COGNITIVE UNDERPINNINGS OF PRESCHOOLERS' OVERIMITATION

By

JENNIFER M. TAMARGO

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2013

To my parents and my husband John Leschitz

ACKNOWLEDGMENTS

I thank the participants, their parents, childcare centers, and research assistants for their cooperation and involvement in this study. I also thank my supervisory committee for their contributions to this project. Finally, I thank John, my family, and my friends for their emotional and financial support throughout this process.

TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

COGNITIVE UNDERPINNINGS OF PRESCHOOLERS' OVERIMITATION

By

Jennifer M. Tamargo

August 2013

Chair: M. Jeffrey Farrar
Major: Psychology

Recent studies find that when presented with novel tasks, preschoolers and adults will imitate another's intentional actions even if those actions are irrelevant for task success. This learning technique is termed overimitation (production of both irrelevant and relevant actions). Some suggest overimitation occurs because of an "automatic causal encoding" (ACE) process in which humans will automatically infer all intentional actions on novel tasks as being causally necessary. However, only one study has altered the order of irrelevant and relevant actions and conclusions regarding the influence of action order on overimitation remains incomplete. The current study's first aim examined the occurrence of overimitation in preschoolers when irrelevant actions occurred before goal achievement vs. after goal achievement. Some researchers suggest that ACE is "turned off" if obvious violations to causality occur. To support ACE hypothesis, it was expected that after goal irrelevant actions should be largely ignored as it would be obvious that these actions did not influence goal achievement.

The second and primary aim was to examine the roles of false belief (FB) and self-regulation (S-R) on children's overimitation as these skills advance during the preschool years as well. The examination of developmental influences on overimitation

is sparse, but there is a consistent trend that this imitation style increases with age. Preschoolers (*N* = 83, *M* = 4.4-years) observed a model produce a combination of relevant and irrelevant actions on two novel tasks. Children's FB understanding, S-R, and receptive language were also measured. Children's performance on FB and S-R measures were expected to predict the occurrence of overimitation when children observed a model produce intentional actions.

Overimitation occurred more often when actions were intentional, increased with age, and persisted when intentional irrelevant actions occurred after goal achievement as previously reported in prior studies. Results also highlighted several new patterns. Overimitation was related to self-regulatory skills and when children reported a perspective to "copy actions" they were more likely to engage in overimitation. It is proposed that overimitation occurs because humans automatically infer intentional actions on novel tasks as having a general *purpose* and overimitation may be evidence of true "rational" imitation.

CHAPTER 1
INTRODUCTION

Numerous studies have demonstrated children are capable of learning in a variety of social contexts including imitation, direct instruction, and collaborative interaction (Flynn, 2010; Meltzoff, 1995; Want & Harris, 2001). Some suggest the way humans engage in social learning is unique and has facilitated the development of culture (Tomasello, Kruger, & Ratner, 1993). Specifically, human's engagement in imitation has been a main focus of the developmental literature. A vast amount of research demonstrates that young toddlers are selective in their imitation (e.g., ignore unnecessary or irrelevant actions) and that they are especially sensitive to intention when determining what to imitate (Brugger, Lariviere, Mumme, & Bushnell, 2007; Carpenter, Akhtar, & Tomasello, 1998; Gergely, Bekkering, & Király, 2002; Williamson, Meltzoff, & Markman, 2008). Despite these findings, several more recent studies document the occurrence of "overimitation" (i.e. production of irrelevant and relevant actions) in preschoolers' and adults' observational learning (Gardiner, Greif, & Bjorklund, 2011; Lyons, Young, & Keil, 2007; McGuigan, Makinson, & Whiten, 2011; McGuigan, Whiten, Flynn, & Horner, 2007).

As defined in Lyons et al. (2007), overimitation refers to imitation of irrelevant actions (i.e., actions unnecessary for task success) coupled with relevant actions. There are several arguments regarding the underlying causes of overimitation; however investigation of these hypotheses remains limited. Some researchers suggest preschoolers engage in overimitation because they encode all intentional actions as having "causal meaning" and this process of encoding is essentially "automatic" (Gardiner et al., 2012; Lyons et al., 2007; Lyons, Damrosch Lin, Macris, & Keil, 2011;

McGuigan et al., 2011). Alternatively, others suggest that overimitation occurs for more "social" reasons—e.g., a sensitivity to being taught (Csibra & Gergely, 2009), a general motivation to be social with others (Nielsen, 2008), or tendency to attend to intention (Horner & Whiten 2005). However in these studies, the irrelevant actions occur *before* goal achievement and it is not clear if this action sequence promotes overimitation. Only one study has presented children with an irrelevant action after goal achievement and while the authors note children engaged in overimitation, the study only included one test trial and did not consider age differences (Simpson & Riggs, 2011). Further, there was no condition in which children witnessed both types of irrelevant actions (before goal irrelevant and after goal irrelevant) and thus whether children overimitate with before goal irrelevant actions *more* than after goal irrelevant actions is not conclusive from the findings of this one study. When presented with both types of irrelevant actions, it could be that actions presented prior to goal achievement are perceived differently than actions that occur after goal achievement. If overimitation persists when irrelevant actions occur after goal achievement, this may suggest overimitation occurs for more social reasons since it would be more obvious that the actions have no causal relevance. The current study examines this methodological issue.

In addition, despite the hypotheses regarding the underpinnings of overimitation, the examination of cognitive achievements that relate to the occurrence of overimitation has remained largely unexplored. There is some evidence suggesting this method of learning increases with age (Brugger et al., 2007; McGuigan et al., 2011) and the primary aim of the current study is to examine cognitive factors that may influence the phenomenon of overimitation in preschoolers. It has long been suggested that children's ability to engage in social learning may be influenced by achievements in specific social cognitive and executive function (EF) skills (Flynn & Whiten, 2008; Lyons et al., 2007; Tomasello, 1999; Williamson et al., 2008). For example, Tomasello has argued that developmental changes in self-regulation and false belief (FB) advance preschoolers' ability to learn through others (Tomasello et al., 1993). In relation, there is some evidence to suggest that FB understanding relates to developmental differences in children's perception and understanding of "informants" and "teachers" (DiYanni & Keleman, 2008; Ziv & Frye, 2004). Other studies also find that advances in self-regulation predict growth in other cognitive domains such as FB (Flynn, 2007) and later academic achievement (Bull, Epsy, & Weibe, 2008; McClelland, Cameron, Connor, Farris, Jewkes, & Morrison, 2007). The current study will examine the roles of FB understanding and self-regulation on children's engagement in overimitation as children experience major growth in these skills during the preschool years.

CHAPTER 2
LITERATURE REVIEW

There are several perspectives regarding the importance of social learning in human development. It has been proposed that the skill of imitation specifically is a highly adaptive learning strategy which facilitates the development of culture in general (McGuigan et al., 2011; Tennie, Call, & Tomasello, 2009; Whiten, Custance, Gomez, Texidor, & Bard, 1996). Non-human primates often engage in more emulation in which they will copy another's goal, but not the means to achieve that goal (Horner & Whiten, 2005; Nagell, Olguin, & Tomasello, 1993). In contrast, when observing others, humans tend to engage in more imitation in which they will copy both the means and the goal. The ability to copy another's means in addition to another's goal allows one to learn different types of strategies and behaviors to achieve the same goal (Williamson et al., 2008). Thus, the skill of imitation is particularly influential in humans' ability to gain knowledge about physical causality as well as socially acceptable behaviors in general (Lyons et al., 2011; Over & Carpenter, 2011; Williamson et al., 2008). As described below, several studies emphasize the flexibility with which toddlers engage in imitation and more recent research highlights a developmental shift in the way preschoolers' imitate others in novel situations.

Imitation and Intention Understanding

It is clear that intention understanding is an early social cognitive achievement which influences young toddlers' engagement in imitative learning. Young toddlers are capable of making inferences about others' behaviors and these inferences influence their engagement in imitation. For example, toddlers make inferences about the intended goals of others. Meltzoff (1995) demonstrated that when a model only produced a failed attempt at reaching her goal, toddlers produced the model's intended goal rather than imitating the model's failed attempt behavior. In relation, toddlers become increasingly sensitive to a model's intended actions when deciding what actions to imitate. Carpenter et al. (1998) presented toddlers with a two-action demonstration sequence on a variety of tasks. In one condition, children witnessed the "mistake" followed by the intentional action whereas the order was switched in another condition (i.e., intentional then mistake action presentation). In the third condition, "intentional-only" actions were presented twice to reflect a "two-action" sequence as was presented in the accidental conditions. Carpenter et al. (1998) found that toddlers in the intentional-only condition produced the full two-action sequence significantly more than the toddlers in the two accidental conditions. Further, majority of toddlers only produced the intentional action regardless of when the mistake was presented (before or after the intentional action). Both of these findings highlight that toddlers do not simply "mimic" all actions during observational learning and consider the intentionality behind a model's action (Carpenter et al., 1998).

Other studies propose toddlers use context when interpreting another's behavior and will differentially imitate a model's behaviors depending on situational demands. For example, in Gergely et al. (2002) toddlers in one condition witnessed a model produce an inefficient behavior (i.e. using her head to turn on a light) while her hands were "occupied." Toddlers in an alternate condition witnessed a model produce the same inefficient behavior but her hands were "free." Gergely et al. (2002) found that more toddlers imitated the model's means of turning on the light when her hands were free during the demonstration than when her hands were occupied. The authors suggest that this finding indicates that children reduce imitation of inefficient behaviors when there is a “rational” reason for the production of the inefficient behavior (e.g., model’s hands were occupied).

Further findings from Carpenter, Call, and Tomasello (2005) suggest that toddlers will use a model’s goal to make inferences about that model’s actions or behavior. When a model’s end goal is ambiguous, toddlers produce more of that model’s “exact” behaviors whereas when a model’s end goal is obvious, toddlers are more likely to “omit” specific behaviors that are unrelated to the goal (Carpenter et al., 2005). In relation, there is evidence to suggest that toddlers are also selective in their imitation of irrelevant and relevant actions. Brugger et al. (2007) presented 15-month-olds with a two action novel task in which the necessity of the first action varied by condition. In one condition, the first action was unnecessary (irrelevant) for task success (e.g., removing a Velcro “latch” that did not really hold a container lid shut). In an alternate condition the first action was necessary (e.g., removing a Velcro latch that held a container lid shut). The 15-month olds were more likely to produce the first action when it was relevant than when it was irrelevant and in a second study with 14- and 16-month olds, the same pattern emerged (Brugger et al., 2007). Thus, it seems that young toddlers are capable of making inferences about others’ behaviors and will use these inferences when engaging in observational learning.

Overimitation

Despite the ample evidence that toddlers are selective in their imitation, preschool children often engage in “overimitation” in which they will produce both causally irrelevant actions and relevant actions on novel tasks. Lyons et al. (2007) found that preschoolers engaged in overimitation on a novel task even after they demonstrated the ability to identify unnecessary actions on familiar objects in a training session. In addition, children's overimitation persisted when the model was absent during the child's attempt (i.e., after social pressure to conform was removed) and when the model asked children directly *not* to produce "extra/silly" actions (Lyons et al., 2007). Findings from McGuigan et al. (2007) also indicate that preschoolers persist in their overimitation of irrelevant actions even when task components are transparent—a situation in which causally necessary actions should be easier for children to identify.

However, Lyons et al. (2007) find that overimitation is significantly lower when basic causal principles are more obviously violated. For example, Lyons et al. (2007) presented children with a set of two containers. In one condition, the containers were connected with a tube and in an alternate condition the set of containers was not connected. One container contained a concealed object while the other container did not. Thus actions performed on the container without the object were unnecessary for object retrieval and actions produced on the container with the object were relevant to object retrieval. In both conditions, irrelevant actions were always presented "intentionally" and were presented before the relevant action and object retrieval (i.e., goal achievement). The only difference between conditions was the connection of the two containers. The percentage of children producing irrelevant actions in the "connected condition" was significantly higher than in the "disconnected condition." Thus in situations in which the causal plausibility of actions is compromised in a more salient manner (e.g., actions are literally produced on separate objects) children display less engagement in overimitation (Lyons et al., 2007). According to Lyons and colleagues (2007), these findings support that overimitation is automatic and occurs because children infer that another's intentional actions convey causal meaning and this automatic encoding is only "turned off" when obvious violations to causal plausibility occur (e.g., violation to contact principle).

Lyons et al. (2011) also highlights that the occurrence of overimitation is heavily influenced by a model's intent. Lyons et al. (2011) presented children with a model that *intentionally* or *unintentionally* produced an unnecessary action when solving a "puzzle box" in which a tool was used to retrieve an object. The intentional model was "attentive" while he produced the irrelevant action. In contrast, the unintentional model was "distracted" (e.g., talking on the phone) when producing the same irrelevant action. Children produced significantly fewer irrelevant actions when the model appeared "unintentional" than when the model appeared intentional in her action. Gardiner et al. (2011) also found that when irrelevant actions are presented as a "mistake" (i.e., unintentional), preschoolers decreased their production of the irrelevant action and this pattern occurred for 3-, 4-, and 5-year-olds.

However as mentioned, none of these studies present irrelevant actions after object retrieval (or goal achievement). While children may attend to intent behind actions they may also attend to when the actions occur relative to a goal. The only study that reversed the order of irrelevant-relevant actions (Simpson & Riggs, 2011) did not directly examine whether overimitation with before goal irrelevant actions occurs more than overimitation with after goal irrelevant actions. It could be that model intent influences overimitation more than action order and this finding could suggest a more social motivation for overimitation.

In addition, prior studies on overimitation do not consider developmental influences on the occurrence of overimitation though there are clear individual differences in preschoolers' overimitation. For example, in Lyons et al. (2007) only 60% of children in the connected container condition were producing irrelevant actions and the sample size (n = 29) was relatively small to determine age differences given the large age range included and the between subjects design. Similarly, Kenward (2012) examined overimitation in 3- and 5-year-olds and measured their tendency to "protest" when a third party (e.g., a puppet) did not produce the unnecessary action and instead only produced the relevant action (thus the puppet achieved the goal). Kenward (2012) only included children that engaged in overimitation for analysis and reported 60% of children were overimitating on at least three of four tasks, some 3-year-olds would not engage in overimitation at all, and some children protested the puppet's omission of the unnecessary action even though they themselves did not produce the unnecessary action. Finally, Gardiner et al. (2012) categorized 3-, 4-, and 5-year-olds as "poor imitators" (i.e., no/little production of actions—either relevant or irrelevant), "precise imitators" (produced model's actions precisely), and "perseverative imitators" (produced actions more often than was demonstrated). However, the authors did not report the proportion of each age group that made up these categories. In addition, roughly 25% of preschoolers were considered to be "poor imitators" after witnessing an intentional irrelevant action followed by a relevant action, suggesting they did not engage in overimitation (Gardiner et al., 2012). Taken together these studies suggest that while most preschoolers engage in overimitation there remains a subsample of preschoolers who are not engaging in this method of learning. Thus, these studies highlight individual differences in the occurrence of overimitation and these differences may be influenced by developmental factors other than age.

Despite the lack of age differences in the studies just mentioned, findings from Brugger et al. (2007) and McGuigan et al. (2007; 2011) suggest there are developmental differences in the occurrence of overimitation and the trend is that this method of learning seems to *increase* with age. McGuigan et al. (2011) measured overimitation in 3-year-olds, 5-year-olds, and adults (20-to-63-years). The main focus of their study was to determine if a *model's age* (e.g., child vs. adult model) would influence the occurrence of overimitation in the three age groups. All participants observed a model (either a child or an adult) produce intentional irrelevant actions when solving a novel task ("puzzle-box"). All age groups engaged in more overimitation when the model was an *adult*. In addition, 5-year-olds produced a higher proportion of irrelevant actions than 3-year-olds (finding marginally significant, $p < .054$) and more surprisingly, *adults* produced significantly higher proportions of irrelevant actions than both of the preschool age groups (McGuigan et al., 2011). Again, results revealed individual differences in the proportion of irrelevant actions produced in that 30% of the actions produced by 3-year-olds were irrelevant whereas almost 50% of the actions produced by 5-year-olds were irrelevant actions. In line with Lyons et al. (2007), McGuigan et al. (2011) propose that even as adults we continue to "automatically encode" intentional actions on novel tasks as being causally relevant *and* this encoding is especially strong when the model is considered to be an "expert" given adults engaged in more overimitation when the model was an adult than when the model was a child. However, close review of the responses from participant interviews in McGuigan et al. (2011) may suggest alternate influences on the adults' engagement in overimitation.

At the close of the experiment, McGuigan et al. (2011) asked the adult participants about their thoughts regarding the goal of the experiment. The authors sorted participant responses into six different categories and report frequencies for each category (Table 1; McGuigan et al., 2011). For those in the "child model" condition, 62% of responses related to reasons of "problem-solving test" and/or "object/goal achievement." Thus most participant responses for the "child model" condition were more related to a perceived goal of *task performance*. In contrast, for those in the "adult model" condition, roughly 79% of responses related to reasons of "imitative learning of complete sequence," "imitate illogical actions," "memory experiment" and "observation test." These response categories all focused more on a perceived goal of *copy actions.* Recall that adults engaged in more overimitation in the adult model condition than in the child model condition and did so more often than both preschool age groups. Taken together, the findings from McGuigan et al. (2011) suggest a) the age of the model influenced the type of inferences that adult participants made about the experiment and b) adult participants produced more irrelevant actions when the model was an adult. It is proposed that these response differences may imply overimitation is influenced by the learner's interpretations about a "why" a model is producing irrelevant actions. Lyons et al. (2007) propose learners specifically infer intentional actions are produced because they are "causally necessary" but the responses just reviewed suggest otherwise. In addition, while Lyons et al. (2007) suggest that social cognitive advances may support children's causal inferences they do not directly explore this notion. Given the increase in overimitation during the preschool years, the social cognitive achievement of FB specifically may be influential in children's overimitation.

False Belief Understanding

In understanding FBs, one recognizes that beliefs are separate from the physical world and do not always reflect reality—i.e., beliefs of self or another can be false. Thus the ability to coordinate between conflicting representations is a key feature of FB understanding. During the preschool years, children undergo significant change in their ability to demonstrate and apply FB understanding. Specifically, children are relatively poor in FB understanding at age 3-years, but most are proficient in this understanding by the age of 5-years (Wellman, Cross, & Watson, 2001). There is evidence to suggest that FB understanding influences how individuals interpret the actions and information provided by others and it is proposed that this influence may extend to individuals' engagement in overimitation.

Unlike 3-year-olds, 4-year-olds are capable of monitoring others for *both* accuracy and inaccuracy and demonstrate an understanding that accurate informants can sometimes be *wrong* (Corriveau, Meints, & Harris, 2009). The authors suggest this developmental difference may be influenced by the changes that occur in children's FB understanding at this age (though no measures of FB were included in their study). Further, children's application of FB understanding influences their interpretation of "why" an informant made a particular mistake (Robinson & Nurmsoo, 2009). For example, in Robinson and Nurmsoo (2009) children received information from either an "ignorant" (i.e., "poorly informed") informant or an "unreliable" (i.e., "adequately informed" but consistently inaccurate) informant. Children were more likely to endorse the "ignorant" informant if they attributed the informant's inaccuracy to a FB held by that informant than those who did not display this reasoning (Robinson & Nurmsoo, 2009). In contrast, children's performance on traditional FB tasks did not relate to their endorsement of informants (Robinson & Nurmsoo, 2009). Thus, children's ability to *apply* FB understanding may be more influential in their interpretations of others than their ability to pass traditional FB tasks per se.

The research on children's understanding of *teaching* further supports this notion. Ziv and Frye (2004) found developmental differences in the information children use when making predictions about another's teaching attempts. Young preschoolers (3- and 4-years) seem to focus on the *knowledge difference* between a teacher and a pupil when making predictions about whether or not a teacher will attempt to teach (Ziv & Frye, 2004). That is, if a teacher and a pupil possess the same knowledge (e.g., both know how to read) then young children tend to predict that the teacher will *not* attempt to teach the pupil regardless of that teacher's *belief* about the pupil's knowledge. In contrast, by age 5-years, children's predictions of whether or not an individual will attempt teach a pupil are heavily influenced by the individual's *beliefs* about the pupil's knowledge (Ziv & Frye, 2004). For example, if a teacher *falsely* believes that a pupil cannot read, older children often predict that the teacher will attempt to teach the pupil how to read. In addition, older children make this prediction after demonstrating that they understand there is not a real "knowledge difference" between the teacher and the pupil (i.e., children are aware that in reality, both can read) (Ziv & Frye, 2004). This suggests that older preschoolers are attending more to individuals' thoughts and perceptions when interpreting and predicting the behavior of others than younger preschoolers.

With the phenomenon of overimitation, it may be that individuals who are *less* sophisticated in their FB reasoning focus more on the model's intended action and goal. In contrast, individuals who are more advanced in applying FB reasoning may focus more on the full "scene" and consider *why* a model would produce irrelevant actions. In other words, individuals who are more advanced in their FB reasoning may make more advanced inferences about the model's thoughts and consequently her behavior. For example, individuals with greater FB understanding may infer the model is trying to teach and/or intends for the individual to produce all actions (e.g., they make a "social inference"). Individuals with more advanced FB reasoning may be more inclined to make a "social inference" about the model's motive and use this perspective to guide their own behavior on the task. Children with greater FB understanding may be capable of recognizing a model's irrelevant actions in a conflicting manner—i.e., as "causally unnecessary" based on their own observation, but also as "necessary to produce" based on their inferences about the model's purpose.

Self-Regulation

In addition to FB, children's executive functioning may also be influential in the occurrence of overimitation given the age and individual difference trends described previously. Executive functioning (EF) refers to processes that monitor and control one's thoughts and behaviors and some suggest working memory, inhibition, and attention switching are separate components of EF (Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000). The skill of inhibitory control specifically relates to one's self-regulation (e.g., compliance and effortful control) along with other executive function skills including working memory and attention (Cameron Ponitz, McClelland, Jewkes, Conner, Farris, & Morrison, 2008) and children become considerably better at controlling their own behavior during the preschool years (Carlson, 2005; Garon, Bryson, & Smith, 2008). Inhibitory control requires one to inhibit a dominant response whereas *conflict* inhibitory control tasks require one to act in conflict to one's natural/dominant response. It may be that children's ability to regulate their behavior facilitates their ability to inhibit "ignoring" an unnecessary action.

As mentioned, when a model's goal is obvious, toddlers show a tendency to omit behaviors unrelated to the goal (Carpenter et al., 2005). Other studies have also found that older preschoolers are more likely to remain faithful to the exact methods they observe in social learning contexts (Flynn & Whiten, 2008; Flynn & Whiten, 2012). In addition, McGuigan et al. (2011) found that both 5-year-olds and adults had significantly greater loyalty to the adult model's method than the 3-year-olds. McGuigan et al. (2007) also find that 3-year-olds are more likely to engage in "emulation" (i.e., production of the end goal but not the method) than 5-year-olds. Though McGuigan et al. (2007) found no significant age differences in the "time to reward retrieval," children who used emulation were faster to retrieve the reward than those that engaged in overimitation, which may suggest that the demands to regulate one's behavior and "stay on task" (i.e., sustain attention) may be greater when overimitation is employed. Children increase their selective attention and become better at shifting and sustaining attention across the preschool years (Garon et al., 2008).

Current Study

In sum, studies examining overimitation have documented individual differences in children's tendency to overimitate. However, these studies have only examined external factors (e.g., social pressure to conform, causal plausibility, model's intent, model's age, etc.) that contribute to the occurrence of overimitation. With the exception of age, no study to date has examined internal factors that may influence overimitation. In addition, Lyons and colleagues (2007; 2011) propose that children engage in overimitation because they view intentional actions as causally necessary, but only one study has manipulated action order and findings from this study do not address whether children overimitate with before goal irrelevant actions more so than with after goal irrelevant actions.

To address these issues, the current study has two aims 1) to explore the occurrence of overimitation when irrelevant actions occur before vs. after goal achievement and 2) to examine the independent roles of FB and S-R in children's engagement in overimitation. Two novel problem-solving tasks will be used to investigate the development of children's overimitation. Children will be randomly assigned to one of three conditions: *relevant(correct)* + *after goal irrelevant* (CI), *mistake(unintentional) irrelevant* + *relevant* + *after goal irrelevant* (MCI)*, intentional irrelevant* + *relevant* + *after goal irrelevant* (ICI). In all conditions, children will witness the same "relevant" and "after goal" irrelevant actions. The "before goal" irrelevant action will vary across the three conditions (i.e., unintentional in MCI, intentional in ICI, and non-existent in CI).

The first aim was to explore the occurrence of overimitation when irrelevant actions occur *before* goal achievement versus *after* goal achievement. Lyons and colleagues (2007; 2011) argue that children automatically infer a model is trying to convey causally meaningful actions when she produces intentional actions (irrelevant and relevant)—i.e., children make "causal inferences" about the model's motive. Considering this argument, one would expect that children will ignore an intentional irrelevant action if the action is presented *after* a goal has been achieved given it would be more salient that the action is unrelated to (and unnecessary for) task success. If Lyons argument is supported, overimitation would not be expected to occur frequently in the CI and MCI conditions and overimitation would only occur with the “before goal” irrelevant action in the ICI condition. However, if children persist in their overimitation when an intentional irrelevant action occurs *after* goal achievement, this would seem to suggest that children are not making causal assumptions about intentional actions because it would be an obvious violation of causal plausibility. Overimitation with after goal irrelevant actions may suggest that engagement in overimitation occurs for more “social” reasons as opposed to causal reasons. Regardless of whether overimitation extends to “after goal” irrelevant actions, it was expected that overimitation with the *before* goal action would not occur frequently in the MCI condition given the irrelevant action is presented as *unintentional*.

The primary aim of the current study was to examine the independent roles of FB and S-R on children’s engagement in overimitation. Considering how children apply FB understanding in their decisions to endorse an informant and their predictions as to when an individual will teach, FB may also be influential in children’s tendency to overimitate during observational learning. FB understanding was expected to be positively related to children’s overimitation with *intentional* irrelevant actions (not unintentional). Children with greater FB reasoning may be more inclined to make a social inference about the model’s motive for performing the irrelevant action and use this inference to guide their copying behavior. Further, due to the attention and inhibitory demands required to produce and attend to irrelevant actions, children’s self-regulation may also play a role in their ability to overimitate. The role of S-R is somewhat less clear, but it may be positively related to overimitation of *intentional* irrelevant actions as children may need to inhibit the natural tendency to "ignore" the irrelevant action. Williamson et al. (2008) report that children's own experiences will influence their engagement in imitation and they propose that memory and inhibition underpin imitation because these executive function skills assist in overriding one's own means to a goal in order to produce another's means to achieve that goal.

CHAPTER 3
METHOD

Participants

Ninety-seven preschoolers were recruited from local childcare centers. All children participating were required to speak English as their primary language due to the standardized language measure used in this study. Participants who completed all testing sessions received a $10 Target gift card as compensation and child participants were offered stickers after each testing session. Forty-three boys and 40 girls between the ages of 41- and 66-months (*M* = 53-months, *SD* = 7-months) were included for analysis. Among the 14 participants withdrawn from the study, two children were ineligible as they were not native English speakers, seven children refused to participate and experimenter error occurred in the testing of five children. Majority of the participants were Caucasian (82.3%). Parent report of income indicated most participants were from middle- to upper-income households.

Measures

Language

Children's receptive language was measured with the Peabody Picture Vocabulary Test, Fourth Edition (PPVT; Dunn & Dunn 2007) which is a widely used standardized measure of receptive language. Children were shown a page with four pictures and asked to point to the picture specified by the measure. Standard procedures were followed to establish a child's base set. The number of items a child got correct provided a raw receptive language score.

False Belief (FB)

Considering the focus on children's understanding of conflicting representation, FB tasks were used as opposed to a more general measure of children's "theory of mind" such as that developed by Wellman and Liu (2004). Traditional *unexpected location* (UL) and *unexpected content* (UC) tasks were used to measure children's FB understanding relative to the domains of *location* and *objects* respectively. In addition children received a FB task modeled after Ziv and Frye (2004) which addressed the domain of *knowledge*. This type of FB task was chosen given the focus on children's ability to make inferences about a model's perspective/motive.

FB understanding: unexpected location

UL tasks were based on the Sally-Anne task and presented to children in the form of a picture book. The basic storyline was that one naïve character ("Sally") hid an object and another character ("Anne") changed the location of the object while Sally was away. The experimenter read statements while showing the child the corresponding pictures. Once the story was complete, children were asked a FB question regarding where the naïve character would look for the object. Children were also asked two memory control questions regarding the old location of the object and the new location of the object.

FB understanding: unexpected content

UC tasks will involve tangible objects. One version of the UC task included a Band-Aid box that contained a small toy and the other version included a crayon box that contained ribbons. During each UC task, the experimenter asked the child what he/she thought was inside the box. The experimenter then showed the contents of the box to the child for the child to identify and re-closed the box once the child answered.

The experimenter then asked the child a FB question regarding his/her own original thoughts about the contents and a memory control question regarding the actual contents of the box. The experimenter then asked a second FB question regarding a naïve other's thoughts about the contents of the box.

FB understanding: knowledge

Modeled after Ziv and Frye (2004), children heard stories about a teacher's beliefs about an individual's knowledge. Children viewed a picture book and the experimenter read statements corresponding to each picture. In one version, the teacher *underestimated* an individual's knowledge (e.g., teacher thought the individual did not have a skill when in reality the individual did have the skill). In a different version of this task, the teacher *overestimated* an individual's knowledge (e.g., teacher thought the individual could perform a skill when in reality the individual could not). After each story, children were asked about the individual's true knowledge and the teacher's thoughts about that individual's knowledge. The test question asked children to predict whether or not the teacher would attempt to teach. The current study added an explanation question which required children to explain their prediction (e.g., why will s/he do that?).

Scoring: FB location and object

Children received one point for each FB test question they answered correctly. If a child answered a memory control question incorrectly, the FB test question associated with the memory question was coded as incorrect. For the UL tasks there were two FB questions related to the naïve other's belief. If the child indicated the naïve other would look for the object in the original location, the answer was coded as correct. The UC tasks included four FB questions regarding the child's own beliefs and a naïve other's beliefs. A response was coded as correct if the child identified his/her own original belief. In addition, if the child indicated the naïve other was unaware of the actual box contents, the answer was coded as correct. Children's total FB score ranged from zero to six.

Coding and scoring: FB knowledge

The FB *knowledge* test questions addressed children's predictions about an individual's (a "teacher's") decision to teach. Of interest for the current study was the *type* of prediction children made rather than the accuracy of children's predictions, thus children's FB understanding of knowledge was considered separately from children's FB understanding of location/objects. Prediction explanations that referenced the *teacher's belief* (e.g., because she thinks he can't read) were coded as "belief" predictions whereas explanations that referred to the individual's *true knowledge* (e.g., because he can read) were coded as "true knowledge" predictions. In some instances children referred to a *role* or *characteristic* of the teacher and/or the individual (e.g., because she likes to teach) and these responses were coded as "role" predictions. When children did not provide an explanation for their prediction (e.g., I don't know), children's prediction responses that corresponded to the teacher's belief were coded as *belief* whereas predictions that corresponded to the individual's true knowledge were coded as *true knowledge*. Children received a "belief prediction" score which was simply a tally of their belief predictions—thus, belief prediction scores ranged from zero to two.

Self-Regulation (S-R)

Two types of executive function tasks are described below. Each was used to measure children's self-regulation. Both tasks are typically administered to children in the reported age ranges (Carlson 2005; Cameron Ponitz et al., 2008).

Day/night stroop

The day/night stroop-like task (Gerstadt, Hong, & Diamond, 1994) measured children's *conflict inhibitory control*. Children were shown two types of picture cards, one with a picture of the sun representing "day" and one with a picture of the moon and stars representing "night." This task required children to say "day" when shown the night card and to say "night" when shown the day card. Children were first trained on the rules for the task (e.g., *when you see this card, I want you to say day [night]*). Children were then given four practice trials. The experimenter repeated the training up to four times when children failed the practice trial. The testing block contained eight "day" cards and eight "night" cards and these were presented in a fixed random order. If children's first response corresponded to the rule provided the response was scored as correct. Children received one point for each correct response they provided. Day/Night scores range from zero to 16.

Head-to-toes

The "*Head-to-Toes*" task measures inhibitory control, working memory, and attention (Cameron Ponitz et al., 2008). This task was chosen because it has been tested with children between the ages of 3- and 6-years and has been found to be reliable, valid, and yields variability in children's performances (Cameron Ponitz et al., 2008). In this task, children were told two commands: "touch your head" and "touch your toes." Children were instructed that the "game" was to do the opposite of what the experimenter said. For example, if the experimenter said "*touch your head*" the correct action was for the child to touch their toes. As with the day/night task, the experimenter asked the child two questions to ensure their understanding of the rule. Children received four practice trials and the rule was repeated up to three times when children failed in practice as suggested in Cameron Ponitz et al. (2008). Children received 10 test trials. Using the scoring criteria from Cameron Ponitz et al. (2008), two points indicated a complete correct response whereas one point indicated a self-corrected response (e.g., start in the wrong direction but self-correct to the correct direction). A score of zero indicated a completely incorrect response. The test items were presented in a fixed random order and Head-to-Toes scores range from zero to 20. Children's scores on each S-R task were combined to obtain a total S-R score ranging from zero to 36.

Problem-Solving Tasks

Children received two novel problem-solving tasks in which they needed to use a tool to retrieve an object. Apparatus descriptions and action coding procedures are discussed further below.

Trap-tube apparatus

The trap-tube apparatus was modeled after Horner and Whiten (2007). The tube was constructed from clear plastic material and measured roughly 50.8cm in length (Appendix Figure A-1). A rectangular trap (12.7cm in length) was located underneath the center of the tube and an object was placed in the tube to either the left or right of this trap. One side of the trap contained a flap in order for the experimenter to retrieve the object from the trap as needed. A wooden support held the tube in order for the apparatus to be placed on a table during testing sessions. The tool to retrieve the object was a lightweight stick measuring 51.8cm in length. A flip latch was mounted on the wooden support stand to serve as the "after goal" irrelevant action. Refer to Appendix Figure A-1 for relevant and irrelevant action components.

Puzzle-box apparatus

The puzzle-box apparatus was a modified version of the box design used in McGuigan et al. (2011). The puzzle-box was constructed from clear plastic boxes measuring 26.7 x 15.2 x 16.5cm (Appendix B). One box was placed on top of another to create a transparent barrier between the boxes. The top box had a small uncovered opening. A plastic block was mounted on the top of the box to serve as the “after goal” irrelevant action. The bottom box had a small opening on the front and this opening was attached to a small opaque box which contained an object. The opening on the bottom box was covered by a small lift door. A magnet tipped tool measuring roughly 16cm accompanied the puzzle-box as this tool was required for object retrieval. Actions on the top box were irrelevant to task success (i.e., object retrieval). Refer to Appendix B for relevant and irrelevant action components.

Procedure

The current study was a 2(task: puzzle-box, trap-tube) x 3(condition: CI, MCI, ICI) mixed design with condition being between-subjects and task being within-subjects. The FB tasks, S-R tasks, and problem-solving tasks were administered on different days in counterbalanced order. The language measure was always administered on the last testing session. Testing sessions lasted between 20-30 minutes per child. Both problem-solving tasks and the S-R tasks were video recorded.

In measuring engagement in overimitation, children in each age group (3-years, 4-years, 5-years) were randomly assigned to one of three demonstration conditions (CI, ICI, MCI). At the start of each demonstration, the “model” experimenter did not say anything. Children were told to watch the model by a second experimenter not performing the demonstration. The conditions and model’s actions are described below.

All after goal irrelevant actions were presented as intentional whereas before goal irrelevant actions varied between conditions.

CI Condition

This condition presented a *relevant(correct)* + *irrelevant* (CI) action sequence. The model experimenter picked up the stick and performed the relevant action (i.e., the correct solution) to the task followed by the "after goal" irrelevant action (action A). She said "*There I got it!*"after performing the relevant action and "*There*" after performing action A.

MCI Condition

This condition presented *mistake irrelevant* + *relevant* + *irrelevant actions* (MCI). The model experimenter performed the "before goal" irrelevant action (action B) and said "*Ooops!"* and grimaced after performing the action to indicate the action was *unintentional*. She then performed the relevant action and action A as presented in the CI condition.

ICI Condition

This condition presented an *intentional irrelevant* + *relevant* + *irrelevant* (ICI). The model experimenter used the same exact actions as MCI but said "*There*" after action B to indicate the before goal irrelevant action was *intentional.* She then performed the relevant action and action A again saying "*There*" after each of these actions.

Children received the same type of demonstration for each of the problem-solving tasks. All of the irrelevant and relevant actions were identical in each condition with the exception of irrelevant before action which was not performed in the CI condition. Demonstration was provided on two trials (*Trial 1* and *Trial 3*). The second experimenter cued children to attempt the task by saying "*it's your turn*" and avoided instructing children to imitate or reproduce the demonstrating model's actions. Children attempted the task on their own for a total of six test trials (Appendix A, Figure A-2). Children were asked three questions to assess their understanding of the tasks after they fully completed each task—*What did we want you to do in this game? How do you win the game? What did you have to do to win?*

Children's attempts on the problem-solving tasks were categorized into specific imitation action types as follows:

1. Insufficient imitation: production of before or after irrelevant actions only or new method. No relevant action produced.
2. Relevant-only: production of relevant action only
3. Overimitation before*: production of before irrelevant + relevant action only. No after action produced (*not applicable for CI condition).
4. Overimitation after: production of relevant + after irrelevant action only. No before action produced.
5. Exact overimitation*: production of all model's actions in same order of presentation. (*equivalent to overimitation after for CI condition).

On each trial, a child's action(s) could only be categorized into one of the five action codes. Once actions on each trial were coded, the total number of trials in which children produced each action type was tallied for each task. Thus, each action type is a dependent variable and indicates the number of trials in which children produced the said action (i.e., *exact overimitation* represents the number of times children engaged in exact overimitation and so on). For each action, frequencies ranged from zero to six on each task and "total" frequencies (composite of both tasks) ranged from zero to 12.

CHAPTER 4
RESULTS

Inter-Rater Reliability

An independent observer who was naïve to the hypothesis coded data of 25 randomly selected participants (30% of the total sample). Inter-rater reliability was high. All Cohen's κ ≥ .88 for the coding of action types at each trial and task understanding questions (Table 4-1).

Table 4-2 presents the means and standard deviations for the individual variables and total action type variables. The FB Knowledge variable reflects children's "belief prediction" score, rather than children's "accurate" prediction score and was not included in the FB Understanding composite given the focus on prediction type rather than prediction accuracy. A one-way ANOVA examined initial condition group differences in the individual variables. There were no significant group differences in Age, $F(2, 80) = .08$, $p = .92$; Language, $F(2, 80) = .70$, $p = .50$; FB Understanding, $F(2, 80) = 2.43$, $p = .10$; FB Knowledge, $F(2, 80) = .05$, $p = .95$; or S-R, $F(2, 79) = .49$, $p = .61$.

As noted, presentation order of the Tap and Block irrelevant actions were counterbalanced on the puzzle-box (Tap-before action/Block-after action vs. Block-before action/Tap-after action). A between-subjects MANOVA was conducted with insufficient imitation, relevant-only, overimitation after, and exact overimitation action types as dependent variables. The overall MANOVA revealed no significant effect of order on action type, $F(4,73) = 2.01$, $p = .10$, $\eta^2 = .09$. An independent samples *t*-test also indicated no significant difference in the occurrence of overimitation before between Tap-Block and Block-Tap orders, $t(54) = 1.254$, $p = .22$. Preliminary analyses also indicated children’s actions on the puzzle-box and trap-tube were highly correlated (all *r*s[79] ranged .43 to .60, all *ps* < .001). Thus “total action type” frequencies were used for analysis (i.e., total insufficient, total relevant-only, etc.). The raw data for action types was not normally distributed. Reported analyses were conducted with log transformed scores for the total action type variables unless otherwise noted.

Occurrence of Overimitation

Overimitation Across Conditions

The first aim of the current study was to examine the extent to which overimitation occurs when an irrelevant action is presented *after* goal completion. A between-subjects MANOVA was conducted with condition (3: CI, ICI, MCI) and age (3: 3-years, 4-years, 5-years) as the between-subjects variables and action types *overimitation after* and *exact overimitation* as the dependent variables. The assumption of homogeneity of variance could not be supported for *Overimitation After* variable ($F[2, 72] = 9.63$, $p < .001$) thus Pillai’s trace is used for estimation of *F*-statistics in the analysis. The overall MANOVA revealed a significant main effect of condition ($F[4,144] = 6.95$, $p < .001$, $\eta^2 = .16$), but there was no main effect of age ($F[4,144] = 1.28$, $p = .28$) nor an interaction between age and condition ($F[8,144] = 0.98$, $p = .48$). For parsimony, the between-subjects MANOVA was re-run with age variable removed. To examine the significant effects, follow-up univariate ANOVAs revealed a significant main effect of condition on *Overimitation After* ($F[2,78] = 7.91$ $p < .01$, $\eta^2 = .17$) and *Exact Overimitation* ($F[2,78] = 6.40$, $p < .01$, $\eta^2 = .14$). Main effects were examined using Bonferroni corrections to control for alpha inflation.

As expected the occurrence of *exact overimitation* was significantly lower in the MCI condition ($M = 0.67$, $SD = 0.96$) than the CI ($M = 1.38$, $SD = 1.05$; $t[78] = -2.69$, $p <$

.05) and ICI (M = 1.54, SD = 0.92; t[78] = -3.36, p < .01) conditions. The *overimitation after* action type occurred significantly more in the CI (M = 1.38, SD = 1.05) condition than the ICI (M = 0.42, SD = 0.60; t[78] = 3.95, p < .001) but not the MCI condition (M = 0.79, SD = 0.96; t[78] = 2.43, p = .052) condition. It was speculated that the mistake action in the MCI condition might emphasize the intentionality of the after goal irrelevant action and thus elicit more *overimitation after* when compared to the ICI condition. However, there was no significant difference in the occurrence of *overimitation after* between the ICI and MCI conditions (Figure 4-1).

Considering before goal irrelevant actions were not presented in the CI condition, a between subjects t-test was conducted to examine condition differences in *overimitation before* action type. It was expected that *overimitation before* would occur more frequently in the ICI condition than the MCI condition, however the t-test revealed no significant difference in the occurrence of this action type between the two conditions, $t(54) = -0.42$, $p = .68$.

Overimitation Within Conditions

The occurrence of overimitation within conditions was also considered. A RMANOVA was conducted with condition as a between subjects variable and action types *overimitation after* and *exact overimitation* as within subjects variables. As displayed in Figure 4-1, the overall RMANOVA revealed a significant interaction between condition and overimitation type (F[2,78] = 11.83, p < .001, η^2 = .23). Effects were examined using Bonferroni corrections to control for alpha inflation. There were no differences in occurrence of each overimitation type within the CI and MCI conditions. Within the ICI condition, engagement in *exact overimitation* (M = 1.54, SD = 0.92) occurred significantly more than *overimitation after* (M = 0.42, SD = 0.60; t[78] = 6.04, p < .001).

A second RMANOVA was conducted with the CI condition removed and *overimitation before* action type added. Again there was a significant interaction between condition and overimitation type (F[2,108] = 6.27, p < .01, η^2 = .10). Bonferroni corrections were again applied to control for alpha inflation. No significant differences in overimitation types emerged within the MCI condition. Within the ICI condition, *exact overimitation* (M = 1.54, SD = 0.92) also occurred significantly more than *overimitation before* (M = 0.68, SD = 0.88; t[78] = 4.63, p < .001) but there was no difference in the occurrence of *overimitation after* or *overimitation before* actions. Thus children in the ICI condition engaged in significantly more exact overimitation than the other overimitation types whereas no differences in overimitation type emerged within the CI and MCI conditions.

Influence of Individual Factors on Overimitation

Of central interest was to examine the influence of FB and S-R on the occurrence of overimitation. First the role of these skills on each *type* of overimitation was explored. It was expected that FB variables and S-R would be positively related to overimitation with intentional actions—i.e, *exact overimitation* (CI and ICI conditions), *overimitation before* (ICI condition only), and *overimitation after* (CI and MCI conditions). Table 4-3 presents partial correlations within each condition to examine the relationships between individual variables (language, S-R, FB Understanding, and FB Knowledge) and the total overimitation action types controlling for age.

Controlling for age, S-R was significantly related to *exact overimitation* in the CI condition (r[21] = .45, p < .05) but contrary to expectations the relationship was not significant in the ICI condition. S-R was significantly related to *overimitation after* for the CI condition, but the relationship did not reach significance in the MCI condition though the correlation coefficient suggests a moderate relationship exists as was expected (r[25] = .38, p = .05). In contrast to expectations, no significant relationship emerged between S-R and *overimitation before* in the ICI condition and neither FB Understanding nor FB Knowledge was significantly related to any type of overimitation in any of the conditions.

Categorization of Overimitation

To examine the roles of S-R and FB on the occurrence of overimitation more generally, children were categorized by their general dominant action type. Frequencies of *overimitation before, overimitation after,* and *overimitation exact* were combined to create a "total overimitation" variable and frequencies of *insufficient* and *relevant-only* actions types were combined to create a "total non-overimitation" variable. Frequencies for each variable ranged from zero to 12 since children attempted 12 trials total. Children were categorized as having an "overimitation" dominant action type if they had a total overimitation frequency of seven or greater (i.e., they engaged in overimitation for at least seven out of 12 trials). Conversely, children were categorized as having a dominant "non-overimitation" action type if they had a total non-overimitation frequency of seven or greater. Three participants were removed from analyses with general dominant action type as these children engaged in an equal amount of overimitation and non-overimitation (i.e., score of six on each category) and thus were not dominant in either action type.

Multiple logistic regressions were conducted with General Dominant Action Type (Non-overimitation [0] vs. Overimitation [1]). To start, stepwise logistic regression was conducted with all individual variables and condition as predictors considering no studies have explored the role of developmental factors (with the exception of age) on the occurrence of overimitation. Backward entry was used to protect against suppressor effects and the condition variable was dummy coded with the CI condition as the reference group. The best fitting stepwise model revealed age, S-R, and condition as significant predictors of overimitation.

Based on the stepwise results, a hierarchical logistic regression was conducted to examine the unique influence of each variable. Condition was entered first with age and S-R entered at steps two and three respectively. As displayed in Table 4-4, the model with condition, age, and S-R was significantly better than the null model (χ^2[4] = 22.04) and the addition of S-R significantly improved the model beyond the age and condition model (χ^2[1] = 4.22). Age (B = .09 [0.05], $p < .05$) was a significant predictor of overimitation with increasing age indicating greater probability of overimitation. S-R was marginally significant (B = .06 [0.03], $p = .045$) with the same pattern of higher scores indicating greater probability of overimitation. In addition, being in the ICI condition (B = 2.10 [0.75], $p < .01$) was associated with a higher probability of engaging in overimitation when compared to the CI condition. However the model was relatively average in percentage of correct predictions (75%). Sensitivity and specificity was 54% and 86% respectively with Hosmer and Lemeshow's R^2 = .21.

In review of age differences, frequencies displayed 45% of three year olds engaged in overimitation whereas 65% and 83% of four and five year olds engaged in overimitation respectively (Figure 4-2). Similarly, in categorizing children as "high" and "low" self-regulators (median split; ≥ 22 = high, < 22 = low), 78% of high self-regulators engaged in overimitation compared to roughly half (51%) of low self-regulators (Figure 4-3).

Insufficient and Relevant Action Types

The occurrence of "insufficient imitation" indicated that children only produced an irrelevant or novel action and did not produce the relevant action (i.e., did not attempt to achieve the goal). A one-way ANOVA indicated there was no significant effect of condition on insufficient action type, $F(2,78) = .79$, $p = .47$. In addition, children who did not produce any irrelevant actions and instead only produced actions relevant for goal success were by definition not engaged in overimitation. A one-way ANOVA indicated there was a significant main effect of condition on relevant-only action type, $F(2,78) = 9.24$, $p < .001$, $\eta^2 = .19$. Relevant only actions occurred more frequently in the CI condition ($M = 1.29$, $SD = 0.16$) than the MCI ($M = 0.66$, $SD = .16$; $t[78] = 2.83$, $p < .05$) and ICI ($M = 0.36$, $SD = 0.15$; $t[78] = 4.24$, $p < .01$) conditions. There was no significant difference in the occurrence of relevant only actions between the MCI and ICI conditions.

Considering the relationship between *insufficient* and *relevant-only* actions and individual variables controlling for age, S-R was marginally related to *insufficient* actions in the ICI condition ($r[25] = -.38$, $p = .05$) and *relevant-only* actions in the CI condition ($r[21] = -.41$, $p = .05$). Though this finding is not quite significant, the pattern suggests children with higher S-R produced less *insufficient* and *relevant-only* actions in the ICI and CI conditions respectively. In addition, children's general FB Understanding was significantly related to *relevant-only* actions ($r[25] = .44$, $p < .05$) in the MCI condition. This finding suggests children with greater FB understanding produced more *relevant-*

only actions in the MCI condition, which is the opposite of the relationship pattern that was displayed in the CI condition ($r[22] = -.37$, $p = .07$).

Task Understanding Responses

Children's responses to the task understanding questions fell into three main categories: Don't Know, Copy Actions, and Get Object. Responses of "I don't know" or completely random responses (e.g., "you have to listen to your mommy") were categorized as Don't Know response types. Responses referencing production of the irrelevant and relevant actions (e.g., you take it out [demo taking out the block] and you take it [gestured to frog] out with the stick) and/or referenced copying in general (e.g., "you win the game by doing it like they show you") were categorized as "Copy Actions" responses. Responses referencing the object only ("get the [frog/mouse]") and/or the relevant-only action ("you put the stick in and get the frog out") were categorized as "Get Object" responses. Arguably, referencing the relevant-only action indicates children were "copying an action" but the action was necessary to achieve the true goal of "getting the object." Refer to Table 4-1 for coding reliability. Responses from each task were combined and response frequencies are displayed in Table 4-5.

Majority of children in the ICI and MCI conditions suggested getting the object (i.e., the frog or the mouse) was both the goal and how to win the game. Responses from children in the CI condition on these two questions were almost evenly split between "don't know" and "get object." When asked what they had to *do* to win (i.e., "Action to Win"), 48% of children in the ICI condition gave responses relating to "copy actions," whereas the majority of children in the CI and MCI conditions gave a response relating to "get the object."

Chi-square tests were conducted to examine the association between children's general dominant action type (overimitation vs. non-overimitation) and "copy action" responses (copy action vs. non-copy action response). For all three questions, general dominant action type was significantly associated with a "copy action" response (Table 4-6). Across all three questions, over 80% of children who gave a response related to "copy actions" engaged in overimitation. When children gave a "non-copy" response, roughly 57% engaged in overimitation.

Table 4-1. Report of interrater reliability (Cohen's Kappa)

	Puzzle-box Cohen'sκ	Trap-tube Cohen'sκ
Trial 1	0.90	0.95
Trial 2	1.00	0.88
Trial 3	0.89	0.90
Trial 4	1.00	0.95
Trial 5	1.00	0.89
Trial 6	1.00	0.95
What did we want you to do in this game? (Game Goal)	1.00	1.00
How do you win this game? (Win)	1.00	0.95
What did you have to *do* to win? (Action to Win)	0.95	0.90

Note. All *p*-values < .001

Table 4-2. Descriptive statistics for individual variables and total action types by condition

	CI (*n* = 27)		ICI (*n* = 28)		MCI (*n* = 28)	
	M	SD	M	SD	M	SD
Age (months)	54.19	7.16	53.50	7.13	53.11	6.82
PPVT	87.89	20.20	94.07	22.64	92.75	18.41
Self-regulation	19.46[a]	10.05	20.64	10.74	18.36	10.44
FB understanding	2.89	2.03	3.82	2.06	2.80	2.30
FB knowledge	0.67	0.78	0.68	0.82	0.71	0.81
Insufficient	2.60[b]	3.25	3.07	2.82	3.25	3.33
Relevant	4.36[b]	4.25	0.71	1.27	1.93	3.20
Overimitation before	-	-	1.96	2.86	2.29	3.59
Overimitation after	5.04[b]	4.41	0.86	1.38	2.50	3.50
Exact overimitation	5.04[b]	4.41	5.36	4.15	2.04	3.13

Note. PPVT = Peabody Picture Vocabulary Test (raw scores); FB = false belief; [a]*n* = 26 due to missing data; [b]*n* = 25 due to missing data.

Table 4-3. Partialled age correlations between Individual variables and action types by condition

	1	2	3	4	5	6	7	8	9
CI (n = 27)									
1. Language	–	.39[b]	.49**	.71***	-.10	-.05	–	.00	.00
2. Self-regulation		–	.27	.26	-.05	-.41[b]	–	.45*	.45*
3. FB understanding			–	.50**	.01	-.37	–	.12	.12
4. FB knowledge				–	-.18*	-.02	–	-.03	-.03
5. Insufficient					–	-.34	–	-.31	-.31
6. Relevant-only						–	–	-.61**	-.61**
7. Overimitation before[a]							–	–	–
8. Overimitation after								–	1.00***
9. Exact overimitation									–
ICI (n = 28)									
1. Language	–	.32	.39*	.36	-.20	.41*	-.17	.16	.03
2. Self-regulation		–	.18	-.08	-.38[b]	-.05	.03	-.01	.12
3. FB understanding			–	.03	-.13	.17	.02	-.29	-.22
4. FB knowledge				–	.11	.09	-.19	.08	-.01
5. Insufficient					–	.14	-.06	.16	-.49**
6. Relevant-only						–	-.03	.12	-.55**
7. Overimitation before							–	-.18	-.40*
8. Overimitation after								–	-.13
9. Exact overimitation									–
MCI (n = 28)									
1. Language	–	.07	.20	.38[b]	.17	-.15	.32	-.05	.33
2. Self-regulation		–	.21	.43*	.02	.03	-.07	.38[b]	-.15
3. FB understanding			–	.38[b]	-.13	.44*	-.21	.06	.08
4. FB knowledge				–	-.10	-.05	.11	-.06	.03
5. Insufficient					–	-.27	-.11	-.14	-.33
6. Relevant-only						–	-.24	-.14	-.21
7. Overimitation before							–	-.46*	-.17
8. Overimitation after								–	-.04
9. Exact overimitation									–

Note. [a] not applicable in CI condition; [b] p = .05, * p < .05. ** p < .01, *** p < .001

Table 4-4. Hierarchical logistic regression of predictors of general overimitation

Step	Variable	Model χ^2	*B*	*SE B*	*Exp(B)*
Null Model		102.72			
	Constant		0.60	0.24	1.81
Step 1		95.31			
	Condition: ICI vs CI		1.64**	0.63	5.13
	Condition: MCI vs CI		0.79	0.57	2.20
Step 2		84.91			
	Condition: ICI vs CI		2.06**	0.71	7.81
	Condition: MCI vs CI		1.02	0.63	2.78
	Age		0.12**	0.04	1.13
Step 3		80.69			
	Condition: ICI vs CI		2.10**	0.74	8.14
	Condition: MCI vs CI		1.19	0.66	3.30
	Age		0.09*	0.04	1.10
	Self-regulation		0.06[a]	0.03	1.06

Note. [a] $p = .045$, * $p < .05$, ** $p < .01$

Table 4-5. Frequencies of task understanding responses

	CI		ICI		MCI	
Question/Response	N	%	N	%	N	%
Game goal?						
Don't know	26	50%	15	27%	19	35%
Copy actions	4	8%	17	30%	12	22%
Get object	22	42%	24	43%	24	44%
How do you win?						
Don't know	28	54%	16	29%	16	29%
Copy actions	3	6%	15	27%	10	18%
Get object	21	40%	25	45%	30	54%
Action to win?						
Don't know	16	31%	15	27%	17	30%
Copy actions	6	12%	27	48%	13	23%
Get object	29	57%	14	25%	26	46%
Totals						
Don't know (*n* = 168)	70	42%	46	27%	52	31%
Copy actions (*n* =107)	13	12%	59	55%	35	33%
Get object (*n* = 215)	72	34%	63	29%	80	37%

Table 4-6. Chi-square tests with copy action responses

	Copy as game goal[a]		Copy as how to win[b]		Copy as action to win[c]	
	Yes	No	Yes	No	Yes	No
Overimitation	21 84.0%	30 56.6%	19 86.4%	32 57.1%	26 81.3%	25 55.6%
Non-overimitation	4 16.0%	23 43.4%	3 13.6%	24 42.7%	6 18.8%	20 44.4%

Note. [a] $\chi^2(1) = 5.63$, $p < .05$, [b] $\chi^2(1) = 5.96$, $p < .05$, [c] $\chi^2(1) = 5.52$, $p < .05$

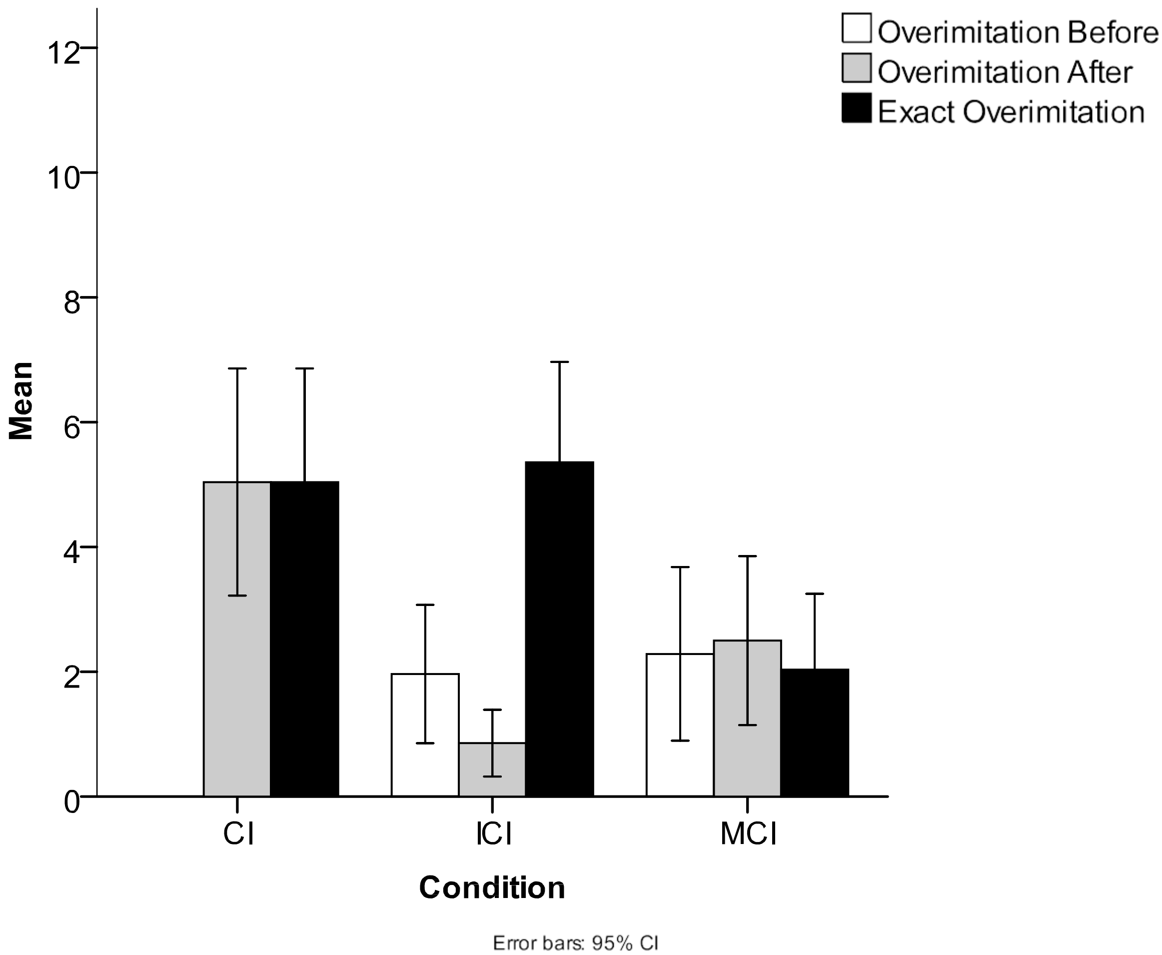

Figure 4-1. Overimitation action types by condition. *Note.* Asterisk indicates exact overimitation in MCI is significantly lower than CI and ICI conditions ($p < .05$; $p < .01$) and overimitation after in ICI is significantly lower than CI condition ($p < .001$).

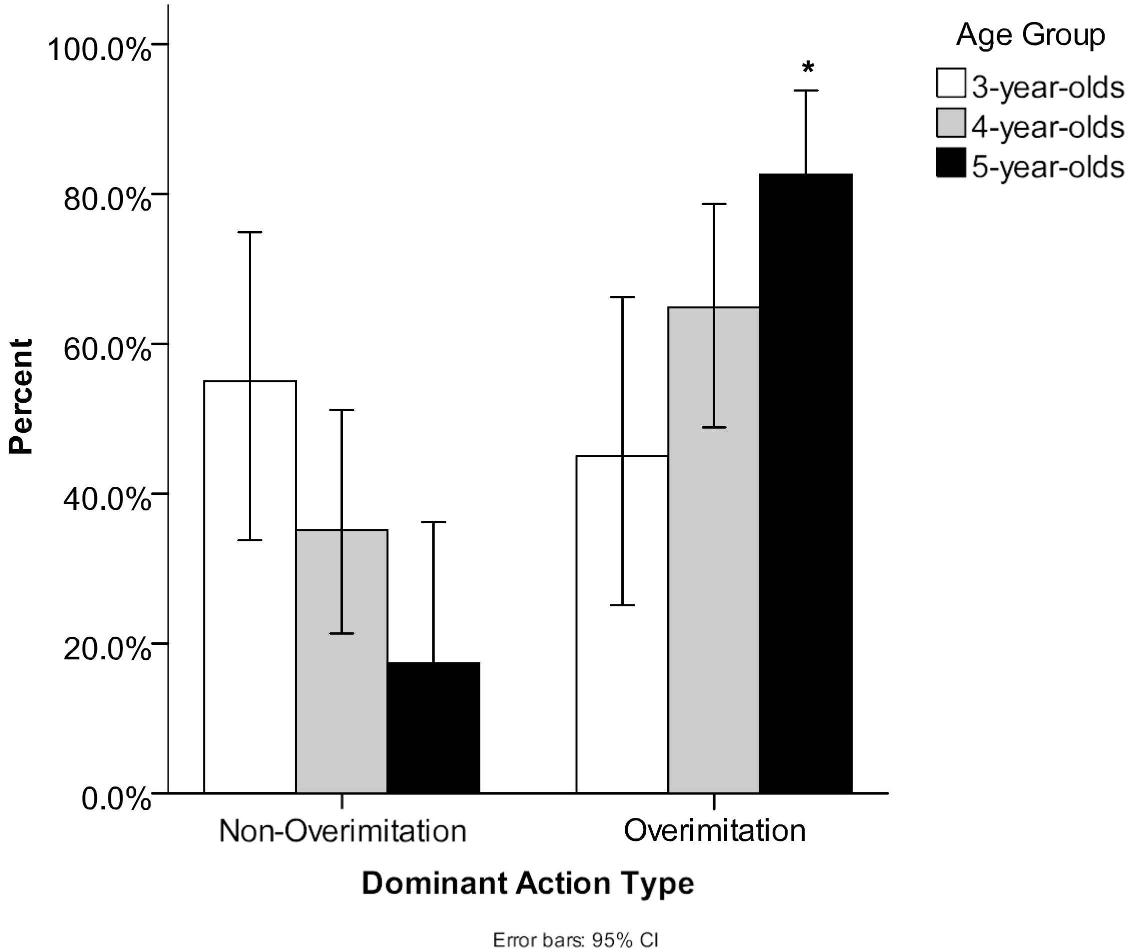

Figure 4-2. Dominant action type by age. *Note.* Asterisk indicates 5-year-olds engaged in overimitation significantly more than non-overimitation ($p < .05$).

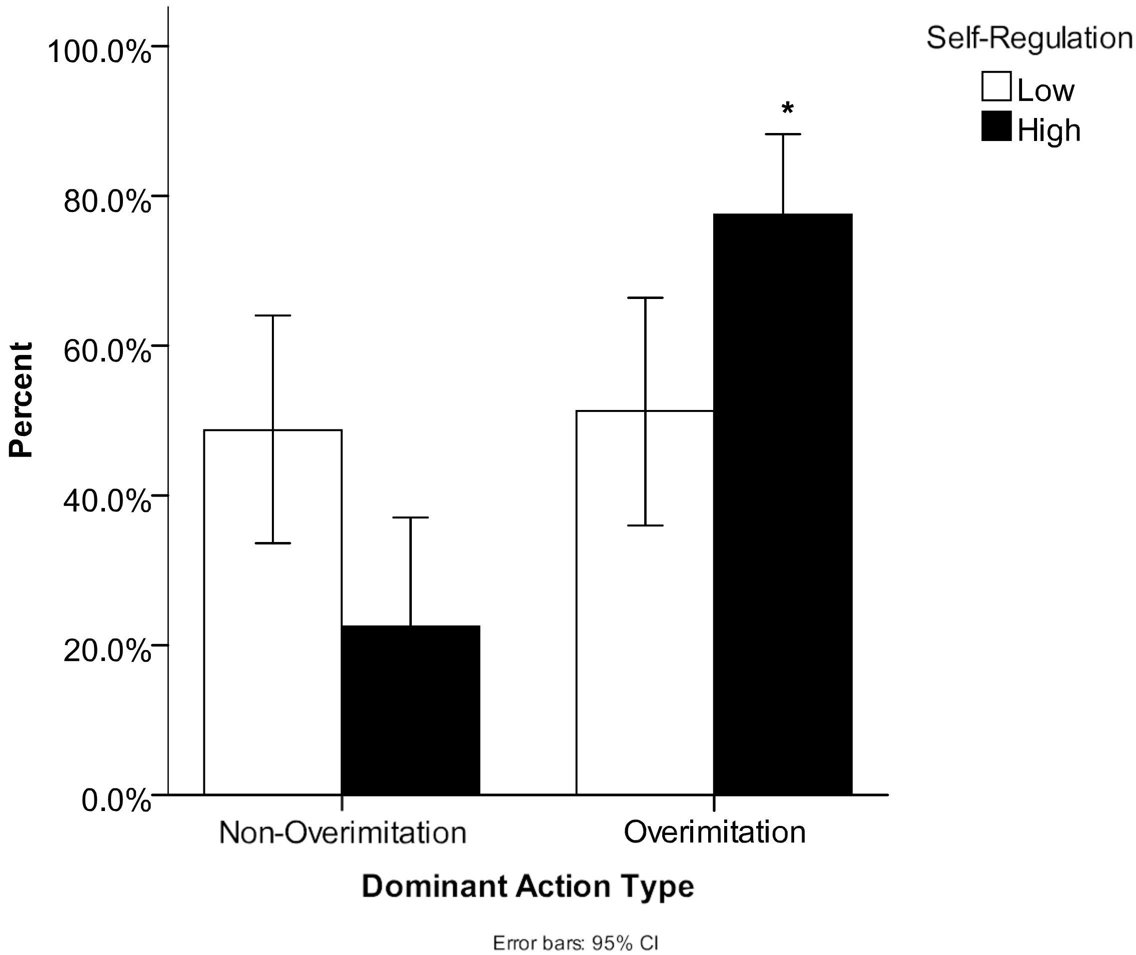

Figure 4-3. Dominant action type by self-regulation. *Note.* Asterisk indicates children with higher self-regulation engaged in overimitation significantly more than non-overimitation ($p < .05$).

CHAPTER 5
DISCUSSION

The current study extends the investigation of preschoolers' engagement in overimitation and replicates several patterns from prior studies of overimitation. As mentioned, overimitation refers to imitation of both irrelevant and relevant actions (Lyons et al., 2007). While studies have found this type of imitation generally emerges in the preschool years; there has been very little investigation of developmental factors that influence the occurrence of overimitation. In addition, only one study presented irrelevant actions prior to goal achievement (Simpson & Riggs, 2011) and it was not clear if overimitation occurred more frequently with irrelevant actions presented prior to a goal. Investigation of developmental factors and the extent to which overimitation persists after goal achievement inform current explanations as to why overimitation occurs at all.

Occurrence of Overimitation

All conditions in the current study presented children with an irrelevant action after the goal achievement. The conditions only varied in presentation of before goal irrelevant actions (i.e., as non-existent, as intentional, or as unintentional). No study reviewed has manipulated both model intent and action sequence when investigating the influence of these factors on overimitation. Results strengthen the conclusions that model intent will alter the occurrence of overimitation (Gardiner et al., 2011; Lyons et al., 2011) and action order does not have an influence on the occurrence of overimitation (Simpson & Riggs, 2011). Children in the current study engaged in more exact overimitation (i.e., produced all actions exactly as modeled) when actions were presented intentionally (as in the CI and ICI conditions). More specifically, children in the CI condition engaged in more overimitation with the after goal irrelevant action than children in the ICI condition, but only marginally more than the MCI condition. In addition, within in the ICI condition, children engaged in significantly more exact overimitation than the other types of overimitation suggesting children viewed (consciously or unconsciously) all intentional actions as being important to copy.

It could be argued that these patterns support the proposal by Lyons et al. (2011) that humans engage in overimitation because of unconscious "automatic causal encoding" (ACE) when they are presented with intentional actions on a novel task. However, findings from Lyons et al. (2007) indicate overimitation occurs less frequently when obvious violations of causal plausibility occur. It was expected that if children were making causal inferences, they would have largely ignored the after goal irrelevant actions because these actions were clearly unrelated to goal achievement (i.e., retrieval of the objects occurred first). In addition, both tasks were transparent and children could see the causal structure of each however neither of these changes deterred children from engaging in overimitation. ACE hypothesis would suggest children's overimitation may have persisted because the after goal irrelevant actions in the current study were performed on the same physical apparatus and children may have erroneously assumed causal meaning behind the intentional actions even though these actions had no possible effects on the goal (object retrieval).

However, examining children's responses to task understanding questions yields a different interpretation as to why children engaged in overimitation. Over 80% of those who gave "copy action" responses engaged in overimitation whereas roughly 57% of those who gave non-copy responses overimitated. To support ACE hypothesis, the “copy action” responses could offer further evidence that children viewed copying as necessary because intentional actions were unconsciously viewed as having causal importance for success. An alternate interpretation is that children viewed copying as the general *purpose* of the interaction/experiment (“copying needed to play”). The second interpretation seems more likely when considering this finding replicates the pattern found in McGuigan et al. (2011).

Adults in their study engaged in overimitation considerably more when they witnessed an adult model and of those in this condition, roughly 79% gave copy action responses (e.g., “imitate illogical actions,” “observation test,” etc.) when asked about the purpose of the experiment. Clearly these responses do not reflect that adults assumed causal importance of actions and even if causal encoding was unconscious it seems odd for adults to continue overimitating across several trials after they had gained experience with the task. Further, when adults observed a child model overimitation decreased. These adults’ responses were more related to task performance (e.g., “object/goal achievement,” or “problem-solving” task). These responses suggest adults were capable of recognizing the causal nature of the novel task and how to achieve the task goal. In addition, when Horner and Whiten (2005) presented preschoolers with a demonstration on the puzzle-box, children in a pilot study indicated they viewed the game as a “copying game.” Taken together it seems more likely that one’s perspective of the full situation/experiment may guide their copying behavior and this perspective is not necessarily limited to causal inferences.

Influences on Overimitation

The age trend described in McGuigan et al. (2011) was also replicated and general overimitation increased with age. The skills of FB and S-R had varying influences on children's overimitation though both had some influence on children's engagement in observational learning. The occurrence of overimitation in general was best predicted by age, S-R, and condition. Older children, greater self-regulatory skills, and the ICI condition had a larger influence on overimitation. Contrary to expectations no significant relationships emerged between FB understanding and engagement in overimitation, but in the MCI condition, FB was positively related to production of *relevant-only* actions.

In thinking about age differences, this finding challenges the interpretation that children produce irrelevant actions because they attend to intention as Horner and Whiten (2005) propose. This interpretation does not address why age differences emerge within an age group of children that are equally capable of drawing conclusions relative to the intentions of others. The independent role of S-R on overimitation in general suggests there is some executive function component to engagement in overimitation on novel problem-solving tasks. Young children do not need exceptional self-regulatory skills to engage in imitation; however overimitation requires one to produce extra actions unrelated to a task goal.

Carpenter et al. (2005) note that toddlers will reproduce a model's exact actions more when a goal is ambiguous, but when there is a clear goal, toddlers are more inclined to imitate only the necessary action to achieve the goal. It could be argued that the current task goals were unclear and thus children engaged in more overimitation. However the age trend indicates 5-year-olds engaged in more overimitation than 3-year-olds, thus it seems very unlikely that 3-year-olds "got it" and 5-year-olds were confused when thinking about the intended goal. It is suggested that the age trend and consequently the S-R difference emerged due to differences in what 3- and 5-year-olds attend to and thus there may have been a difference in how goals were perceived.

In review of child response frequencies to all task understanding questions, majority of responses in the CI and MCI conditions referred to getting the object as the goal/related to winning and this was more pronounced in the MCI condition. This suggests that as a group, children recognized the task goal and this goal was more obvious if children witnessed a mistake prior to goal achievement. S-R was also related to overimitation after in the CI condition and marginally related in the MCI condition (p = .05) even after controlling for age. It may be that when presented with problem solving tasks in which an end goal is made salient (retrieval of an object) producing intentional irrelevant actions is more of an effort and advances in executive functioning in general may be important for children to attend to all actions, remember the actions, and override the tendency to only produce actions directly related to goal achievement.

Patterns in the ICI condition support this notion as general overimitation was more prevalent in this condition, S-R was unrelated to specific overimitation actions when controlling for age, and children's responses were almost split between "get object" and "copy actions" (63 and 59 respectively). To be classified as a *dominant* overimitator, children had to engage in any form of overimitation (before, after, or exact) on the majority of task trials. General engagement in overimitation may have occurred more in the ICI condition because all three actions were intentional which provided more possibility that overimitation of any type would occur. The three intentional actions in a row also may have been a salient cue to learners that actions should be copied and the viewing three back-to-back intentional actions may have made the end goal less obvious. If children perceived an ambiguous end goal, this may explain why there was no association between S-R and specific overimitation types when controlling for age considering toddlers also produce more exact actions in ambiguous end goal situations.

Finally, the developmental patterns revealed in the MCI condition provide more evidence that children may overimitate because of their perception about the general "purpose of the situation" beyond the "purpose of actions" on the task. The MCI condition provides a unique situation for uncovering what may occur when one is "deciding" what to copy in observational situations. Controlling for age, FB was positively related to production of *relevant-only* actions and S-R was marginally (p = .05) related to engagement in *overimitation after*. In this condition, the mistake action could have reinforced the intentionality behind both the relevant and after goal irrelevant actions. Children with greater self-regulatory skills were better at attending to all actions (even those that occurred after the goal), inhibiting the mistake, and producing an action unrelated to the goal. However, greater FB understanding was associated with more *relevant-only* action type, suggesting that children with greater FB understanding did not limit their decision to "copy or not" to the intentionality behind the model's actions and it could be argued these children were actually more advanced in their reasoning about the situation overall.

Robinson and Nurmsoo (2009) find that children who attribute another's mistakes to a FB held by that individual are more likely to endorse the individual even when the person is repeatedly inaccurate. Thus children in their study were less likely to endorse an individual if the person was unreliable ("adequately informed") than if this individual was simply ignorant ("poorly informed"). Children with greater FB understanding may have viewed the model in the current study as being adequately informed because prior to the model's demonstration children were told to "watch her and you'll have your turn in a minute" which may have cued them to think that this model knew what she was doing. Due to the model's repeated mistakes in the current task children may have judged her to be unreliable and were more motivated to produce the action they viewed as relevant to goal success. In addition, Williamson et al. (2008) find that in situations in which preschoolers have to infer the goal of a task, they will resort to their own methods to achieve that goal when a model is unsuccessful. Thus perceived reliability of a model coupled with intentionality of actions influences imitation in general.

This pattern is a similar to the pattern found in McGuigan et al. (2011) relative to differences in overimitation of "expert" and "non-expert" models. Adults engaged in less overimitation when they witnessed a child model and as mentioned their perceptions of the experiment related to efficient task performance. McGuigan et al. (2011) propose their results support ACE hypothesis and suggest their findings indicate "automatic coding may be particularly strong in the presence of 'expert' models, and diluted in the presence of 'non-experts'" (p. 14). While it is agreed that overimitation may be due to automatic coding, it is proposed this automatic coding is not limited to causality, but rather that there is an automatic encoding to determine the rational purpose of a situation/interaction more generally. This explanation seems more appropriate when considering overimitation extends into adulthood. It is conceivable that adults could make unconscious causal inferences *initially* when presented with a novel task and intentional actions, but it seems doubtful that adults made causal inferences considering McGuigan et al. (2011) report they engaged in overimitation repeatedly over several trials. Adults' repetition of overimitation coupled with adult interview responses suggests one's interpretation of the situation in general (e.g., what is expected of me? why is this person doing this?, etc.) may be guiding their imitative behavior.

Conclusions

Findings from this study offer several replications and clarifications relative to the occurrence of overimitation. As prior studies have found, overimitation occurs more often when actions are intentional, increases during the preschool years, and persists when intentional irrelevant actions occur after goal achievement. Further, overimitation is related to self-regulatory skills when an end goal is obvious and when one has a conscious perspective to "copy actions" they are more likely to engage in overimitation. Taken together, it is proposed that overimitation is influenced by inferences of *purpose* and may reflect true "rational" imitation.

In considering rational imitation, Csibra and Gergely (2009) find infants will produce inefficient actions less often when there is a "rational" reason as to why the inefficient action occurred (e.g., model's hands occupied when model used head to turn on a light) and thus the authors propose infants can rationally imitate. However, Paulus (2012) suggests infants are not really capable of engaging in rational imitation and instead proposes three skills are necessary for one to engage in true "rational" imitation: 1) perceive action capabilities of others, 2) reason about self and others, and 3) engage in counterfactual reasoning (the ability to think about situations hypothetically). Paulus (2012) outlines developmental trends for each of these skills and all three undergo substantial change during the preschool years and are not present in infancy. The last skill proposed by Paulus (2012) seems most relevant to the developmental trend of overimitation. For example, Beck, Riggs, and Gorniak (2009) find that children's receptive vocabulary and inhibitory control predicted their engagement in counterfactual reasoning whereas no relationship emerged between age and children's performance on counterfactual reasoning tasks. Specifically the ability to reason with a principle that one recognizes as false to make a valid conclusion is one example of counterfactual reasoning (Beck et al., 2009). In the current study, children's self-regulation predicted general overimitation and it may be that this relationship is mediated by children's emerging reasoning abilities. For example, in the current study the after goal intentional action on the trap-tube was flipping the latch. It may be that humans have an automatic assumption that "all intentional actions have purpose." Flipping the latch was intentional in the current study and thus the implicit reasoning question becomes, *did flipping the latch have a purpose?* Preschool aged children are capable of identifying actions as unnecessary and toddlers tend to omit actions unrelated to the goal when a goal is obvious (Carpenter et al., 2009; Lyons et al., 2007). Children with greater inhibitory control may recognize flipping the latch has no purpose for the task, but perform it anyway based on the automatic principle that all intentional actions have purpose.

When younger preschoolers engage in observational learning of a novel task, they may consider intended goals relative to that tangible task and guide their behavior to achieve the intended goal. While older preschoolers monitor intended goals relative to a task, they may also start to consider other possible goals such as goals of the interaction or learning experience as a whole. In addition, the FB relation to relevant-only actions in the MCI condition and participant response patterns found in this study, Horner and Whiten (2005), and McGuigan et al. (2011) also support that overimitators may be considering the model's actions within the context of the full setting. The copy action responses of all three studies suggest copying a model's actions was perceived to be "necessary" to achieve an unstated social goal—not causally necessary to achieve the task itself. "Social goal" as it is used here refers to recognition of *purpose*—beyond inference of a model's intent behind actions and independent of the task.

Thus, it is proposed that there may be automatic encoding when one engages in overimitation and overimitation may be an adaptive learning technique in novel situations. However it is proposed that humans automatically encode purpose in general and this purpose is not limited to a physical causal purpose (Lyons et al., 2007; 2011; McGuigan et al., 2011). In thinking of Paulus' (2012) argument, overimitation may be evidence of true rational imitation and may occur because of a human tendency to make rational sense of our world and the behaviors of others. It could be that once humans have developed the ability to reason rationally, it is difficult to stop thinking rationally and thus when another person does something intentionally—there must be a reason why. This claim is supported when considering the age trend in overimitation, the extension of overimitation to after goal actions, the persistence of overimitation after repeated trials, and participant reported task understanding. It is suggested that there is a shift in how humans engage in observational learning during the preschool years but further investigation of the processes driving this change is necessary. The current findings suggest children's developing self-regulatory skills play a role in their changing imitative behaviors. In addition the findings suggest FB understanding may be important for the interpretation of erroneous behaviors and application of this interpretation influences imitative behavior. Overimitation should be further explored with older child populations, more trials, and with non-tool use tasks as these variations may yield different patterns in the frequency of overimitation. In addition, the inclusion of participant exit interviews, executive function, counterfactual reasoning, and social cognitive measures will provide a broader representation of the processes supporting overimitation.

More broadly, the current study contributes to understanding the processes involved in theories of social learning. There are several perspectives relative to the importance of imitation and its importance for the development of culture in our species (Tennie et al., 2009; Whiten et al., 1996).These perspectives suggest imitation is important for our understanding of the physical world (Lyons et al., 2011) and our social world such as learning socially acceptable behaviors (Over & Carpenter, 2011). While several have suggested social cognitive and executive functioning skills play a role in social learning (Flynn, 2010; Lyons et al., 2007; Tomasello et al., 1993; Williamson et al., 2008) the direct examination of such skills as they relate to social learning is sparse. The ability to engage in imitation clearly expands as evidenced by studies on infant imitation (Brugger et al., 2007; Carpenter et al., 1998; 2005; Meltzoff, 1995) and more recent studies on the emergence of overimitation in preschoolers (Gardiner et al., 2011; Lyons et al, 2007; McGuigan et al., 2011). These changes in imitation correspond with developments in social cognitive and executive functioning abilities and the current study highlights how these skills play a role in the emergence of overimitation.

APPENDIX A
TRAP-TUBE TASK

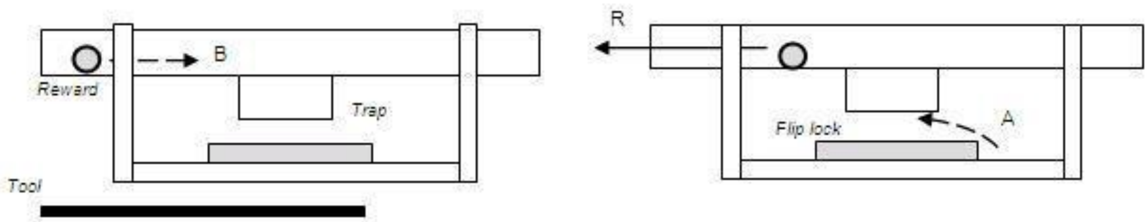

Figure A-1. Trap-tube apparatus and action components. (A) Irrelevant action after object retrieval: flip lock open. (B) Irrelevant action before object retrieval: insert tool, push object towards trap. (R) Relevant (correct) action: insert tool, push object away from trap, retrieve object. Modified version Horner and Whiten (2007) trap-tube.

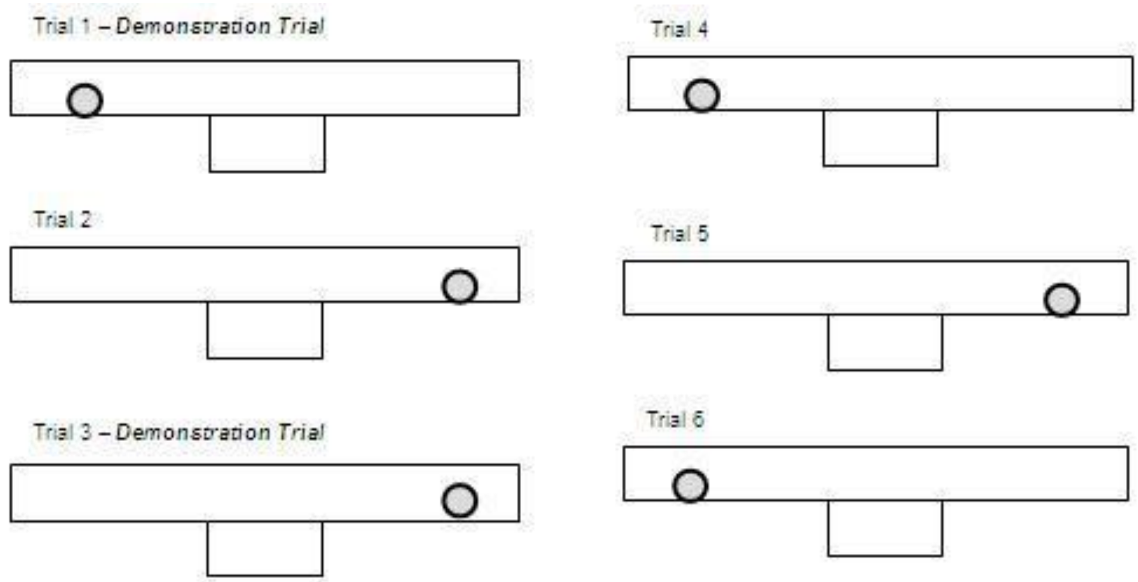

Figure A-2. Trap-tube object placement (modeled after Horner & Whiten, 2007)

APPENDIX B
PUZZLE-BOX TASK

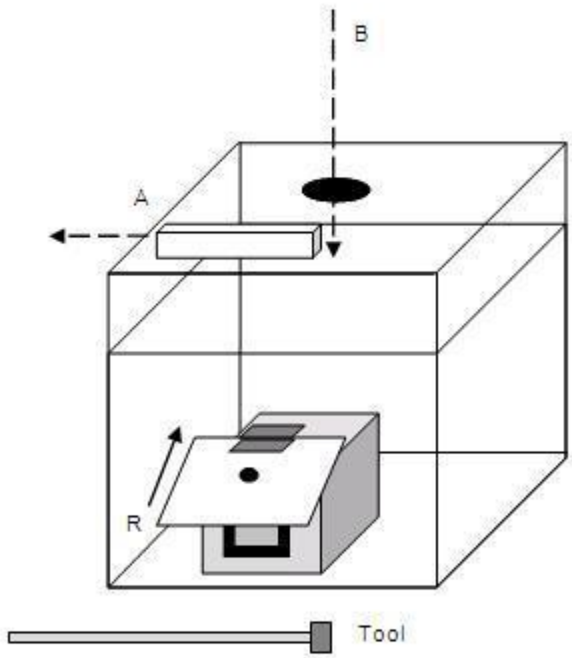

Figure B-1. Modified puzzle-box and action components. (A) Irrelevant action: push block. (B) Irrelevant action: insert tool, tool taps internal barrier of top box. (R) Relevant (correct) action: lift door, insert tool, retrieve object. Modified version of McGuigan et al. (2011) puzzle-box.

REFERENCE LIST

Beck, S.R., Riggs, K.J., & Gorniak, S.L. (2009). Relating developments in children's counterfactual thinking and executive functions. *Thinking and Reasoning, 15,* 337–354.

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the right thing: Infants' selection of actions to imitate from observed event sequences. *Child Development, 78*(3), 806-824.

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology, 33,* 205–228.

Cameron Ponitz, C. E., McClelland, M. M., Jewkes, A. M., Connor, C. M., Farris, C. L., & Morrison, F. J. (2008). Touch your toes! Developing a behavioral measure of preschool self-regulation. *Early Childhood Research Quarterly, 23*, 141-158. doi:10.1016/j.ecresq.2007.01.004

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology, 28*(2), 595–616.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior & Development, 21*(2), 315-330. doi: 10.1016/S0163-6383(98)90009-1

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve and 18-month-olds copy actions in terms of goals. *Developmental Science, 8*(1), F13-F20. doi: 10.1111/j.1467-7687.2004.00385.x

Csibra, G. & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences, 13*, 148-153. doi:10.1016/j.tics.2009.01.005

Corriveau, K. H., Meints, K, & Harris, P. L. (2009). Early tracking of informant accuracy and inaccuracy. *British Journal of Developmental Psychology, 27*(2), 331-342. doi: 10.1348/026151008X310229

DiYanni, C., & Kelemen, D. (2008). Using a bad tool with good intention: Young children's imitation of adults' questionable choices. *Journal of Experimental Child Psychology, 101*, 241–261.

Dunn, L. M., & Dunn, D. M. (2007). *Peabody Picture Vocabulary Test* (4th ed.). Circle Pines, MN: American Guidance Service.

Flynn, E., (2007). The role of inhibitory control in false belief understanding. *Infant and Child Development, 16,* 53-69. doi: 10.1002/icd.500

Flynn, E. (2010). Underpinning collaborative learning. In B. W. Sokol, U. Müller, J. I. M. Carpendale, A. R. Young, & G. Iarocci, (Eds.), *Self and social regulation: Social interaction and the development of social understanding and executive functions*, (pp. 312-336). New York, NY, US: Oxford University Press.

Flynn, E., & Whiten, A. (2008). Cultural transmission of tool use in young children: A diffusion chain study. *Social Development, 17*(3), 699-718. doi: 10.1111/j.1467-9507.2007.00453.x

Flynn, E., & Whiten, A. (2012). Experimental 'microcultures' in young children: Identifying biographic, cognitive, and social predictors of information transmission. *Child Development, 83*(3), 911-925. doi: 10.1111/j.1467-8624.2012.01747.x

Gardiner, A. K., Greif, M. L., & Bjorklund, D. F. (2011). Guided by intention: Preschoolers' Imitation reflects inferences of causation. *Journal of Cognition and Development, 12*(3), 355-373. doi: 10.1080/15248372.2010.542216

Garon, N., Bryson, S. E., & Smith, I.M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31-60. doi: 10.1037/0033-2909.134.1.31

Gergely, G., Bekkering, H. & Király, I. (2002). Rational imitation in preverbal infants. *Nature, 415*, 755. doi:10.1038/415755a

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3½ -7 years old on a stroop-like day-night test. *Cognition, 53*(2), 129-153. doi: 10.1016/0010-0277(94)90068-X

Horner, V. & Whiten, A. (2005). Causal knowledge and imitation/emulation switching in chimpanzees (Pan troglodytes) and children (Homo sapiens). *Animal Cognition, 8,* 164-181. doi:10.1007/s10071-004-0239-6

Horner, V., & Whiten, A. (2007). Learning from others' mistakes? Limits on understanding a trap-tube task by young chimpanzees (pan troglodytes) and children (homo sapiens). *Journal of Comparative Psychology, 121*(1), 12-21. doi:10.1037/0735-7036.121.1.12

Kenward, B. (2012). Over-imitating preschoolers believe unnecessary actions are normative and enforce their performance by a third party. Journal of Experimental *Child Psychology, 112,* 195–207. doi:10.1016/j.jecp.2012.02.006

Lyons, D. E., Damrosch, D. H., Lin, J. K., Macris, D. M., & Keil, F. C. (2011). The scope and limits of overimitation in the transmission of artefact culture. *Philosophical Transactions Royal Society B: Biological Sciences, 366,* 1158-1167. doi: 10.1098/rstb.2010.0335

Lyons, D. E., Young, A. G., & Keil, F. C. (2007). The hidden structure of overimitation. Lyons, *Proceedings of the National Academy of Sciences, 104*(50), 19751-19756.

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43*(4), 947-959. doi: 10.1037/0012-1649.43.4.947

McGuigan, N., Makinson, J. & Whiten, A. (2011). From over-imitation to super-copying: adults imitate causally irrelevant aspects of tool use with higher fidelity than young children. *British Journal of Psychology, 102*, 1–18. doi:10.1348/000712610X493115.

McGuigan, N., Whiten, A., Flynn, E. & Horner, V. (2007). Imitation of causally opaque versus causally transparent tool use by 3- and 5-year-old children*. Cognitive Development, 22*, 353–364. doi:10.1016/j.cogdev.2007.01.001

Meltzoff, A. (1995). Understanding the intentions of others: Reenactment of intended acts by 18 month-old children. *Developmental Psychology, 31*, 838–850. doi:10.1037/0012-1649.31.5.838

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., & Wager, T.D. (2000). The unity and diversity of executive functions and their contributions to complex ‘‘frontal lobe’’ tasks: A latent variable analysis. *Cognitive Psychology 41***,** 49–100. doi: 10.1006/cogp.1999.0734

Nagell, K., Olguin, R. S., & Tomasello, M. (1993). Processes of social learning in the tool use of chimpanzees (*Pan troglodytes*) and human children (*Homo sapiens*). *Journal of Comparative Psychology, 107*(2), 174-186.

Nielsen, M. (2008). The social motivation for social learning. *Behavioral and Brain Sciences, 31,* 33. doi:10.1017/S0140525X0700324X

Over, H., & Carpenter, M. (2011). Putting the social into social learning: Explaining both selectivity and fidelity in children’s copying behavior. *Journal of Comparative Psychology*. doi:10.1037/a0024555.

Paulus, M. (2012). Is it rational to assume that infants imitate rationally? A theoretical analysis and critique. *Human Development, 55*, 107-121. doi:10.1159/000339442

Robinson, E. J., & Nurmsoo, E. (2009). When do children learn from unreliable speakers? *Cognitive Development, 24*(1), 16-22. doi:10.1016/j.cogdev.2008.08.001

Simpson, A., & Riggs, K. J. (2011). Three- and 4-year-olds encode modeled actions in two ways leading to immediate imitation and delayed emulation. *Developmental Psychology, 47*(3), 834–840.

Tennie, C., Call, J., & Tomasello, M. (2009). Ratcheting up the ratchet: On the evolution of cumulative culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*, 2405–2415.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioral and Brain Sciences, 16,* 495-552.

Want S. C., & Harris, P. L. (2001). Learning from other people's mistakes: causal understanding in learning to use a tool. *Child Development*, *72*, 431–443. doi:10.1111/1467-8624.00288

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development, 72*, 655-684. doi: 10.1111/1467-8624.00304

Wellman, H. M. & Liu, D. (2004). Scaling of theory-of-mind tasks. *Child Development*, *75* (2), 523–541.

Whiten, A., Custance, D. M., Gomez, J. C., Teixidor, P., & Bard, K. A. (1996). Imitative learning of artificial fruit processing inchildren (*Homo sapiens*) and chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology, 110*(1), 3-14.

Williamson, R. A., Meltzoff, A. N., & Markman, E. M. (2008). Prior experiences and perceived efficacy in 3-year-olds' imitation. *Developmental Psychology, 44*(1), 275-285. doi: 10.1037/0012-1649.44.1.275

Ziv, M., & Frye, D. (2004). Children's understanding of teaching: The role of knowledge and belief. *Cognitive Development, 19,* 457-477. doi:10.1016/j.cogdev.2004.09.002

BIOGRAPHICAL SKETCH

Jennifer Tamargo was born and raised in Jacksonville, Florida. She graduated from Bishop Kenny High School and received her Bachelor of Arts in psychology (minor social welfare) from the University of North Florida in 2004. In 2011, she completed a graduate certificate in social science methodology and earned her Ph.D. in developmental psychology from the University of Florida in 2013.

As an undergraduate, she held internships with Head Start and the Jacksonville Children's Commission (JCC). Upon graduation, she joined the JCC full-time as a developmental screener for low-income children. After two years with this agency she began the developmental psychology doctorate program at the University of Florida. Primarily, she is interested in the development of social cognition and self-regulation and the roles of these skills in preschoolers' learning development. Her master's thesis addressed the influence of false belief understanding and self-regulation on preschoolers' engagement in learning from direct instruction.

As she continued her studies in developmental psychology she also became interested in evaluation research. She created an evaluation plan for the Early Learning Coalition of Alachua County to evaluate their childcare Intensive Quality Improvement System and assisted in a formative evaluation of summer programs in Duval County with the RAND Corporation. Currently she works with the RAND Corporation as an adjunct research associate for a project assessing the effectiveness of voluntary summer programs on stemming children's summer learning loss.