned, preschoolers taught to use self-instructional plans in the face of tempting distractions while working on a repetitive task spent much more time working and became distracted less often than children who had not been taught to use such verbalizations (Patterson & Mischel, 1976). Taken together, these studies suggest that private speech may help to facilitate performance on a multitude of EF tasks, and that training private speech in young children may help to boost their EF skills.

To date, there have been few studies of the role of private speech on EF performance among high-risk children. One exception is a recent study by Diamond and colleagues (2007) evaluating a preschool program called Tools of the Mind, which is based on Vygotsky's ideas about learning (Bodrova & Leong, 2009). Tools of the Mind is designed to train children to use self-regulatory private speech, dramatic play, and aids to promote memory and attention. In Diamond and colleagues' (2007) evaluation of the Tools of the Mind program, preschool teachers at schools serving low-income children spent 80% of each day promoting EF in the classroom using these methods. After two years of the program, preschoolers were assessed on two commonly used EF tasks, Flanker and Dots. Preschoolers who had participated in the Tools program significantly outperformed children in another program in the district. Additionally, for conditions that were most demanding, the effects of the Tools program were most sizable (Diamond et al., 2007). Although private speech was not the sole tool used to improve EF as part of this program, findings from this study are congruent with other research more explicitly noting the efficacy of private speech in task performance (Kendler & Kendler, 1961; Mischel et al., 1989; Muller, Zelazo, Hood, Leone, & Rohrer, 2004; Patterson & Mischel, 1976). Together, these results suggest that children's use of private speech may be potentially important for the development and training of EF skills. However, because private speech is thought to follow a curvilinear pattern of development, it could be the case that while beneficial, it may reflect a less sophisticated and effective strategy than fully internalized speech.

1.4 Physical Strategies and Executive Function

Physical strategy use might also be beneficial to EF performance. However, there is very little extant research on children's use of physical strategies and only one study thus far that has examined the two together. Mischel and Mischel (1983) found that during a delay of gratification task, children who covered the toy or averted their gaze or closed their eyes were able to delay longer and additionally that older children more consistently chose this strategy than younger children, resulting in better performance on the task.

Raver, Blackburn, Bancroft, and Torp (1999) studied low-income preschoolers during a delay task. Findings showed that children who abided by the experimenter's instructions not to touch the prohibited object spent significantly more time distracting themselves, significantly less time focusing on the prohibited object, and more time self-soothing than did children who did not follow directions. They also found that children who used more self-distraction were significantly less likely to touch the object and showed greater peer competence.

More recently, Carlson and Beck (2009) examined both verbal and physical strategy use in 3- to 4-year old children during a delay of gratification task. They found that in this age group, physical strategies were most common, however, use of verbal strategies increased over time. Additionally, they found that use of closing eyes or averting gaze was most consistently positively related to performance on the battery of

EF tasks administered while physical restraint (such as sitting on their hands) was not related to EF performance on any task. Verbal strategy use including talking/singing, rule reminders, and pretense, was less consistently related to EF performance, with some verbal strategies being related to performance on some EF tasks but not others.

Overall, this research suggests that physical strategies may also facilitate children's performance on EF tasks. Results also underscore the need for a greater understanding of physical strategy use as well as the need to examine verbal and physical strategy use together. It remains unclear whether one type of strategy use is generally more sophisticated and more effective than the other, or whether one type of strategy use may be more effective for some types of tasks while the other type of strategy use may be more effective for others.

1.5 Current Studies

In light of the research on the facilitative effects of verbal and physical strategy use on executive function in normative samples of young children, two studies were conducted with the goal of understanding the relation between self-regulatory strategy use and EF in HHM children. Study 1 investigates whether children's spontaneous strategy use predicts EF performance and school outcomes. Study 2, designed as a microtrial, investigates whether training children to use strategies during delay task impacts performance on that task and whether it generalizes to impact performance on other EF tasks. Study 2 aims and hypotheses will be discussed in greater detail following a full discussion of Study 1.

Study 1. In light of the research on the facilitative effects of verbal and physical strategy use on EF in normative samples of young children, the primary goal of this study was to examine the relation between self-regulatory strategy use and EF in HHM children. With so little known about the kinds of strategies HHM children use and the frequency with which they are used, another goal of this study was descriptive—to discover the types of strategies young homeless children use during EF tasks and with what frequency.

The second goal of this study was to understand which type of strategy is most effective for use during an EF task. For this study, the Gift Delay task, a delay of gratification task in which children are asked to wait for a present, was chosen for examination of strategy use because of its relation to general EF performance in this age-group (Carlson & Moses, 2007) and because it provides a relatively long period of time to observe strategy use. Given the paucity of research on this topic, no specific predictions were made about which type of strategy use would facilitate performance best. However, it was predicted that the type of strategy use that best facilitates performance on Gift Delay would also be related to higher EF performance more generally.

Two approaches were used to investigate this question. The first was categorical, based on assigning each child to one of four categories of strategy use that were expected to show increasing levels of EF performance. These categories were as follows: 1) Children who used no strategies (expected to have the lowest scores on EF); 2) children who used verbal strategies alone; 3) children who used both verbal and physical strategies (who may be transitioning from outward private speech to internalized thought) and 4) children who used physical strategies alone.

The second approach was based on a continuous score, in an effort to capture the relative use of physical compared to other strategies. For all children who used strategies of any kind, the proportion of physical strategies was calculated, providing a more precise and continuous measure of physical compared to verbal strategy use.

Because of the strong links between EF and school outcomes, it was expected that the same patterns of strategy use also would forecast academic and social success in kindergarten and 1st grade. Thus, it was hypothesized that there would be a categorical gradient of school success corresponding to the four groups described above, and also that the same pattern of strategy use that predicted higher EF scores would also be associated with better academic and peer social success with peers in school. Further, it was predicted that EF would mediate the relation between strategy use and school adjustment outcomes, supporting the idea that children who use more effective strategies would have better EF skills that in turn promote success at school.

To test this hypothesis, for all children who used strategies of any kind, the proportion of physical strategies was calculated, providing a more precise and continuous measure of physical compared verbal strategy use.

2. Study 1 Material and Methods

2.1 Participants

Participants included 138 children entering kindergarten or 1st grade in the fall of that year and their parents, recruited while the family was residing in an emergency shelter for homeless families. Families were recruited and assessed in three shelter sites, including the two largest family shelters in a major metropolitan area as well as a smaller shelter for vulnerable young families. Due to the nature of the measures, participation required English language fluency for the child and primary caregiver, as well as the mental and physical capabilities to engage the cognitive tasks. Thirteen families with a child in the age range were excluded because they were not fluent in English and two children were excluded due to severe developmental delays that precluded participation. Families were not invited to participate until they had spent at least 3 nights in the shelter (to acclimate). If a family had two or more eligible children, one child was chosen at random to participate in the study. The overall participation rate for the study was 72% of all eligible families, with 6.8% of families declining participation. The remaining families failed to make appointments, could not be rescheduled in time, or never came in direct contact with research staff.

Among the 138 children who participated, 78 (56.5%) were female and 60 (43.5%) were male. The mean age was 5.77 years (SD= .58, range 4.83 – 6.92). Ethnic/racial composition of the sample included 63.8% African American, 16.7% multiracial, 5.8% American Indian, 4.3% Caucasian, 1.4% Asian, and 6.5% other, which is typical of these shelters. Most of the children lived in a single-caregiver household (73%) and most of the primary caregivers were mothers (94.9% mothers, 5% fathers, 0.7% grandmothers). The average length of shelter stay at the time of assessment (reported by parents) was 32.93 days (SD = 44.90).

2.2 Procedures

After completing the consent and assent process, parents and children were assessed separately for approximately 60 minutes on the shelter premises. Children completed a battery of EF tasks and three standardized intelligence subtests, while parents completed a set of structured interview questions and questionnaires about family background and child behavior.

After the school year began, and with permission of the parents, teachers of each child who could be located were contacted and invited to complete a questionnaire about the child's adaptive functioning. As expected, many of the participating families continued to be mobile and thus were difficult to locate. Overall, 82.6% of children were located in schools, and 97.4% of teacher questionnaires for located students were completed and returned, providing teacher outcome data for 80% of the total sample.

2.3 Measures

2.3.1 Executive Function. EF was measured with a battery of six tasks measuring inhibitory control, set-shifting, working memory, and delay of gratification skills. In *Simon Says,* the researcher stated and demonstrated a series of actions, half of which are preceded by the phrase "Simon says" (Kochanska, Murray, & Coy, 1997; Strommen, 1973). The child was instructed to do all the actions preceded by "Simon says" (activation trials) and refrain from doing actions that do not begin with "Simon Says" (inhibition trials). Child behavior was video-recorded and later coded by a team of raters (Kappa [*K*] = .94). Scores were based on the percentage of correct inhibition trials, except for cases in which the child failed all activation trials or failed to inhibit correctly in any of the practice trials. These children were presumed to misunderstand the demands of the task, and thus their scores were considered missing. The second EF task assessed cognitive flexibility indexed by success in shifting on the *Dimensional Change Card Sort* (DCCS: Zelazo, 2006). For this task, children were instructed to sort cards first by color, then by shape. Scores for DCCS reflected the number of correct scores out of six following the rule switch. In the *Peg-Tapping* task (Diamond & Taylor, 1996), children were presented with two rules: tap the table with a wooden dowel twice after the experimenter tapped once and tap once after the experimenter tapped twice. Scores were based on percentage of correct taps (*K* for subsample of 39 = .97). In the *Computerized Pointing Stroop* (Berger, Jones, Rothbart, & Posner, 2000), children saw two different animals on a computer screen and heard an animal sound corresponding to one of the animals. In compatible trials, they were instructed to point to the animal that makes the sound. Then, in the incompatible trials, they were instructed to point to the animal that does not make that sound. Scores were based on percentage of correct incompatible trials.

In addition, there were two tasks involving inhibition in the presence of an anticipated reward to assess EF under "hot" or more emotional conditions. In the *Dinky Toys* task (Kochanska et al., 1997), children were shown a box full of small toys such as rubber balls or spinning tops, and told to ask for, but not to touch, the toy they want. Scores are based on worst transgression (5 point scale), plus the frequency of transgressions and latency to worst transgression. During this task, children received scores of 0- grabbing a toy, 1- touching a toy, 2- point to a toy, 3- moving hands above the level of the table, and 4- no transgression. Child behavior was video-recorded and later coded by a team of trained raters (K = .76 for worst transgression code; 93% agreement for frequency within 1; latency agreement within 2 sec = 95%). The final EF task was *Gift Delay* (Kochanska et al., 1997), which has two distinct parts. In part 1, children were told that, "the rule of the game is no peeking". They were positioned facing away from the experimenter while she noisily wrapped a gift for 1-min. In part 2, the experimenter left the room for 3-min, pretending she "forgot the bow" and reminded the child not to peek at the gift while she was gone. Scores on each part of this task were based on worst transgression (3-point scale for part 1; 6-point scale for part 2), as well as frequency of and latency to worst transgression. During Part 1, children received codes of 0- no transgression, 1- head turning, and 2- body turning. During Part 2, children received codes of 0- no transgression, 1- head turning, 2- body turning, 3- touching the gift bag, 4- looking inside the gift bag, and 5- removing the gift from the bag. Child behavior was video-recorded and later coded, with interrater agreement calculated on the basis of 1/3 of the cases by a team of raters (100% agreement on Part 1 for overall code and 97% agreement for overall code on Part 2; 98% agreement within 1 for frequency of transgressions on both parts; 94% and 89% agreement, respectively, within 2 sec for latency). For each of these three "hot EF" tasks, composite scores were formed by averaging z-scores for transgression code, frequency and latency. Scores were reverse-coded as needed such that high scores reflected better performance and extreme scores were truncated to z-scores of + or – 3.0 before compositing.

An overall EF composite was computed by averaging z-scores from six EF task scores (Simons Says, DCCS, Peg Tapping, Computerized Stroop, Dinky Toys, and Gift

Delay Part 1; Cronbach alpha (α) = .71). The Gift Delay Part 2 score was not included in order to determine whether strategy use during this task was related to performance on other aspects of EF.

2.3.2 Intelligence. Three widely used and well-validated measures that had been pilot-tested with homeless children were chosen to estimate the general factor for IQ: the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV; Dunn & Dunn, 2007) and two nonverbal subscales (Block Design and Matrix Reasoning) of the Wechsler Preschool and Primary Scales of Intelligence, Third Edition (WPPSI-III; Wechsler, 2002). An IQ composite was formed by averaging z-scores from the two nonverbal scores ($r = .29$ in this sample) and then averaging that score with the z-score based on the PPVT ($r = .36$). Confirmatory factor analysis with all of the EF and IQ scores corroborated that EF and IQ could be measured distinctively (Masten et al., 2012).

2.3.3 School Outcomes: Academic Achievement and Peer Acceptance. Measures of school adaptation in two specific areas were drawn from the teacher version of the MacArthur Health and Behavior Questionnaire (HBQ-T; Armstrong, Goldstein, & the MacArthur Working Group on Outcome Assessment, 2003). Academic Achievement was assessed using the five-item HBQ Academic Competence subscale (α = .96 for the present sample). Peer Acceptance was assessed using the eight-item HBQ Peer Acceptance/Rejection subscale (α = .91).

2.3.4 Strategy Use. The strategy-use coding scheme used in this study was originally developed and piloted in smaller study of 66 children with a mean age of 6.01 years (SD = 0.56, range 4.92-7.23) living in a homeless shelter at the time of the study.

Following its use in the pilot study, small changes were made to improve reliability and to better capture the range of behaviors children showed during Simon Says, Peg Tapping, and Gift Delay.

This coding scheme was designed to assess the frequency with which children used a variety of verbal and physical strategies during the Gift Delay Part 2 task. Verbal strategy use was broken down into five categories: (1) use of rule reminders in private speech (e.g., “Don’t touch the gift!”), (2) speech about the gift in absence of rule reminders (e.g., “I wonder what’s in the bag?”), (3) use of distracting speech or talking about an unrelated topic, (4) talk in the context of pretend play, and (5) unintelligible or mouthed speech. Physical strategy use was broken into three categories: (1) covering eyes or sitting on hands, (2) playing with another object or toy in the room, and (3) clear use of somatic distraction beyond simple fidgeting (e.g., beating drums on their legs or counting fingers).

Gift Delay Part 2 was used because it provided the best and longest opportunity to observe spontaneous strategy use. Raters were blind to the hypotheses of this study and blind to performance on other EF tasks as well as to school outcomes.

3. Study 1 Results

3.1 Descriptive Analyses

One of the aims of this study was descriptive in nature—to investigate what types of strategies children use and how often they use them. Results showed that out of the 132 children who completed Gift Delay part 2, 5 (3.8%) used no strategies, none (0%) used verbal strategies only, 61 (46%) used both verbal and physical strategies together, and 66 (50%) used physical strategies only. A further question was whether or not the number of types of strategies used was related to the frequency of strategy use overall. Number of types of strategies used overall and overall frequency of strategy use were strongly correlated ($r(130) = .74$, $p < .01$).

3.2 Strategy Use Data Reduction

Results revealed that while many children used some type of verbal strategy (n=61) and/or some type of physical strategy (n=127), there were not enough children using specific strategies within those categories to perform further data analysis based on subcategories (see Study 1 Table 1 for a summary). Therefore, two variables were calculated: frequency of verbal strategy use and frequency of physical strategy use. Frequency of verbal strategy use was calculated as a sum of the frequencies of the five types of verbal strategies—rule reminders, gift talk, distracting speech, pretend play speech, and unintelligible speech. Interrater reliability based on 30% of the sample was ICC= .96. Frequency of physical strategy use was calculated as a sum of the frequencies of two types of physical strategies—covering/closing eyes or sitting on hands, and somatic distraction. Playing with a toy or other object was excluded because it was judged that in some instances obtaining a toy or other object was in violation of the rule to stay seated while the experimenter was gone. Furthermore, a child's access to a toy or other object varied; therefore this behavior may or may not have occurred due a lack of study control. Interrater reliability based on 30% of the sample for frequency of physical strategies was ICC= .61.

3.3 Strategy Use, EF, and School Outcomes

3.3.1 Categorical approach. To understand whether verbal, physical, or some combination of the two types of strategies were most effective in boosting EF performance and related to school outcomes, children were divided into groups based on the strategies they used. Unfortunately, there were no children who used only verbal strategies and only five children who did not use any strategies (because of the small size of this group, these five children were excluded from further analyses). Therefore, testing was limited to a comparison of two categories. Analyses of covariance (ANCOVAs) were performed to investigate group differences in EF, academic achievement, and peer competence between children who used both verbal and physical strategies together (n = 61) and those who only used physical strategies (n = 66). After controlling for age, gender, and IQ, performance on Gift Delay Part 2 and overall EF performance was significantly higher among children who used physical strategies only ($F(1, 118) = 22.12$, $p < .001$; $F(1, 118) = 6.91$, $p = .01$, respectively). However, after controlling for age, gender, and IQ, there were no significant differences between groups on teacher-rated academic achievement ($F(1, 93) = .55$, $p = .46$) or on teacher-rated peer competence ($F(1, 94) = 2.04$, $p = .16$).

3.3.2 Continuous approach. To further investigate the relation between type of strategy use and EF performance, academic achievement, and peer competence, a series of hierarchical linear regressions were conducted utilizing the proportion of nonverbal strategies out of the total number of strategies used by each child. This proportion allowed for a more precise and continuous measure of physical vs. verbal strategy use to test the hypothesis that the relative use of physical strategies would be positively related to all outcomes of interest. Results of the regressions are presented in Study 1 Tables 1, 2, 3, and 4. After controlling for age, gender, and IQ, the proportion of physical strategies used was significantly related to Gift Delay Part 2 performance ($\beta = .44$, $t(122) = 4.44$, $p < .001$, overall EF performance ($\beta = .32$, $t(126) = 4.52$, $p < .001$), and academic achievement ($\beta = .18$, $t(99) = 2.11$, $p = .04$), and peer competence ($\beta = .26$, $t(101) = 2.71$, $p = .008$).

To test the mediating effect of EF on the relation between the proportion of physical strategy use and each of the school outcomes, I used the bootstrapping method designed for small samples described by Preacher and Hayes (2008). Using their macro for SPSS version 16.0, I tested the total effect of proportion of physical strategy use on academic achievement controlling for age, sex, and IQ with EF as a mediator. With 1,000 bootstrap resamples, this model showed evidence for mediating effects of proportion of physical strategy use through EF. The total effect of proportion of physical strategy use on academic achievement when controlling for age, sex, and IQ was significant (.19, $p = .04$). The direct effect of proportion of strategy use on academic achievement was .06 ($p = .55$). Thus, the indirect effect through EF as a mediator, calculated as the total effect minus the indirect effect, was .13, with a 95% bootstrap confidence interval of .04 to .30. This confidence interval indicates that the indirect effect through the mediator was significantly different from zero. The overall model was significant and explained 33% of the variance. This mediator model is presented in Study 1 Figure 1.

Similarly, I also tested the total effect of proportion of physical strategy use on peer competence controlling for age, sex, and IQ with EF as a mediator. With 1,000 bootstrap resamples, this model showed evidence for mediating effects of proportion of physical strategy use through EF. The total effect of proportion of physical strategy use on peer competence when controlling for age, sex, and IQ was significant (.28, $p = .008$). The direct effect of proportion of strategy use on peer competence was .18 ($p = .12$). Thus, the indirect effect through EF as a mediator, calculated as the total effect minus the indirect effect, was .10, with a 95% bootstrap confidence interval of .01 to .26. This confidence interval indicates that the indirect effect through the mediator was significantly different from zero. The overall model was significant and explained 10% of the variance. This mediator model is presented in Study 1 Figure 2.

4. Study 1 Discussion

4.1 Self-Regulation Strategy Use

The first goal of this study was to determine what kind of strategies and how often children were using such strategies during EF tasks. There have been few studies to date on spontaneous strategy use in children, even though evidence suggests that such strategy use is important for improving EF performance in young children (Diamond et al., 2007). Understanding how children use strategies and what kind of strategies they use naturally may be important for developing programs that teach children strategy use in order to improve EF skills.

Results of this study suggest that very few homeless children in this age group of 5-6 years use no strategies during Gift Delay part 2 (3.8%), and interestingly, that there were no children in this age group who used verbal strategies without using some sort of physical strategy as well. Further, approximately half of the remaining children used verbal and physical strategies together during the task and half used physical strategies alone (46% vs. 50%, respectively).

Interestingly, most children used each type of strategies only once or twice during the 3-minute delay. A further question is whether children who are using many strategies overall are using many different types or seem to rely on one or just a few types of strategies. For both verbal and physical strategies, the high correlation between the types of strategies used and the frequency of strategy use suggests that children who use strategies more frequently also use many types of strategies, rather than relying on just one or a few.

4.2 Strategy Use and Executive Function Performance

It was not feasible to test strategy use comprehensively in this study because there were so few children manifesting no strategy use and none manifesting verbal strategy use alone. However, the comparison between children using both verbal and physical strategies to those using only physical strategies revealed that children who use physical strategies alone perform significantly better on EF tasks. This difference held when controlling for age, suggesting that it is not just that older children were using physical strategies alone and performing better on EF tasks. It also held when controlling for IQ, suggesting that the use of physical strategies alone is not a simple marker of higher cognitive level, but is related to EF beyond the effects of IQ. Results of the regression analysis were consistent with the results of the categorical analysis. The relative frequency with which children used physical strategies out of all the strategies they used was also significantly related to EF performance, suggesting that children who use relatively more physical strategies in comparison to verbal strategies perform better on EF tasks.

It appears that physical strategies are effective in helping young homeless children perform better on this task and are related to EF performance more generally. However, there are several possible explanations for this finding. One explanation is that physical strategies are an outward manifestation of internalized strategic thought. Vygotsky theorized that with development, private speech spoken to the self aloud “goes underground” with development. If this is what physical strategy use represents, based on Vygotsky’s theory and evidence from the literature (Kendler & Kendler, 1961; Mischel et al., 1989; Muller et al., 2004; Patterson & Mischel, 1976; Vygotsky, 1962), it would be predicted that children who use no strategies would demonstrate the lowest EF performance, and that children who demonstrate the sole use of verbal strategies would demonstrate somewhat higher EF performance. However, as these verbal strategies begin to “go underground” (Frauenglass & Diaz, 1985) as represented by children using a combination of verbal and physical strategies, performance on EF tasks and on later school outcomes would improve further. Moreover, when private speech becomes fully internalized and children only manifest physical strategies, performance on EF tasks and subsequent school outcomes would be the highest. Unfortunately, because there were so few children who used no strategies or who used verbal strategies alone, my data did not allow me to test this potential progression.

A second explanation for this finding is that physical strategies are simply more available for use by younger children or children who develop EF skills later, as has been demonstrated for children like those in this sample (Obradović, 2010). Carlson and Beck (2009) demonstrated that in a typically developing sample of 3- to 5-year-olds, older children tend to use verbal strategies more often and younger children use physical strategies more often during a delay of gratification task. Thus, it could be that in fact, verbal strategies are generally the more advanced type of strategy, but that for homeless children, physical strategies are more easily utilized and more effective in boosting performance. A wider age range would have permitted further evaluation of this hypothesis, although it should be noted that at least in the age range of 5-6 years, types of strategy use showed no relation to age.

A third explanation for this finding is that physical strategies may be the most effective type of strategy or the most likely type of strategy for children to spontaneously think of to use for this specific task. If strategy use during other types of tasks had been analyzed, it is possible that verbal strategies would have occurred more often and been more effectively implemented by children. Unfortunately, although strategy use was coded during other tasks, children did not use any type of strategy often enough to analyze this data. Future studies on this topic should seek to examine strategy use during a variety of tasks in order to answer this question and if there does seem to be an effect of task type on strategy use, to examine whether children who flexibly select strategies based on the task have higher overall EF performance than children who consistently use one type of strategy regardless of task type.

4.3 Mediated Effects of Physical Strategy Use on Academic Achievement and Peer Competence

The results of this study are consistent with previous research suggesting that EF skills are important for and predict children's school success in the domains of academic achievement and peer competence (Lengua, 2007; Obradović, 2010). One of the aims of this study was to understand the processes underlying EF, how they contribute to HHM children's performance on EF tasks, and how this performance is predictive of school outcomes. EF skills appear to have a mediating effect linking proportion of physical strategy use to both academic achievement and peer competence. It may be that HHM children who make effective use of physical strategies are better able to focus attention, inhibit impulses, delay gratification, and think flexibly, all of which are important for academic success and positive interactions with peers in the early years of school.

4.4 Limitations

This study had three key limitations. First, the study did not have repeated assessments of strategy use over time, and therefore did not allow for detecting developmental trends in children's use of strategies. Second, the sample size was too small to investigate the relation between specific types of strategies and EF performance and school outcomes. It may be that there are some types of strategies that are more effective than others. Although verbal strategies appear to be overall less effective than physical strategies in promoting EF performance, there may be some types of verbal strategies that are actually just as or more effective than physical strategies. Conversely, there may be some types of physical strategies that are relatively ineffective or may even be detrimental to performance. Future studies should investigate this issue further.

Finally, a further issue that could not be answered by this correlational study alone is whether using strategies actually promotes good EF skills or if it is merely a marker of developmental level. In other words, it could be that children's increasing use of physical strategies actually aids performance or it could be that this increasing reliance on physical strategies is related to development as are EF skills, or both. Given that the relation between physical strategy use and EF performance held when controlling for age and IQ, it seems unlikely that physical strategy use is only a marker of developmental level. Furthermore, previous studies that have experimentally manipulated children's use of physical strategies have shown that performance on EF tasks increases when children are taught physical strategies (Mischel, Shoda, & Rodriguez, 1989), suggesting a facilitative role of physical strategy use.

5. Study 2 Aims and Hypotheses

Thus, Study 2 was designed in part to answer this question: does strategy use facilitate performance on EF tasks or is it merely a marker of developmental level? Importantly, Study 2 therefore provided information about whether training strategy use may be an effective part of a larger program designed to boost EF skills in young high-risk children. Study 2 was designed as a microtrial, training to children to use strategies that were effective in Study 1, on the same delay task and then investigating whether children transfer these strategies to aid performance on other EF tasks. This study had several hypotheses:

1) Children trained to use strategies on the Gift Delay task will use significantly more strategies on this task than children in the control group.

2) Children in the training group will also demonstrate higher scores, indicating a stronger ability to delay gratification, on the Gift Delay task than control children.

3) Children in the training group will also use significantly more strategies on other delay tasks, and will show higher performance on these tasks, than children in the control group.

4) The effect of training on task performance will be mediated by strategy use, such that children trained to use strategies will use more strategies than control children and will thus demonstrate higher task performance.

Additionally, children in both groups also completed a battery of EF tasks assessing working memory, inhibitory control, cognitive flexibility, and selective attention. Given the limited training children received, it was not expected that children in the training group would show better overall EF scores after training than the control group.

Further, there were several exploratory questions regarding this study. First, I aimed to discover whether there were any differences in the types of strategies children learn and utilize most readily and whether different types of strategies relate to task performance in different ways. Given that it remains unclear whether one type of strategy use is generally more sophisticated and more effective than the other, no specific predictions were made about which strategies would be significantly related to training group status and task performance.

Second, while evidence generally supports a curvilinear relation between use of private speech and task performance (Kohlberg, Yaeger & Hjertholm, 1968), the relation between other types of strategy use and task performance remains unclear. Additionally, no previous studies have examined moderators in the relation between training and strategy use. Thus, another exploratory goal of this study was to examine moderators of the relations between training, strategy use, and task performance. Because age and IQ are both significantly related to EF development more generally and because previous theorists have hypothesized relations between age, IQ, and strategy use, these two variables were chosen as exploratory moderators.

6. Study 2 Methods

6.1 Participants

Participants included 106 children their parents, recruited while the family was residing in an emergency shelter for homeless families in the spring and summer before children were entering kindergarten or 1st grade. Families were recruited and assessed in the two largest family shelters in a major metropolitan area, representing the majority of homeless families living in shelters in the area. Due to the nature of the measures, participation required English language fluency for the child and primary caregiver, as well as the mental and physical capabilities to engage the cognitive tasks. Fifty-five families with a child in the age range were excluded because they were not fluent in

English and five children were excluded due to severe developmental delays that precluded participation. Families were not invited to participate until they had spent at least 3 nights in the shelter (to acclimate). If a family had two or more eligible children, one child was chosen at random to participate in the study. The overall participation rate for the study was 60% of all eligible families, with 4.5% of families recruited for the study declining participation after the study was fully explained (the other 95.5% participating). The remaining eligible families failed to make appointments, could not be rescheduled in time, or never came in direct contact with research staff. 68% of all missed families only resided in the shelter during the school year, making them more difficult to recruit and schedule because appointments were only available in the evenings and on Saturdays to accommodate children's school schedules.

Among the 106 children who participated, 49 (46.2%) were female and 57 (53.8%) were male. The mean age was 5.70 years (SD= .60, range 4.40 – 6.92). Ethnic/racial composition of the sample included 64.0% African American, 24.5% multiracial, 7.5% American Indian, 2.8% Caucasian, 2.8% Asian, and 1.9% other, which is typical of these shelters.

Children were randomly assigned to experimental and control groups, stratified by shelter of residence and gender. 55 children (29 female) were in the control group, with a mean age of 5.70 years (SD= .59, range 4.5-6.92), and 51 children (20 female) were in the training group, with a mean age of 5.68 years (SD= .61, range 4.58-6.83).

6.2 Procedures

After completing the consent and assent process, parents and children were assessed separately for approximately 80 minutes on the shelter premises. Children completed a battery of EF tasks and two standardized intelligence subtests, while parents completed a set of structured interview questions and questionnaires about family background and child behavior.

With the exception of one training task, both groups of children were administered the same tasks to be described in more detail below. Children began by completing IQ tasks in order to ensure that training would not affect IQ scores. Then, children completed the training task followed by an EF battery designed to measure children's general EF performance and a generalization task, similar to the training task, to assess whether children generalized strategies taught during the training task to other, similar tasks.

6.3 Measures

6.3.1 Intelligence. Two widely used and well-validated measures that had been pilot-tested with homeless children were chosen to estimate the verbal, nonverbal and general factor for IQ: the Receptive Vocabulary and the Matrix Reasoning subscales of the Wechsler Preschool and Primary Scales of Intelligence, Third Edition (WPPSI-III; Wechsler, 2002). An IQ composite was formed by averaging z-scores from the two scaled scores (r = .34 in this sample).

6.3.2 Gift Delay Training Task. Children in both the training group and the control group were administered Gift Delay (Kochanska et al., 1997) as described in

Study 1. As in Study 1, scores on each part of this task again were based on a code for worst transgression, frequency of transgressions, and latency to worst transgression. Inter-rater agreement was calculated on the basis of 1/3 of the cases that were coded by multiple raters (*K* = .89 and .90 respectively for Part I and Part II; 94.3% and 89.0% agreement within 1 for frequency; 94.3% and 90.0% agreement within 2 seconds for latency). Composites were formed by averaging z-scores for code, frequency and latency. Scores were truncated to a z-score of + or – 3.0 before compositing.

Prior to beginning the task, children in the training group received standard instructions as well as a brief training on possible strategies they may use to help themselves not peek, whereas children in the control group received standard instructions and a brief demonstration of the same activities shown to the children in the training group, but without reference to these activities use as strategies to avoid peeking. Experimenters posted pictures of these strategies on the wall (matching the child's gender and ethnicity), explained them, and encouraged children to practice them as well. Pictures of strategies remained on the wall in front of the child for the duration of the task. These strategies included those that children demonstrated effective use of during Study 1 as well as previously investigated pretend play strategies (Carlson, unpublished data). Children were taught to sit on their hands, cover their eyes, and beat a drum on their legs while waiting. They were also shown how to pretend to be two characters, a fairy and a spaceman. In the training group, children were told that these characters were good at waiting and that if they were struggling to wait, they could "put on their wings/antennae" and pretend to be one of those characters. In the control group, children were simply shown how to be these characters with the explanation that "pretending is fun."

6.3.3 Executive Function. EF was measured with a battery of four tasks measuring inhibitory control, set-shifting, working memory, and selective attention skills. Inhibitory control was assessed via the *Peg Tapping* task (Diamond & Taylor, 1996) previously described. Scores were based on percentage of correct taps (*K* for subsample of 35 = 1.0).

Set-shifting was assessed via a computerized version of the *Dimensional Change Card Sort* (DCCS; Zelazo, 2006) that is a downward extension (Dext) of the NIH Toolbox task by the same name (Zelazo & Bauer, 2013). The DCCS-Dext was modeled on early versions of the Minnesota Executive Function Measure (Carlson & Zelazo, personal communication) and developed by a team at the University of Minnesota to improve the range of the Toolbox EF measures (DCCS and also the Flanker task) for assessing young and more disadvantaged children (Carlson et al., 2015). The DCCS-Dext modifies the standard Toolbox version so that easier levels are included for children who do poorly on the original starting level. Children are asked to sort pictures by shape and by color for more complex levels, sometimes switching from one sorting rule to the other, but there are simpler sorting tasks included (e.g. putting little kitties in the little kitty box). This task is adaptive to minimize the burden on young children.

Children also completed a computerized *Flanker* task, assessing selective attention, which asks children to feed the middle fish while ignoring distracting "flanker" fish on either side. This task (Flanker-Dext) is also a downward extension of the NIH

Toolbox task by the same name, adapted by the Minnesota groups to lower the floor and extend the valid range to younger and more diverse children. Children unable to pass the early levels of the standard Toolbox task are shifted to easier levels of fish trials with greater contrast and more scaffolding (Anderson, Wenzel, Carlson, Zelazo, & Masten, 2013). Flanker-Dext, as well as the modified DCCS have shown good evidence of convergent and construct validity, correlating as expected with age, other EF tasks, and school readiness measures (Wenzel et al., 2013).

Finally, children completed *Forward Backward Word Span* (FBWS; Carlson, Moses, & Brenton, 2002), a task assessing working memory, in which the experimenter reads words aloud and the child repeats the words back to the experimenter. First, the child repeats the words back in the same order as the experimenter (e.g., experimenter says, "*cloud, dog, truck*," child says, "*cloud, dog, truck*.") In the second part, Backward Word Span, the child repeats the words backwards, in the opposite order the experimenter read to them (e.g., experimenter says, "*cup, boat, moon*," child says, "*moon, boat, cup*." In both parts, the experimenter starts with a total of two words and increases the number of words until five total or until the child makes three consecutive errors. The maximum number of consecutive words successfully repeated forward and backward represents the child's score on the task.

An overall EF composite was computed by averaging z-scores from four EF task scores (Peg Tapping, Computerized DCCS, Computerized Flanker, and Forward Backward Word Span; Cronbach alpha (α) = .86).

6.3.4 Toy Prohibition. Finally, at the end of the session, children completed a delay task similar to Gift Delay, in order to assess the extent to which children generalized the strategies that were taught. This task occurred approximately 30 to 40 minutes after the Gift Delay Task, and the picture cue cards of strategies remained on the wall in front of children for this task. Children were administered an adapted version of the *Toy Prohibition* task (Miyake & Friedman, 2011), in which the child is shown three appealing toys (i.e., a toy guitar, a marble maze, and an expandable ball), and asked which one s/he would like to play with. After the child decides on a toy, the experimenter removes the other two toys and tells the child that s/he cannot play with the chosen toy until the experimenter comes back into the room. Just before leaving, children in both groups were given a brief cue to encourage strategy use (i.e. "Sometimes it can be hard to wait. Try to think of something you can do to help yourself wait.") The experimenter then places the toy in front of the child for two minutes and leaves the room. Similar to scores for the Gift Delay task, scores on this task were based on a code for worst transgression, frequency of transgressions, and latency to worst transgression. Inter-rater agreement was calculated on the basis of 1/3 of the cases that were coded by multiple raters ($K = .84$; 98.9% agreement within 1 for frequency; 94.3% agreement within 2 seconds for latency). Composites were formed by averaging z-scores for code, frequency and latency. Scores were truncated to a z-score of + or – 3.0 before compositing.

6.3.5 Strategy Use Coding. The strategy use coding scheme used in this study was similar to that which had been developed for use in Study 1. However, changes were made to this scheme to capture specific strategies taught. Additionally, whereas raters coded all strategies used by children throughout the entire Gift Delay 2 task for Study 1 regardless of whether they occurred before or after peeking, for this study, raters were asked to separately code strategies used before peeking at the present (for Gift Delay) or playing with the toy (for Toy prohibition). Finally, raters were also asked to code the duration of strategy use in addition to the frequency with which children used those strategies during Gift Delay 1, Gift Delay 2, and Toy Prohibition.

For each task, coders were asked to identify the frequency and duration of each of the following trained strategies: (1) covering eyes, (2) sitting on hands, (3) beating on legs, (4) putting on antennae, and (5) putting on wings. In order to ensure that asking coders to code specific strategies did not raise the likelihood of coders identifying an action as that strategy when it was not, coders were also asked to code several strategies that children were not shown, but were somewhat similar to trained strategies, including: (1) closing eyes, (2) crossing arms at chest, (3) stomping feet, and (4) putting on a crown. To capture the possibility that children may have used other strategies in addition to those above, raters were also asked to identify the frequency and duration of all other physical strategies and all other verbal strategies.

Two coders blind to condition and performance on other tasks coded strategy use during Gift Delay 1 and 2, and two coders blind to condition and performance on other tasks coded strategy use during Toy Prohibition. For Gift Delay 1 and 2, inter-rater agreement was calculated on the basis of 1/3 of the cases that were coded by multiple raters (97.1% and 98.3% agreement within 1 for strategy frequency for part 1 and part 2, respectively; 92.6% and 96.5% agreement within 2 seconds for strategy duration, respectively). For Toy Prohibition, inter-rater agreement was also calculated on the basis of 1/3 of the cases that were coded by multiple raters (98.3% agreement within 1 for strategy frequency, and 95.1% agreement within 2 seconds for strategy duration).

7. Study 2 Results

7.1 Descriptive Analyses

Several regression analyses were conducted to ensure that there were no differences between groups on variables that may be related to differences in strategy use and performance. Results revealed no significant group differences in age, IQ, gender, or shelter. Additional regression analyses also revealed no significant relations between covariates and strategy use and performance on each task. Therefore, these covariates were not included as controls in further analyses. Similarly, results revealed no group differences in EF and no relation between strategy use and EF. Therefore, these relations were not explored further.

Additionally, basic descriptive statistics were conducted to examine the frequency and duration of strategy use between groups. In general, children in the training group demonstrated higher mean frequencies and mean durations of strategies taught than children in the control group for Gift Delay Parts 1 and 2, and Toy Prohibition. In contrast, children in the control group demonstrated higher mean frequencies and mean durations of other types of strategies than children in the training group for Gift Delay Parts 1 and 2. For Toy Prohibition, there were no consistent group differences in other mean strategy use frequency and duration. For full descriptive statistics, see Study 2 Tables 1-3.

7.2 Strategy Use Data Reduction

Four strategy variables were created for further data analysis. The target strategy composite was created by summing the frequency and duration of each of the five strategies that the children were shown. These sums were then z-scored and averaged to create the composite. Similarly, the total strategy composite was created from the averaged z-scores of frequency and duration of *all* coded strategies. Finally, although there were not enough children who used each individual strategy they were taught to enable further exploratory examination of these strategies' relation to training status and performance, two variables were created to allow some examination of these relations in two types of strategies: physical and pretend play. The physical strategy variable was created by summing the frequencies and durations of covering eyes, sitting on hands, and beating on legs. Again, the z-scores of frequencies and durations were averaged to create the composite. The pretend play strategy composite was created from the averaged z-scores of frequency and duration of putting on antennae and putting on wings.

7.3 Training, Strategy Use, and Task Performance

Data were analyzed using MPlus Version 7.2 (Muthén & Muthén, 1998-2012). Maximum likelihood estimation with robust standard errors (MLR) was used in all analyses, as this estimation is more robust to univariate non-normality and by default MLR uses Full Information Maximum Likelihood (FIML) to account for missing data (Muthén & Muthén, 1998-2012). As FIML only accounts for missing data in endogenous variables, any exogenous variables with missingness were explicitly brought into the model by inclusion of their variance estimation. In order to test the major study hypotheses that children in the training group would use significantly more strategies than children in the control group, that strategy use would significantly predict task performance on each task, and that the direct effect of training on task performance would be mediated by strategy use, four path analyses were conducted that examined the total effect of training group status on task performance for each task with the target strategy use composite as the mediator.

Model 1, examining strategy use and performance on Gift Delay Parts 1 and 2, is depicted in Study 2 Figure 1. Training group status significantly predicted target strategy use ($\beta=0.564$, $p<0.001$), and target strategy use significantly predicted performance on Gift Delay Parts 1 and 2 ($\beta=0.368$, $p<0.001$) in the expected direction; however, the total effect and the direct effect of training group status on performance on Gift Delay Parts 1 and 2 were not significant ($\beta=0.050$, $p=0.725$; $\beta=-0.157$, $p=0.325$ respectively).

Next, path analyses for each of part of the Gift Delay task were conducted separately, to examine whether the relations between training, strategy use and performance differed between the first part of the task, in which the examiner was in the room, and the second part, in which the examiner left the room. Model 2, examining strategy use and performance on Gift Delay Part 1, is depicted in Study 2 Figure 2. Training group status significantly predicted target strategy use ($\beta=0.716$, $p<0.001$), and target strategy use significantly predicted performance on Gift Delay Part 1 ($\beta=0.170$, $p=0.018$) in the expected direction; however, the total effect and the direct effect of training group status on performance on Gift Delay Part 1 were not significant ($\beta=-0.004$, $p=0.980$; $\beta=-0.126$, $p=0.444$ respectively).

Model 3, examining strategy use and performance on Gift Delay Part 2, is depicted in Study 2 Figure 3. Training group status significantly predicted target strategy use (β=0.434, p=0.006), and target strategy use significantly predicted performance on Gift Delay Part 2 (β=0.331, p<0.001) in the expected direction; however, the total effect and the direct effect of training group status on performance on Gift Delay Part 2 were not significant (β=0.105, p=0.253; β=-0.039, p=0.816 respectively).

Model 4, examining strategy use and performance on Toy Prohibition, is depicted in Study 2 Figure 4. There was a trend in training group status predicting target strategy use (β=0.241, p=0.079), but target strategy use did not significantly predict performance on Toy Prohibition (β=0.033, p=0.113) in the expected direction; additionally, the total effect and the direct effect of training group status on performance on Toy Prohibition were not significant (β=0.000, p=0.989; β=-0.008, p=0.802 respectively).

Following these hypothesis driven tests, a series of exploratory analyses were conducted. In order to test the effects of training on type of strategy use and the effect of type of strategy use on performance on each task, four path analyses were conducted that examined physical and pretend play strategy use as mediators, controlling for one another, in the relation between training group status and performance. Model 4, examining physical versus pretend play strategy use during Gift Delay Parts 1 and 2, is depicted in Study 2 Figure 4. Training group status significantly predicted physical strategy use (β=0.497, p<0.001), and pretend play strategy use (β=0.365, p=0.012). However, while physical strategy use significantly predicted performance on Gift Delay Parts 1 and 2 (β=0.302, p=0.004), pretend play strategy use did not (β=0.109, p=.246).

After performing a Bonferroni correction for multiple tests, the path from training group status to physical strategy use remained significant while no other paths remained significant.

Model 5, examining physical versus pretend play strategy use during Gift Delay Part 1, is depicted in Study 2 Figure 5. Training group status significantly predicted physical strategy use (β=0.599, p=0.000), and pretend play strategy use (β=0.493, p=0.009). However, while pretend play strategy use significantly predicted performance on Gift Delay Part 1 (β=0.117, p=0.023), physical strategy use did not (β=0.101, p=.245). After performing a Bonferroni correction for multiple tests, the path from training group status to physical strategy use remained significant while no other paths remained significant.

Model 6, examining physical versus pretend play strategy use during Gift Delay Part 2, is depicted in Study 2 Figure 6. Training group status significantly predicted physical strategy use (β=0.422, p=0.015), but not pretend play strategy use (β=0.240, p=.218). Similarly, physical strategy use significantly predicted performance on Gift Delay Part 2 (β=0.301, p=0.013) while pretend play strategy use did not (β=0.059, p=1.556). None of these paths remained significant after performing a Bonferroni correction for multiple tests.

Model 7, examining physical strategy use during Toy Prohibition is depicted in Study 2 Figure 7. Pretend play strategy use was not examined because there was so little variability in the data that the model could not be run. Training group status did not significantly predict physical strategy use (β=0.205, p=.239). Similarly, physical strategy use did not significantly predict performance on Toy Prohibition (β=0.020, p=.995).

7.4 Moderation Effects on Training and Strategy Use

A final exploratory question of this study was whether or not variables such as age and IQ moderate the relations between training group status, strategy use, and performance on the three delay tasks. A series of exploratory analyses were conducted to examine the moderating effects of age and IQ on each of the paths in Model 1 (examining Gift Delay Parts 1 and 2 together) and Model 4 (examining Toy Prohibition) as well as the moderating effects of age and IQ on each of the paths in models examining pretend versus physical strategy use on Gift Delay Parts 1 and 2 together. This was not examined for Toy Prohibition given that the incidence of pretend play strategy use was so low during this task. Moderating effects on paths in Models 2 and 3 (examining Gift Delay Part 1 and Gift Delay Part 2 separately) were not examined in order to minimize tests performed. Results revealed several significant moderating effects of age for paths in the Gift Delay Part 1 and 2 models, but no moderating effects on paths for the Toy Prohibition model and no moderating effects of IQ on paths in any model. Because EF performance is highly correlated with age, the main and interactive effects of EF performance were added as control variables to significant interactions.

First, age moderated the relation between group status and target strategy use (β=0.047, p=0.029); this interaction did not remain significant after performing a Bonferonni correction for multiple tests. After adding EF control variables, this interaction remained marginally significant (β=0.044, p=0.057). More specifically, age moderated the relation between group status and physical strategy use (β=0.044, p=0.040), but not pretend play strategy use; this interaction did no remain significant after performing a Bonferonni correction for multiple tests. After adding EF control variables, this interaction remained marginally significant (β=0.044, p=0.053).

Second, age moderated the relation between target strategy use and performance on Gift Delay Parts 1 and 2 (β=0.019, p=0.000); this interaction remained significant after adding EF control variables (β=0.017, p=0.000) and after performing a Bonferroni correction. More specifically, age moderated the relation between physical strategy use and Gift Delay Parts 1 and 2 performance (β=0.019, p=0.000); this interaction remained significant after adding EF control variables (β=0.018, p=0.000) and after performing a Bonferroni correction. Age did not significantly moderate the relation between pretend play strategy use and Gift Delay Parts 1 and 2 performance.

Finally, age moderated the total effect of training group status on Gift Delay Parts 1 and 2 performance (β=0.043, p=0.020); this interaction remained significant after performing a Bonferroni correction, but not after adding EF control variables (β=0.037, p=0.057). Probing this interaction revealed that the relation between training group status and Gift Delay 1 and 2 performance was significant for children one standard deviation above the mean age (β=0.361, p=0.032), but not for children at the mean age (β=0.054, p=0.700), nor for children one standard deviation below the mean age (β=-0.025, p=0.231). Age did not moderate the direct effect of training group status on Gift Delay Parts 1 and 2 performance (β=0.029, p=0.107).

8. Study 2 Discussion

8.1 Training Effects on Strategy Use

Results of the four main path analyses examining training, strategy use, and performance on Gift Delay Parts 1 and 2 and Toy Prohibition suggest that training was effective in teaching HHM children to use strategies during the tasks. Training was significantly related to target strategy use during Gift Delay Parts 1 and 2, suggesting that children in the training group did use the strategies they were taught immediately after training. On the Toy Prohibition task, training was marginally related to strategy use, suggesting some possible transfer of training effects to a generalization task. More intensive or repeated training may facilitate better transfer to generalization tasks. Given that the Toy Prohibition task was very similar in content to the Gift Delay Task on which children were trained, transfer to other, more different tasks may require more training on a greater variety of tasks so that children come to better understand the range of circumstances in which such strategies may be useful.

Exploratory analyses examining physical versus pretend play strategy use as well as moderators of the impact of training on strategy use revealed some interesting directions for future research, but should be interpreted cautiously given the possibility of Type 1 error resulting from multiple tests. Model 5, examining physical versus pretend play strategy use during Gift Delay Part 1, suggests that training significantly impacted HHM children’s use of both physical and pretend play strategies during Gift Delay Part 1. In contrast, Model 6, examining physical versus pretend play strategy use during Gift Delay Part 2, suggests that training only impacted HHM children’s use of physical strategies, but not pretend play strategies. However, this finding may be confounded by reduced variability in the pretend play variable and overall reduction in model power. Overall, it appears that both physical and pretend play strategy use can be trained and should be examined in future studies. Additionally, given previous findings that pretend play strategies appear to increase with age (Carlson & Beck, 2009), future research should include a broader age range of children to examine whether older children are better able to learn and utilize pretend play strategies than are younger children.

Examination of moderators revealed that age moderated the relation between training and strategy use on Gift Delay Parts 1 and 2, such that older children appeared to benefit more from training than did younger children. More specifically, age moderated the relation between training and physical strategy use, but not the relation between training and pretend play strategy use, such that older children appeared to use more physical strategies as a result of training than did younger children. Again, because so many moderations were examined, these results should be interpreted with caution, but these results coupled with previous findings that older children are generally more likely to use strategies than younger children and that children of different ages differentially benefit from strategy use (Carlson & Beck, 2009; Luria, 1959; Müller et al., 2009), suggest that researchers should continue to examine age as a moderator of training on strategy use. At the same time, when EF was entered as a control variable, both of these interactions became marginally significant, suggesting that EF may in part account for age differences in the effectiveness of training since older children also tend to have stronger EF skills. It may be that children who have better EF skills are better able to take advantage of training, perhaps because they are better able to pay attention to the training and remember strategies taught. Additionally, in this age group, particularly, in which some children have school experience whereas others do not, age differences in the effectiveness of training may also be due to children's experience with formalized instruction. Perhaps older children in this age group, who also have more school experience, are more familiar with and better able to take advantage of a training situation that has some similarities to school instruction.

8.2 Strategy Use and Task Performance

Results suggest that children's use of trained strategies is related to their performance on Gift Delay Parts 1 and 2, as predicted, but that strategy use is not related to performance on Toy Prohibition. It is unclear why strategy use is not related to performance on Toy Prohibition, especially given the similarity of the tasks. One explanation is that while children may have used the trained strategies, they were less aware of how these strategies might help them to succeed on this task as opposed to the Gift Delay task. They may have been unable to generalize the reasoning behind using the strategies to another task. For instance, they may not have understood that just as covering one's eyes would help them not to peek at a present, it would also help them avoid the temptation of playing with a toy. An alternative explanation is that Toy Prohibition is arguably a more difficult task because the desirable object is placed in children's line of sight and within easy reach. Thus, it may be more difficult to resist touching or playing with the toy, even when given strategies. Perhaps the task is so difficult for children that the strategies just are not enough to help children resist temptation. The sample size for this study was not large enough to allow counterbalancing of training on Toy Prohibition versus Gift Delay, but future studies could train groups of children on different tasks to allow assessment of whether there are some tasks for which these kinds of strategies just are not useful or if children are struggling to transfer the reasoning behind strategy use from one task to another.

Exploratory analyses examining the effect of physical versus pretend play strategy use on performance on Gift Delay Parts 1 and 2 provide some evidence that pretend play strategies are related to performance on Gift Delay Part 1 whereas physical strategies are related to performance on Gift Delay Part 2. This may indicate that physical strategies are more effective in situations where task demands are higher because there is no external monitor of behavior whereas pretend play strategy use may be effective in less demanding situations. Again, given the exploratory nature of these results, much more research is needed to determine whether there are meaningful differences in delay tasks that make one kind of strategy more effective for one kind of task than another.

Examination of moderators of these relations revealed that age significantly moderated the relation between strategy use and Gift Delay Part 1 and Part 2 performance, such that the relation between strategy use and performance was stronger for older children. More specifically, whereas pretend play strategy use remained unrelated to Gift Delay Parts 1 and 2 performance, physical strategy use was most strongly related to performance for older children. Importantly, these interactions remained significant after Bonferroni correction, suggesting that these findings are not likely due to Type 1 error, and offer interesting direction for future research.

Additionally, these interactions remained significant after controlling for EF, suggesting that older children are not better able to use these strategies because of stronger EF skills, but rather that age impacts this relation between strategy use and performance in some other way. Taken together, these findings suggest that older HHM children may be better able to use physical strategies to boost performance on delay tasks whereas for younger children, this type of strategy use may not be as effective in boosting performance. Future research should explore other variables that may be related to age, such as school experience, could explain these interaction effects.

8.3 Training Effects on Task Performance

The major question of this study was whether training strategy use is an "active ingredient" of larger interventions designed to boost EF skills in HHM children. Unfortunately, results do not provide a definitive answer to this question. While there was no relation between training and performance on the tasks, it is clear that training did impact strategy use, which was in turn related to task performance on Gift Delay Parts 1 and 2. There are several possible explanations for this finding.

First, as discussed regarding Study 1, it may be that the observed relation between strategy use and task performance is influenced by some third variable that is related to both. Children at a higher developmental level may use more strategies and also perform better on these tasks, but strategy use does not actually aid children's ability to delay. Again, however, this explanation seems somewhat unlikely because in this study, there was no relation between strategy use and age, IQ, or general EF performance.

Second, it may be that this particular intervention is more effective for some children than others. Results showed that for Gift Delay Parts 1 and 2, age moderated the relation between training and performance such that training impacted performance on Gift Delay Parts 1 and 2 only for children one standard deviation above the mean age. When adding EF control variables, this effect became marginally significant. This effect became nonsignificant when adding strategy use as a mediator. Taken together with findings that training appeared most related to strategy use and strategy use appeared most related to performance for older children, it appears that older children who have stronger EF skills learn to use strategies more easily and in turn, use them more effectively to boost performance on the task than do younger children with poorer EF skills. Although the observed interaction of age and training effect on performance was exploratory, it points to the possibility that this kind of intervention may be most beneficial for older children in this population.

A third explanation for this finding is that these delay of gratification tasks are complex and require a complex set of skills to perform well. Thus, while strategy use does impact task performance, there are also many other skills that were not trained that also impact task performance. Results suggest that this is the case given that while strategy use and performance were related, they were not highly related. Therefore, even though training does appear to impact children's use of strategies and these strategies do potentially aid children's performance on the task, because there are many other variables that also impact performance on the task, the total effect of training on performance could not be detected. From this perspective, training strategy use would be identified as a "active ingredient" in larger EF-focused interventions, but one of many that have the potential to impact children's delay of gratification and EF skills more generally.

8.4 Limitations

This had several key limitations. First, the small sample size precluded the investigation of 1) whether children differ in their ability to learn specific strategies, and 2) whether specific strategies are more highly related to task performance than others. Additionally, in microtrial research, in which the aim is to discover even small intervention effects, the small sample size limited the ability to do this because only relatively large effects were detectable.

Second, while the goal of microtrial research is to focus on one very specific intervention strategy, this study only focused on delay of gratification training and performance. Thus, it remains unclear whether similar types of strategy use would be effective in boosting performance on other kinds of EF tasks. Previous research has shown that similar pretend play strategies have been effective in boosting performance on computerized EF tasks (Carlson, unpublished data), but it is more difficult to imagine how the specific physical strategies that were the focus of this study would translate to other kinds of tasks. Although the focus of this particular study was intentionally limited to strategy use for delay of gratification tasks, the next logical question is to what extent are these skills generalizable to other kinds of tasks and in what ways could this intervention strategy be effectively utilized by larger interventions such that children actually learn to use these skills in the real world.

A third limitation of this study was its limited scope in training and following children's performance over time. Results from this study suggest that training strategy use may be effective in boosting performance immediately after training, but questions remain about whether children would benefit from this kind of training over time. Thus, future studies should examine whether repeated training over days or weeks would impact performance in the short- and long-term.

9. Overall Conclusions

Taken together, results from these studies suggest that individual differences in self-regulation oriented strategy use are related to EF skills in severely impoverished children, which in turn, impact school outcomes in the domains of academic achievement and peer competence. Additionally, there is some evidence that training strategy use is an effective means of boosting delay skills, particularly for older HHM children. Results of Study 2 provide some evidence of generalization of these skills, although much more research is needed in this area, particularly that which examines longer-term, more intensive strategy-use training interventions. Nevertheless, results of Study 2 suggest that teaching children strategies to self-regulate may be an important component of interventions aiming to boost EF skills more generally in this population. Future work should aim to replicate and extend findings not only by including more intensive training, but also by training strategy use on other kinds of delay tasks to more fully examine generalization, and examining transfer of skills several days or weeks after training, and more distally in other contexts, such as in the classroom.

Although results suggest that physical strategies are associated with better EF skills, physical strategies may represent internalized verbal strategies as they become more automatic. Testing this kind of progression in development, particularly in the context of intervention efforts, is an important direction for future longitudinal research and may also help to identify the level at which a child is functioning, with implications for tailoring interventions. Alternatively, physical strategies may be the most effective strategies to use for this particular task. Thus, future studies should investigate strategy use during a variety of tasks to determine whether this is the case. Such research would also have important implications for interventions, suggesting a need to teach children a variety of strategies as well as the situations during which they are most effective to have the greatest effect on boosting EF skills.

As evidence accumulates on the importance of EF skills for a positive transition to school, especially among high-risk children (eg. Masten et al., 2012; Obradović, 2010), it is becoming increasingly important to understand the mechanisms underlying good EF performance so that interventions can be developed to promote these skills. For this population, in particular, an understanding of the specific mechanisms underlying good EF skills and the active ingredients of interventions aiming to boost EF skills is imperative so that short-term, effective interventions can be developed for children who may not remain in programming for more than a month due to unstable housing. Thus, an understanding of these active ingredients, such as strategy use, will aid in the development of interventions aimed at the promotion of EFs with long-term implications for school success.

Study 1 Tables and Figures

Table 1. Basic Correlations Between Regression Variables

	1	2	3	4	5	6	7
1. Age							
2. Gender	.01						
3. IQ	.17*	-.02					
4. Proportion of Physical Strategies	.16	.04	.07				
5. Gift Delay 2 Performance	.12	.04	.23**	.45***			
6. EF Composite	.40***	-.09	.47***	.39***	.49**		
7. Academic Achievement	-.09	-.11	.49***	.19	.22*	.39***	
8. Peer Competence	.08	.06	.10	.28**	.30**	.29**	.31**

Note: $^{*}p < .05$; $^{**}p<.01$; $^{***}p < .001$

Table 2. Hierarchical Regression of Variables Predicting Gift Delay (Part 2) Performance

	Variable	B	SE B	β	ΔR^2	F for ΔR^2
Step 1					.02	.97
	Age	.13	.12	.10		
	Gender	.10	.14	.07		
Step 2					.04	5.31*
	Age	.09	.11	.07		
	Gender	.10	.14	.07		
	IQ	.16	.07	.21*		
Step 3					.19	28.92***
	Age	-.01	.10	-.01		
	Gender	.09	.12	.06		
	IQ	.15	.06	.19*		
	Physical Strategy Proportion	1.27	.24	.44***		
Total R^2	.24					
Overall F	9.49***					

Note: n = 126; $^{*}p < .05$;$^{***}p < .001$

Table 3. Hierarchical Regression of Variables Predicting Executive Function Composite

	Variable	B	SE B	β	ΔR^2	*F* for ΔR^2
Step 1					.15	10.67***
	Age	.61	.13	.38***		
	Gender	-.09	.16	-.04		
Step 2						
	Age	.52	.12	.32***	.17	30.02***
	Gender	-.10	.14	-.05		
	IQ	.49	.09	.41***		
Step 3					.10	20.40***
	Age	.44	.11	.27***		
	Gender	-.12	.13	-.06		
	IQ	.47	.08	.40***		
	Physical Strategy Proportion	1.18	.27	.32***		
Total R^2	.41					
Overall *F*	21.41***					

Note: n = 126; ****p* < .001

Table 4. Hierarchical Regression of Variables Predicting Academic Achievement

	Variable	B	SE B	β	ΔR^2	*F* for ΔR^2
Step 1					.02	1.14
	Age	-.17	.16	-.11		
	Gender	-.17	.19	-.10		
Step 2					.24	31.13***
	Age	-.27	.14	-.18*		
	Gender	-.07	.16	-.04		
	IQ	.59	.11	.50***		
Step 3					.03	4.46*
	Age	-.29	.14	-.19*		
	Gender	-.11	.16	-.06		
	IQ	.57	.10	.48***		
	Physical Strategy Proportion	.70	.33	.18*		
Total R^2	.30					
Overall *F*	9.95***					

Note: n = 99; **p* < .05; ****p* < .001

Table 5. Hierarchical Regression of Variables Predicting Peer Competence

	Variable	B	SE B	β	ΔR^2	*F* for ΔR^2
Step 1					.01	.55
	Age	.06	.10	.07		
	Gender	.10	.12	.07		
Step 2					.01	1.23
	Age	.06	.10	.06		
	Gender	.10	.12	.08		
	IQ	.09	.08	.11		
Step 3					.07	7.32**
	Age	.04	.10	.04		
	Gender	.07	.12	.05		
	IQ	.08	.08	.10		
	Physical Strategy Proportion	.68	.25	.26**		
Total R^2	.09					
Overall *F*	2.45*					

Note: n = 101; ***p* < .01, **p* < .05

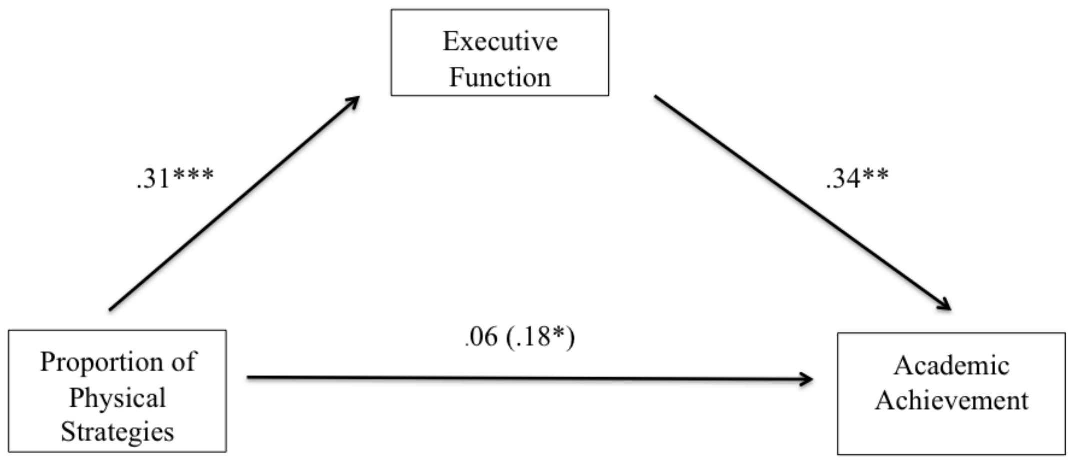

Figure 1. Model of indirect effects of proportion of physical strategy use on academic achievement through executive function. Control variables of age, gender, and IQ were included but not shown here. *p < .05, two-tailed. **p <.01, two-tailed. ***p < .001, two-tailed.

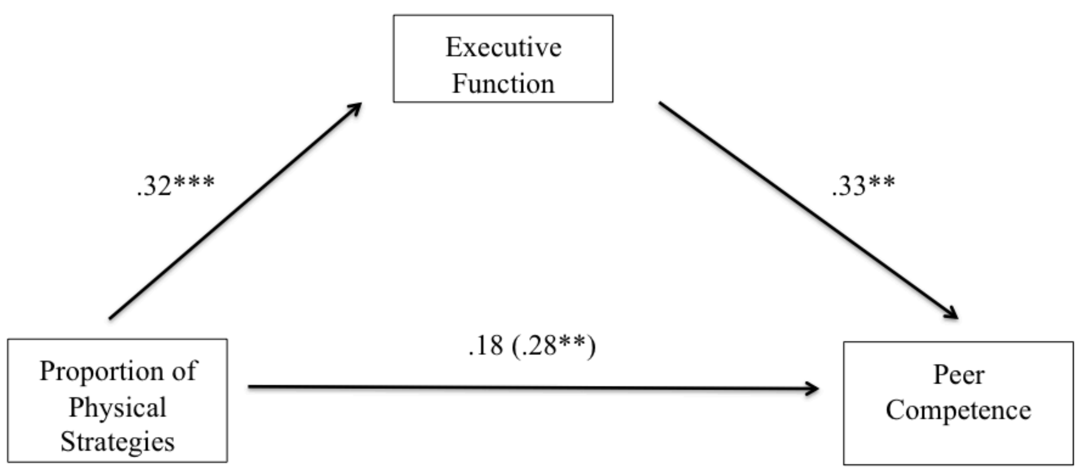

Figure 2. Model of indirect effects of proportion of physical strategy use on peer competence through executive function. Control variables of age, gender, and IQ were included but not shown here. *p < .05, two-tailed. **p <.01, two-tailed. ***p < .001, two-tailed.

Study 2 Tables and Figures

Table 1. Gift Delay Part 1 Strategy Use Descriptives

	Frequency Mean (SD)		Frequency Range		Duration Mean (SD)		Duration Range	
Strategy Type	Control (n=54)	Training (n=49)	Control (n=54)	Training (n=49)	Control (n=54)	Training (n=49)	Control (n=54)	Training (n=49)
Covering eyes	**0.63 (0.83)**	**1.35 (1.36)**	**0-3**	**0-5**	**9.39 (17.67)**	**14.84 (18.22)**	**0-60**	**0-59**
Sitting on hands	**0.17 (0.37)**	**0.49 (0.87)**	**0-1**	**0-4**	**2.06 (7.74)**	**7.22 (15.66)**	**0-41**	**0-60**
Beating on legs	**0.13 (0.39)**	**0.35 (0.95)**	**0-2**	**0-4**	**0.20 (1.09)**	**1.65 (4.38)**	**0-7**	**0-20**
Putting on antennae	**0.05 (0.23)**	**0.31 (0.74)**	**0-1**	**0-3**	**0.15 (.83)**	**2.25 (6.91)**	**0-6**	**0-35**
Putting on wings	**0.07 (0.33)**	**0.35 (0.72)**	**0-2**	**0-3**	**0.28 (1.77)**	**3.59 (10.91)**	**0-13**	**0-55**
Closing eyes	0.30 (0.74)	0.18 (0.75)	0-3	0-5	4.61 (12.58)	4.27 (13.29)	0-53	0-60
Crossing arms	0.06 (0.23)	0.02 (0.14)	0-1	0-1	0.61 (3.52)	1.20 (8.43)	0-25	0-59
Stomping feet	0.06 (0.23)	0.02 (0.14)	0-1	0-1	0.50 (2.22)	0.02 (0.14)	0-13	0-1
Putting on crown	0.00 (0.00)	0.02 (0.14)	0-0	0-1	0.00 (0.00)	0.02 (0.14)	0-0	0-1
Other physical strategies	0.96 (1.18)	0.82 (1.20)	0-5	0-4	15.13 (20.22)	10.63 (17.40)	0-100	0-60
Other verbal strategies	2.09 (2.43)	2.06 (2.52)	0-9	0-10	6.30 (10.15)	5.65 (7.24)	0-49	0-23

Note: Bold indicates strategies that were taught to child

Table 2. Gift Delay Part 2 Strategy Use Descriptives

Strategy Type	Frequency Mean (SD)		Frequency Range		Duration Mean (SD)		Duration Range	
	Control (n=50-51)	Training (n=45-46)	Control (n=50-51)	Training (n=45-46)	Control (n=51)	Training (n=46)	Control (n=51)	Training (n=46)
Covering eyes	**.32 (.89)**	**.57 (1.34)**	**0-5**	**0-6**	**3.92 (16.04)**	**7.54 (23.53)**	**0-108**	**0-106**
Sitting on hands	**.14 (.35)**	**.36 (.90)**	**0-1**	**0-5**	**2.96 (13.97)**	**15.61 (35.22)**	**0-96**	**0-120**
Beating on legs	**.26 (.63)**	**.28 (.81)**	**0-3**	**0-4**	**2.43 (7.65)**	**6.17 (21.25)**	**0-45**	**0-102**
Putting on antennae	**.10 (.30)**	**.09 (.46)**	**0-1**	**0-3**	**.18 (.59)**	**.26 (1.49)**	**0-3**	**0-10**
Putting on wings	**.08 (.34)**	**.22 (.76)**	**0-2**	**0-4**	**.14 (.63)**	**2.83 (11.16)**	**0-4**	**0-66**
Closing eyes	.22 (.78)	.02 (.15)	0-4	0-1	3.61 (14.05)	.15 (1.03)	0-70	0-7
Crossing arms	.04 (.20)	.11 (.44)	0-1	0-2	.94 (5.69)	1.44 (6.52)	0-40	0-41
Stomping feet	.20 (.14)	.22 (.15)	0-1	0-1	.26 (1.82)	.15 (1.03)	0-13	0-7
Putting on crown	0.00 (0.00)	.22 (.15)	0-0	0-1	0.00 (0.00)	.07 (.44)	0-0	0-3
Other physical strategies	.86 (1.11)	.67 (1.19)	0-4	0-5	13.73 (19.95)	7.70 (12.54)	0-67	0-41
Other verbal strategies	1.14 (2.26)	1.44 (2.81)	0-11	0-11	7.02 (15.30)	7.39 (15.09)	0-64	0-71

Note: Bold indicates strategies that were taught to children

Table 3. Toy Prohibition Strategy Use Descriptives

	Frequency Mean (SD)		Frequency Range		Duration Mean (SD)		Duration Range	
Strategy Type	Control (n=52)	Training (n=47)	Control (n=52)	Training (n=47)	Control (n=52)	Training (n=47)	Control (n=52)	Training (n=47)
Covering eyes	**.04 (.19)**	**0.00 (.0.00)**	**0-1**	**0-0**	**.12 (.58)**	**0.00 (0.00)**	**0-3**	**0-0**
Sitting on hands	**.04 (.19)**	**.11 (.32)**	**0-1**	**0-1**	**2.98 (17.24)**	**4.36 (20.04)**	**0-120**	**0-115**
Beating on legs	**.02 (.14)**	**.13 (.49)**	**0-1**	**0-3**	**.25 (1.80)**	**1.81 (6.78)**	**0-13**	**0-38**
Putting on antennae	**0.00 (0.00)**	**.09 (.41)**	**0-0**	**0-2**	**0.00 (0.00)**	**.32 (1.70)**	**0-0**	**0-11**
Putting on wings	**0.00 (0.00)**	**.06 (.32)**	**0-0**	**0-2**	**0.00 (0.00)**	**.26 (1.29)**	**0-0**	**0-8**
Closing eyes	0.00 (0.00)	.02 (.15)	0-0	0-1	0.00 (0.00)	.15 (1.02)	0-0	0-7
Crossing arms	.08 (.27)	.09 (.41)	0-1	0-2	1.35 (6.14)	.70 (3.37)	0-35	0-17
Stomping feet	02 (.14)	0.00 (.0.00)	0-1	0-0	.27 (1.94)	0.00 (0.00)	0-14	0-0
Putting on crown	0.00 (0.00)	0.00 (.0.00)	0-0	0-0	0.00 (0.00)	0.00 (0.00)	0-0	0-0
Other physical strategies	.87 (1.31)	.85 (1.12)	0-4	0-4	19.25 (33.26	21.23 (36.78)	0-120	0-120
Other verbal strategies	.17 (.55)	.60 (1.14)	0-3	0-5	2.75 (10.93)	12.72 (29.04)	0-60	0-120

Note: Bold indicates strategies that were taught to children

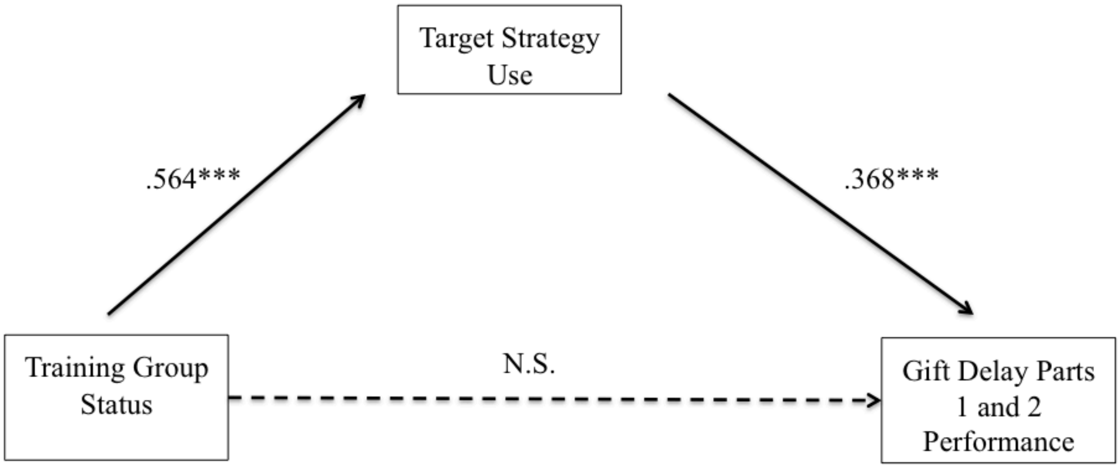

Figure 1. Path analysis of relations between training group status, target strategy use, and performance on Gift Delay Parts 1 and 2 (n=104). *$p < .05$, **$p <.01$, ***$p < .001$, one-tailed.

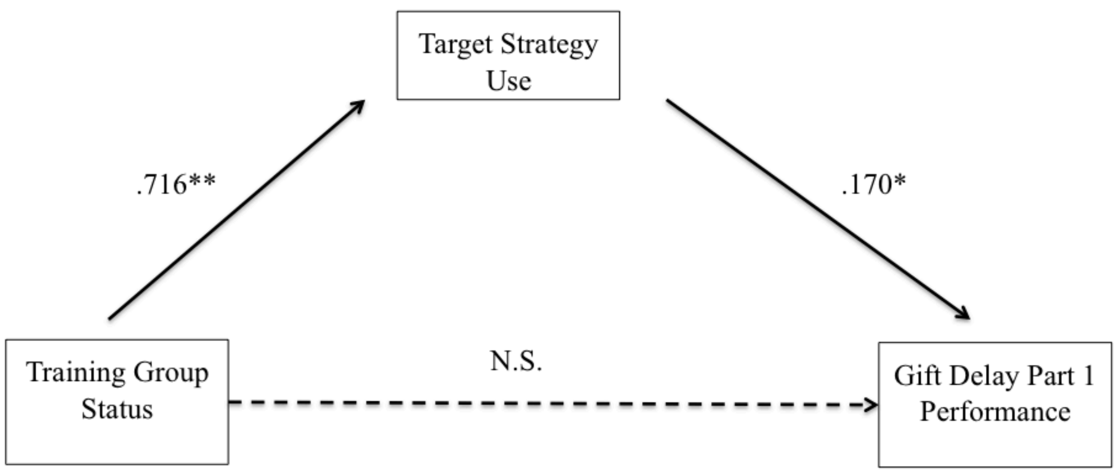

Figure 2. Path analysis of relations between training group status, target strategy use, and performance on Gift Delay Part 1 (n=104). *$p < .05$, **$p <.01$, ***$p < .001$, one-tailed.

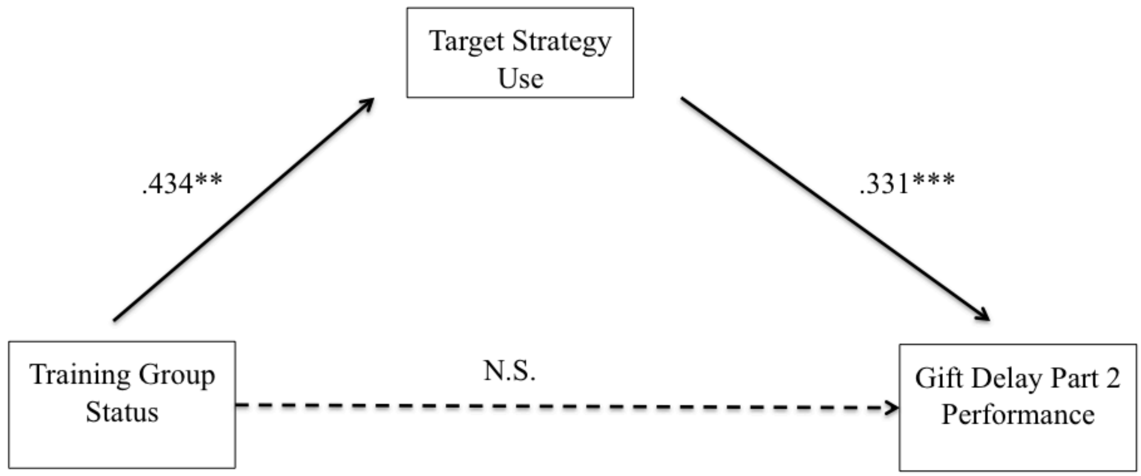

Figure 3. Path analysis of relations between training group status, target strategy use, and performance on Gift Delay Part 2 (n=104). *p < .05, **p <.01, ***p < .001, one-tailed.

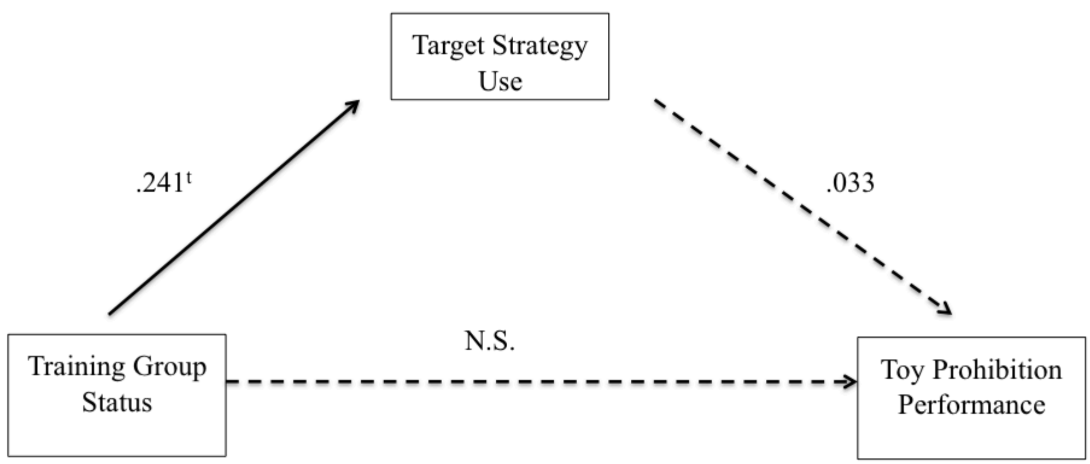

Figure 4. Path analysis of relations between training group status, target strategy use, and performance on Toy Prohibition (n=99). ^{t}p < .10, *p <.05, one-tailed.

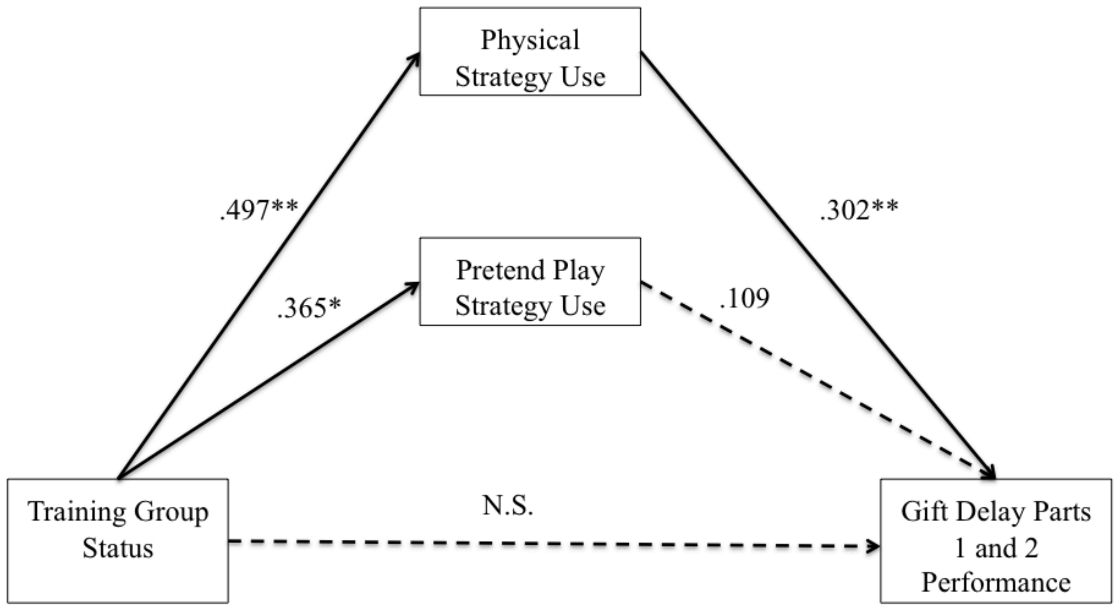

Figure 5. Path analysis of relations between training group status, physical and pretend play strategy use, and performance on Gift Delay Parts 1 and 2 (n=104). $*p < .05$, $**p < .01$, $***p < .001$, two-tailed.

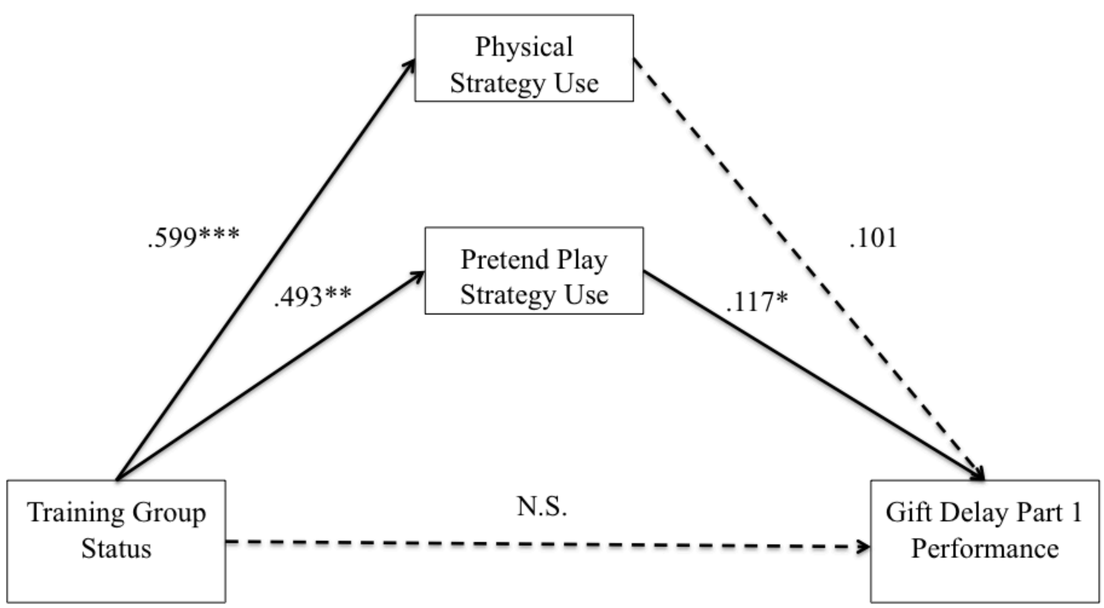

Figure 6. Path analysis of relations between training group status, physical and pretend play strategy use, and performance on Gift Delay Part 1 (n=104). $^{t}p < .10$, $*p < .05$, $**p < .01$, $**p < .001$, two-tailed.

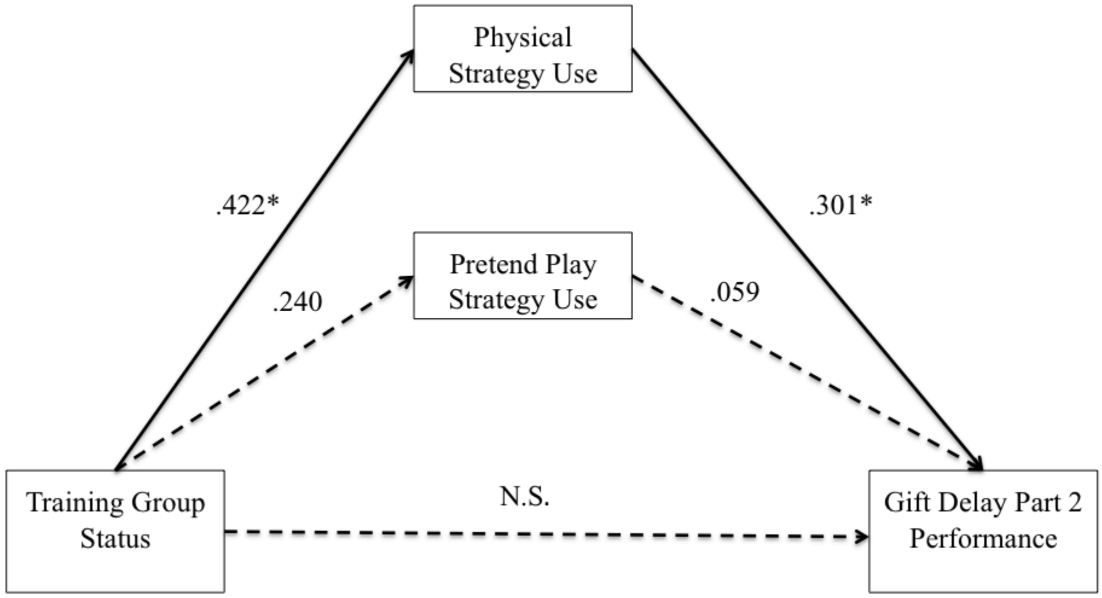

Figure 7. Path analysis of relations between training group status, physical and pretend play strategy use, and performance on Gift Delay Part 2 (n=104). *p < .05, **p <.01, ***p < .001, two-tailed.

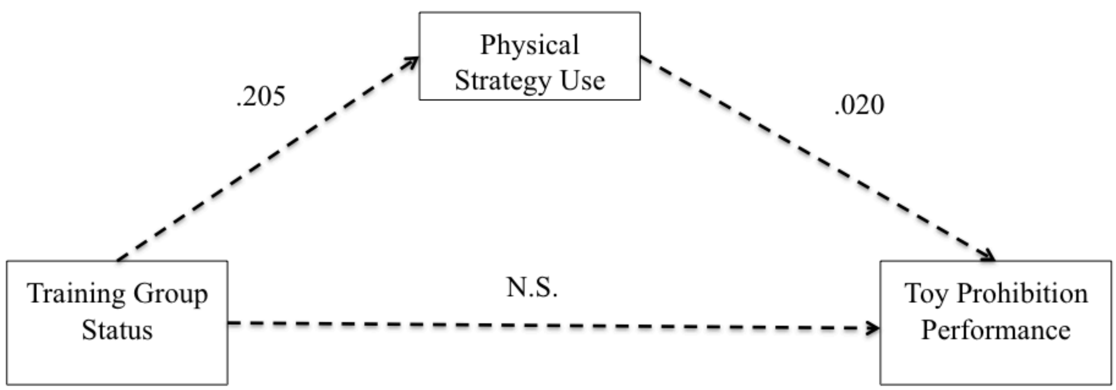

Figure 8. Path analysis of relations between training group status, physical and pretend play strategy use, and performance on Toy Prohibition (n=99). *p < .05, **p <.01, ***p < .001, two-tailed.

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