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# Selective Learning From Others:
# Children's Motive-based Inferences About an Individual's Credibility

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# Selective Learning From Others:
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**by**

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# Dedication

This dissertation is dedicated to my beloved parents, Lourdes and Bolivar, for their infinite support and encouragement.

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# Selective Learning From Others:
# Children's Motive-based Inferences About an Individual's Credibility

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People are highly attentive to others' motivations when assessing credibility. For instance, political candidates who appear to act against self-interests (e.g., praise an opponent) are considered more trustworthy than those who act in self-serving ways (e.g., attack an opponent or praise themselves). How early in life does self-interest based trust/skepticism develop? A main goal of the dissertation was to test whether children's trust behaviors are influenced by self-interest cues.

In two studies, adult and child participants ($N$ = 136) played a finding game with another player. The other player served as the informant for the location of hidden prizes. Participants, seated in another room, had to guess (from two potential locations) where they thought the prize actually was. Informants were incentivized via reward rules to be truthful (informants only benefitted if participants guessed correctly) or deceitful (informants only benefitted if participants guessed incorrectly). If participants can infer the informants' credibility solely from reward rules associated with self-interest, they should trust the other player less often if interests conflict.

A second goal was to identify socio-cognitive skills that may be associated with people's ability to (mis)trust selectively. Some of the skills that were investigated

include: participants' ability to remember and manipulate information, awareness that people can infer others' intentions, understanding that people may arrive at different conclusions when reasoning about the same stimuli, and general intuitions about whether others are likely to keep their word.

Like adults, children playing the finding game sometimes adjusted their behavior flexibly and strategically to match self-interests—without having prior expectations about another individual's predisposition to cooperate. Specifically, children and adults trusted their partner more often when the game incentivized cooperation versus competition. However, our results also suggest that children's ability to benefit from cooperation incentives has not fully developed in the elementary school years: even 9-year-olds seemed more suspicious of partners with common interests than did adults. Children's working memory skills predicted whether they would perform similarly to adults. Taken together, these findings significantly advance our understanding of children's trust judgments as guided by their self-interest based inferences.

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# 1. Introduction

Many contemporary theories of developmental psychology have continued Piaget's conception of children as autonomous theorists or "little scientists" who will arrive at their own notions of the world by actively exploring the environments, and gathering evidence about their naïve theories (e.g., Carey, 1985; Gopnik & Meltzoff, 1997; Gopnik & Wellman, 1994; Wellman & Gelman, 1997). It is often assumed that theory formation about domains such as permanence of objects and conservation of quantity will mostly depend on the child's first-hand observations. Moreover, children will update these provisional theories as they find evidence in favor and against previous conceptions. Another group of researchers argue that human minds are highly constrained innately (i.e., so that we can only formulate a rather small set of possible representations and rules; e.g., Barkow, Cosmides, & Tooby, 1992; Pinker, 1989; Spelke, Breinlinger, Macomber, & Jacobson, 1992).

Lately, a complementary line of research has received increasing attention: children also appear to construct theories based on direct instruction, and this reliance on others' epistemic guidance can be considered "a deep-seated part of our psychological design" (Harris, 2002, p. 316). Indeed, it is easy to think about topics that people learn about even when direct experience is not usually an option: germs, black holes, or the brain; verifying birth dates, one's biological parents' identity, or the shape of the earth. And yet children will develop understandings of all these topics. This reliance on others, however, does not imply that children are helplessly gullible, believing and doing everything that they are told; with age, children develop skills at judging the credibility of

potential sources (Koenig & Harris, 2005). In this work, I examine both previous findings that address children's selective learning from others, as well as new horizons of research on people's endorsement of others' instruction. Specifically, I will review findings on children's use of contextual information—such as an information source's competence, social attributes, and motivational cues—to decide whether to accept that source's teachings. I will also summarize what is currently known about individual differences in socio-cognitive development that affect children's selective learning.

### 1.1. LEARNING FROM OTHERS

Humans, unlike any other species, learn to attain a goal by reproducing strategies previously used by their conspecifics, who they perceive as intentional agents like themselves. This ability has allowed for cumulative cultural learning wherein a group can invent symbolic artifacts that another can learn, improve and pass on to the next generation (Tomasello, 2000). However, this adaptive way of transmitting knowledge has at the very least two requirements: Firstly an individual has to be able to recognize another as an intentional being with whom to share goals; secondly, this individual has to believe that the instructed strategy is effective for obtaining the goal that is being pursued. For example, when trying to learn the function or location of an object, the individual has to recognize the instructive intention of a potential information source. However, it is equally important to be able to assume that the information provided is accurate, and that it can be implemented as an appropriate strategy to fulfill the goal of using or finding the object. Recently, a growing body of research has examined multiple factors that allow children to determine whether a source is credible and/or worth

learning from (e.g., Birch, Vauthier & Bloom, 2008; Harris, 2007; Koenig, Clement, & Harris, 2004).

### 1.1.1. Competence

To date, most of the research examining children's selective learning from others has used a "history of competence" methodology. Specifically, prior to testing their preferences children are provided with behavioral evidence of a source's reliability in the task at hand (e.g., for a word learning task, showing a source labeling accurately/inaccurately).

Starting in infancy, children can track and make use of a target's apparent competence to inform their learning decisions. Chow, Poulin-Dubois, and Lewis (2008) presented 14-month-olds with a target who expressed happiness and excitement after looking inside a container that either had an interesting toy (reliable looker condition) or was empty (unreliable looker condition). The question was whether children' gaze-following in a subsequent task depended on their knowledge of the target's prior competence, gained during the container task. Once the history of reliability had been established, the target leaned sideways to look at an object hidden behind a barrier that the children had to go around to see. Gaze following was measured by whether the infant proactively moved a short distance to gain visual access to the back of the barrier that the target's gaze was directed to. Children in the reliable looker condition were significantly more likely to follow the target's gaze than those who saw the target previously expressing excitement for an empty container. These results suggest that children were able to use the target's apparent competence to selectively choose whose gaze to follow.

Young children also appear to take into account a target's competence when deciding whether or not to imitate an instrumental behavior. Using a procedure similar to the one described above, Poulin-Dubois, Brooker, and Polonia (2011) presented 14-month-olds with a target who was portrayed as either reliable or unreliable in the emotional referencing task described above. Then, the target performed an atypical behavior (i.e., illuminated a light using her forehead), and, after placing the light in front of the infant, observed whether the infant reproduced this unusual behavior. As expected, a greater number of children imitated the behavior when the target had been reliable rather than unreliable. Likewise, Zmyj, Buttelmann, Carpenter, and Daum (2010) found that 14-month-olds were more likely to imitate a target's subsequent behavior (i.e., using his/her forehead to illuminate a light) when the target previously had been portrayed as competent (e.g., putting a shoe on the foot) as opposed to incompetent (e.g., putting a shoe on the hand) when using familiar objects. Finally, 16-month-olds are attentive to the competence of a target who labels familiar objects (e.g., a ball) truthfully or falsely; children will look longer (as if being more surprised) and try to correct a target more often if she labels an object falsely (e.g., calls the ball a "shoe") rather than truthfully (e.g., calls the ball a "ball"; Koenig & Echols, 2003).

Children's use of competence continues to develop and to play a role in their learning decisions during toddlerhood. For instance, 2-year-old children become attentive to more subtle cues of competence such as a target's expressed confidence when deciding who to imitate. Specifically, 2-year-olds will prefer to imitate a target who shows confidence (e.g., shoulders back, knowledgeable facial expression) as opposed to

uncertainty (e.g., shoulder shrugging, puzzled facial expression) when performing an action (e.g., using a novel tool to move other objects; Birch, Akmal & Frampton, 2010). Further, because of the greater understanding of verbal communication that characterizes this age, toddlers continue to monitor the perceived competence of targets based not only on targets' actions, but also claims. For example, 24-month-olds will be less likely to remember novel second labels for familiar objects (e.g., using "blicket" to refer to a shoe) when taught by incompetent versus competent targets, that is, from a target who either previously labeled an initial group of familiar objects falsely (called a duck a "cat") or expressed ignorance for familiar objects ("I don't know what that is"), versus one who labeled the objects truthfully. However, this epistemic selectivity is still developing, as toddlers will sometimes accept first labels for novel objects even when taught by seemingly incompetent targets (Koenig & Woodward, 2010; Krogh-Jespersen & Echols, 2012).

Despite 2-year-olds' relative success in distinguishing between competent and incompetent targets, their selective learning is not fully developed. For example, when 30-month-olds try to identify the location (out of three possible ones) of an object that they initially hid—but was later moved to another location by a second experimenter in their absence—they will search in the new location indicated by a bystander target, even when the target has offered them false information about other objects' locations (Ganea, Koenig & Gordon Millett, 2011). A similar lack of selectivity (i.e., children's endorsements of previously incompetent sources) is observed when false claims correspond with 30-month-olds' naïve theories (i.e., an expectation that unsupported

objects fall straight down; Jaswal, 2010). Luckily there are strategies that can improve young children's performance involving object-locating tasks, such as giving them an opportunity to gain confidence in their own predictions (see Jaswal, 2010; Experiment 4; Ma & Ganea, 2010; Experiments 2-3).

During the preschool years, children's attentiveness to competence as a cue for credibility becomes appreciably more sophisticated. Whereas 2-year-olds can keep track of a single labeler's behavior (Koenig & Woodward, 2010; Krogh-Jespersen & Echols, 2012), 3-year-olds are able to monitor two labelers' actions simultaneously. Further, these children preferentially endorse names for novel objects provided by the previously competent over incompetent target (e.g., Birch, Vauthier & Bloom, 2008; Koenig, Clement & Harris, 2004). Also, 3-year-olds remember the competence of the targets, and continue to use this information to guide their word learning up to a week after initial exposure (Corriveau & Harris, 2009a). Starting in their 4$^{th}$ year of life, children can efficiently monitor the relative competence of different targets (e.g., target 1 being a reliable labeler ¾ of the time vs. target 2 being reliable ¼ of the time; Pasquini, Corriveau, Koenig & Harris, 2007), as well as selectively imitate competent over incompetent targets in rule-based games (Rakoczy, Warneken & Tomasello, 2009). Finally, 5- but not 4-year-olds take into account a target's history of purposeful trickery to selectively learn the location of a hidden prize. Specifically, when presented with a target who either previously helped or tricked another player in a sticker finding game, 5-year-olds are more likely to endorse the previously helpful target's subsequent claims (Vanderbilt, Liu, & Heyman, 2011).

In addition, children are "flexible" in their attentiveness to—and inferences about—a source's history of competence and credibility. For instance, Koenig and Echols (2003) presented 16-month-olds with a target who labeled objects (that were familiar to the child) either truthfully or falsely. However, the circumstances under which the target labeled the objects varied by visual access (i.e., the target was facing directly toward or away from the objects). Infants looked longer (an indication of greater surprise) when an untruthful target mislabeled objects that were in front versus behind him or her. Similarly, infants correctively labeled (i.e., attempted the "correct answer") more often when a target mislabeled objects in front of him or her. Thus, by 16 months of age infants attend not only to unfavorable outcomes (e.g., apparent incompetence), but also to circumstances that explain targets' mental states.

Children's sensitivity to the causes behind instances of incompetence extends to their learning decisions. Nurmsoo and Robinson (2009a) introduced 3- to 6-year-old children to a puppet with whom they played a visual identity game. In the uninformed condition the puppet first misidentified several hidden objects' properties (e.g., color) while being unable to see the objects. In the informed condition the puppet also misidentified the objects' properties, except that it had full (visual) access to the objects. In subsequent trials, during which the puppet was better informed, children endorsed the puppet's subsequent claims more often if it had previously erred for reasonable (poorly informed) rather than unreasonable (erring while fully informed) causes (but see Nurmsoo & Robinson, 2009b, for different outcomes in novel labeling tasks).

Interestingly, children's apparent reasoning about knowledge states also applies to instances of positive outcomes (e.g., competence): 4- and 5-year-olds, but not 3-year-olds, differentially favor a target who proved to be competent by its own merits (labeling objects truthfully without help) over another who appeared competent because of the assistance of a third party (someone whispered to it the correct labels for the objects; Einav & Robinson, 2011). Finally, children are attentive to indirect cues of competence, such as expertise (Sobel & Corriveau, 2010): Four-year-olds heard a target correctly predict the function of one type of object (e.g., those activating a machine's green light) but claiming ignorance about other objects (i.e., responded "I don't know" for objects that activated the machine's red light). Children endorsed subsequent information in a different domain (e.g., names of objects) when provided by the target, but only if related to the target's particular domain of knowledge (e.g., the "green" expert provides labels for objects that trigger the green light).

In summary, from very early in development children show the ability to be attentive to a target's competence. By 14 months of age children start making use of this information to decide who to imitate and learn from. In the next 3 to 5 years of life children's ability to infer credibility from competence increases significantly, allowing them to monitor several targets at once, retain this information longer, prefer helpful over deceiving sources, and flexibly reason about causes for erring.

### 1.1.2. Social cues

The aforementioned studies make an invaluable contribution to the literature on children's selective learning from others. However, in those studies it is assumed that

people will have access to critical information such as a source's previous history of reliability. Though ideal, in real life it is often not possible to determine if someone has been consistently competent in the past (e.g., when asking strangers for directions to a conference in an unfamiliar location). A number of studies have shown that when uncertain about a source's actual competence, children do not perform randomly, but instead make use of social cues such as majority consensus (Corriveau, Fusaro, & Harris, 2009), and familiarity (Corriveau & Harris, 2009b) to decide from whom to learn.

Evidence of children's receptiveness to social attributes (indirectly) related to credibility can be found during the preschool years. For instance, 3-year-olds will pay close attention to social consensus (i.e., three targets overtly supporting a statement vs. one dissenter who does not), and will preferentially accept information offered by non-dissenting over dissenting targets (Corriveau et al, 2009). Similarly, when deciding who to trust 4-year-olds will take into account whether bystanders nod their heads in agreement or shake their heads in disagreement when listening to each of two targets provide contrasting information; moreover, children will prefer to learn from the socially 'endorsed' target even when the bystanders are no longer present (Fusaro & Harris, 2008). Finally, children seem to be influenced by a model's 'prestige'; that is, after watching bystanders stand between two targets and preferentially attend to only one of the targets, 3- to 4-year-olds will take into account the targets' spectators (or lack thereof) and will prefer to imitate the 'prestigious' over the non-prestigious target's actions (Chudek, Heller, Birch & Henrich, 2012).

In addition to paying attention to social cues based on others' feedback (e.g., consensus), children also use social cues that are inherently characteristic of source, such as familiarity and similarity. For example, when faced with interpersonally similar and dissimilar sources whose reliability is unknown, 3- to 5-year-olds will preferentially accept information provided by similar over dissimilar targets (Reyes-Jaquez & Echols, 2013). Other instances in which children effectively use social attributes to infer a target's credibility include preferentially learning from benevolent over malevolent (Mascaro & Sperber, 2009), familiar over unfamiliar (Corriveau et al., 2009; Corriveau & Harris, 2009b), native-accented over foreign-accented (Kinzler, Corriveau & Harris, 2011), and adult over child targets (Jaswal & Neely, 2006; Rakoczy, Hamann, Warneken & Tomasello, 2010, imitation task; but see VanderBorght & Jaswal, 2009; Rakoczy, Hamann, Warneken & Tomasello, 2010, labeling task, for contrasting findings).

Arguably, children's systematic preference for learning from targets with these attributes can be an adaptive strategy, due to socially proximal targets (e.g., familiar, similar) being considered more likely to cooperate (Antal, Ohtsuki, Wakeley, Taylor, & Nowaka, 2009) and less likely to deceive (Whiten & Byrne, 1988) than distal ones.

In summary, in the absence of reliability information, even preschoolers are able to infer a source's credibility from its social attributes; that is, they tend to base their learning decisions on social cues readily available in the environment, such as consensus and interpersonal similarity.

### 1.1.3. Motivations

Motives are another important piece of information that people are highly attentive to when assessing credibility. For instance, political candidates who appear to act against self-interests (e.g., praise an opponent) are considered more credible than those who act in self-serving ways (e.g., attack an opponent or praise themselves; Combs & Keller, 2010). Further, adults are warier about claims made by sources when monetary self-interest is involved. Specifically, adults are more likely to accept information from a partner about the outcome of a coin flip when interests are common (i.e., both benefit from the participant making a correct guess about the outcome) rather than conflicting (i.e., only one of the partners benefits from a correct guess; Boudreau, McCubbins, & Coulson, 2009; also see Balliet & Van Lange, 2012, for a review). Whether children effectively use motives to infer credibility is perhaps the least explored inquiry in the selective learning literature. As briefly mentioned, there have been studies testing whether children differentially learn from helping over deceiving targets (Vanderbilt et al, 2011; see also Jaswal, Croft, Setia, & Cole, 2010; Mascaro & Sperber, 2009).

The main limitation of these studies is that, because children have key information about a partner's previous actions or reputation (e.g., having deceived another partner during a game), children's learning choices could be explained by behavioral rather than motive based inferences. Specifically, when competing in a game, children could *associate* the other player with a particular outcome and choose accordingly (e.g., the other player always points to the wrong box; I should choose the

opposite). Indeed, there is initial evidence that children place more weight on outcome versus intent information (Liu, Vanderbilt, & Heyman, 2013).

To my knowledge, only two studies have presented children with motivational cues exclusively (i.e., without also providing behavioral evidence)—hence avoiding the above ambiguity when interpreting the results. In these studies children are simply asked to make explicit judgments about others' credibility: when presented with scenarios of nonmaterial gains (e.g., social desirability), even preschoolers may judge as less credible someone who acts in line with (e.g., reports feeling sick, does not want to go to camp) rather than against (e.g., reports feeling sick, wants to go to camp) self-interests (Gee & Heyman, 2007). Conversely, when evaluating scenarios with material rewards (e.g., there is a prize for winning a race), children younger than 7 years fail to show an understanding that self-interest affects credibility; that is, 5- to 6-year-olds judge as more credible someone who makes a self-regarding statement (e.g., claiming to have won a race whose outcome was ambiguous, to win a prize) rather than against self-interests (e.g., claiming to have lost the close race; Mills & Keil, 2005).

Although valuable, these findings are constrained in that children's explicit awareness of a source's credibility does not guarantee that they selectively learn from that source (Mills, 2013). For example, Vanderbilt et al (2011) found that 4-year-olds identified informants who previously provided the correct (vs. incorrect) location of stickers as more motivated to help (i.e., explicit awareness). However, they failed to integrate that knowledge to avoid learning from deceitful sources (i.e., continued to accept misleading information from that source). Thus, it remains unknown whether

children demonstrate behaviorally (i.e., by deciding whether or not to endorse a claim) an understanding of the relation between self-interest and credibility. This is important because, in the real world, judgments of credibility are typically revealed through actual behavior. A goal of this dissertation was to test whether children's learning decisions are influenced by self-interest cues exclusively.

### 1.1.4. Individual differences

To date very few studies have examined individual differences in socio-cognitive development that affect children's selective learning. Further, to my knowledge these studies have focused solely on the relation between theory of mind development and selective learning (e.g., Fusaro & Harris, 2008; Pasquini et al., 2007; Vanderbilt et al., 2011). For example, Fusaro and Harris (2008) found that children who performed better on false belief tasks were more likely to use an informant's previous reliability to evaluate that informant's future claims (but see Pasquini et al., 2007, for null findings). In light of this limitation in the literature, another goal when designing my dissertation was to identify additional socio-cognitive abilities that develop to support people's motive-based credibility inferences.

## 2. Experiment 1

A first experiment was conducted to validate a plausible methodology for testing whether children's learning and instructive behaviors are influenced by self-interest cues exclusively. Building on a procedure used by Boudreau and colleagues with adults (2009, see above), participants played a finding game with (what they believed was) another player. Half of the time the participants served as informants for hidden prizes' locations; for the remaining half the "other" player was the informant. Informants were incentivized via reward rules to be truthful or deceitful. The assumption was that without a basis for pre-judgment (e.g., informants' trickery, negative traits), informants' current credibility potentially could be inferred from reward rules—leading participants to believe the other player less often if interests conflicted. When acting as informants, it was expected that participants' instructions would be less truthful when interests conflicted.

There are two possibilities regarding the age at which children are able to integrate self-interest information to their learning and instructive behaviors. Firstly, 7-year-olds (the earliest age at which children show an understanding of the relation between reward-based self-interest and credibility; Mills & Keil, 2005) could selectively learn from informants guided exclusively by self-interest information. Conversely, it may be too cognitively taxing for 7-year-olds to detect, remember, and integrate these cues into their learning decisions (see Vanderbilt et al, 2011). These two possibilities also apply to children's instructions when acting as informants. To distinguish these possibilities, 7-year-olds participated in the study. Nine-year-olds were included for their relatively greater capacity to integrate multiple cues (e.g., Lagattuta, Sayfan, & Blattman,

2010). Adults were selected for their documented success in similar tasks (e.g., Boudreau, McCubbins, & Coulson, 2009).

## 2.1. METHOD

### 2.1.1 Participants

Twenty-eight 7-year-olds ($M_{age}$ = 7 years 4 months; range: 6 years 1 months – 7 years 10 months; 14 females), twenty-eight 9-year-olds ($M_{age}$ = 9 years 2 months; range: 8 years 1 months – 9 years 11 months; 14 females), and forty (university student) adults ($M_{age}$ = 19 years; 20 females) were recruited using a university's participant databases. The majority of participants were Caucasian and from middle-class families.

### 2.1.2. Materials

"Smarties" candy and tickets to $25/$50 Amazon.com gift card drawings were used as prizes for children and adults, respectively. Participants sent messages or guessed about prizes' location via a computer keyboard with a blue and a red key, which matched the colors of two origami boxes used to hide prizes.

### 2.1.3. Procedure

Participants played a game consisting of four within-subjects conditions: guesser-common interests, guesser-conflicting interests, witness-common interests, and witness-conflicting interests.

Participants played each of two separate roles: witness and guesser. When in the witness role, participants observed the experimenter hide a prize (candy/drawing ticket) under a blue or red box, and sent a text message (via the computer) to a guesser about the

prize's location. Participants in the guesser role had to decide—after receiving the witness's message—where they thought the prize was actually hidden (see Figure 1). Witnesses and guessers initially learned that it was up to witnesses to send true or false information.

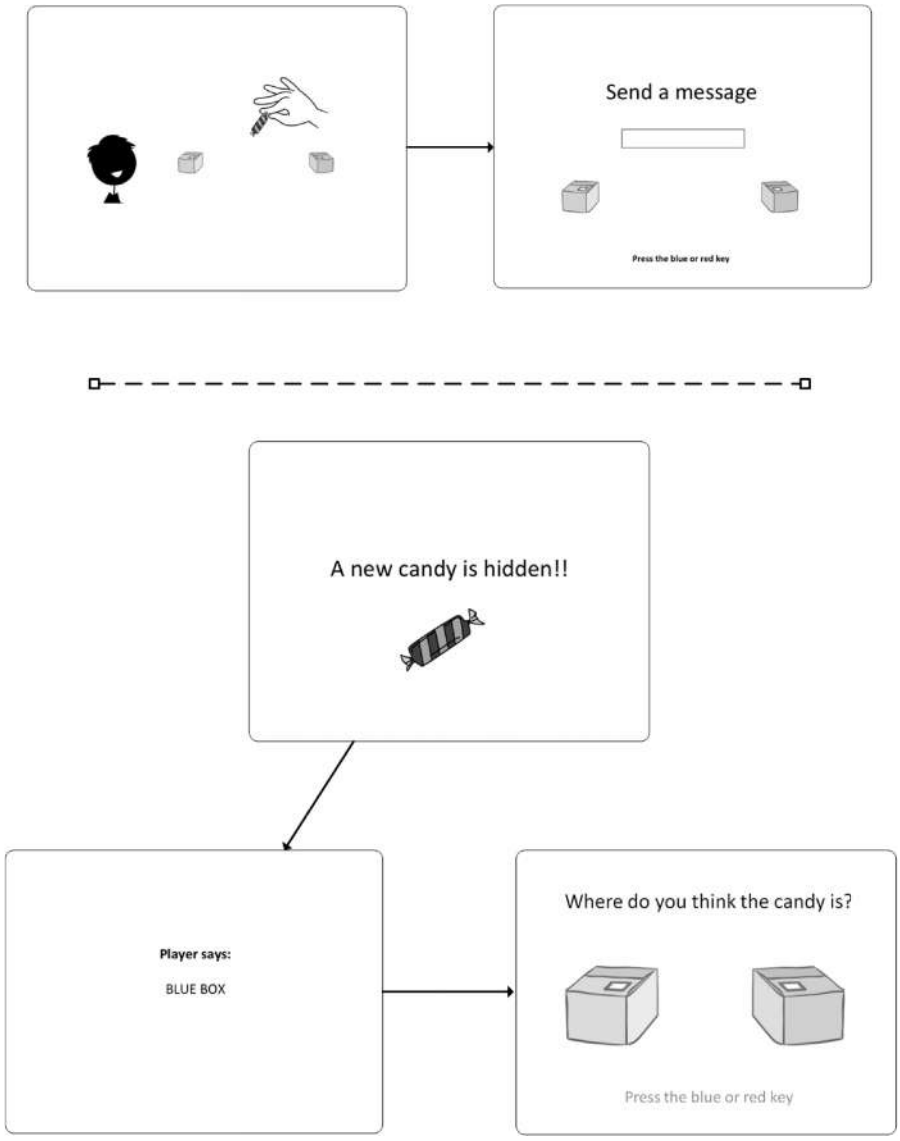



*Figure 1.* Sample sequence for participants in the role of witness (top) and guesser (bottom).

Additionally, there were two reward rules/incentives: common and conflicting interests. When interests were common, every time guessers selected the correct box, both guessers and witnesses earned an item. If guessers selected the incorrect box, neither player earned an item. When interests conflicted, the item was contested, so that witnesses only earned an item if guessers chose the wrong box, and guessers only earned one when correct. Participants were led to believe that they were playing, during each trial, with an unknown peer seated in a separate lab room who played the opposite role (e.g., guesser if the participant was a witness); in actuality, the stimuli were preprogrammed in the computer.

Before playing, participants learned that performance feedback (e.g., who won prizes during each trial) would be provided only at the end of the experiment. Thus, deciding to believe or cooperate with others was based solely on inference of motives and its relation to credibility/expectations. To control for effects of experience with the task, an equal number of participants played four rounds (10 trials each) in one of two randomly assigned sequences: a) guesser-common, guesser-conflicting, witness-common, witness-conflicting, or b) witness-common, witness-conflicting, guesser-common, guesser-conflicting interests.

Conflicting trials always came last in hopes of obtaining the most accurate (i.e., still fresh in memory) explicit judgments possible at the end of the experiment. Specifically, right after the game was over, the experimenter explicitly reminded participants about the conflicting reward rules. Then, the experimenter claimed to be "just

curious" about participants' strategies during their last round of trials (which was always played under the conflicting rules). Half of the participants were asked to explain their decisions when guessing ("Did you sometimes believe the other player's message? Why? Did you think the other player was trying to trick you or not really? Why?"), whereas the other half was asked about sending messages ("Did you sometimes send the right answer? Why? I am just curious!") This explored whether guessers expected the other player to trick them, and whether witnesses intended to deceive the other player during conflicting trials.

#### *2.1.3.1. Guesser: common/conflicting interests*

Participants learned that prizes would be hidden in the other player's room by another experimenter. They were told that every time a prize was hidden, the other player would send a message that "may or may not be correct," and it was the participant's job to guess where the prize was hidden. The experimenter explained the reward rules, mentioned that the other player knew them too, and quizzed participants to ensure that they understood the rules by asking: "Can you repeat back the rules?"; "What happens when you guess correctly/incorrectly?" No participant in any condition needed more than two repetitions of the rules to answer these questions correctly. The experimenter then left the room to provide participants with privacy.

#### *2.1.3.2. Witness: common/conflicting interests*

The experimenter brought prizes (e.g., Smarties) and hiding boxes, and informed participants they would be sending messages to the other player—the guesser—about the prizes' location. The experimenter explained the rules (which the other player supposedly

also knew), and sat facing away from the participant, positioned so the participant could observe the hiding. The experimenter said to participants that it was fine whether they "sent the right or wrong answer."

#### *2.1.3.3. Script excerpt for explaining the game rules*

Provided below is an excerpt of the wording used to explain the common and conflicting rules of the game when participants played as witnesses. The rules were explained to participants after they were trained on using the computer, and told that another player and experimenter were in a separate room.

For the common interests round, participants were told: "Now it is time to start playing. These are the rules of the game: Every time the other player guesses correctly where I hid the candy both you and the other player will get a piece of candy. Every time the other player guesses wrong, neither of you will get a piece of candy. Can you repeat back the rules? What happens when the other player guesses correctly/incorrectly? The other player also knows these are the game rules."

Then, for the conflicting interests round, participants were told: "I will continue to hide candy, but the rules have changed for this new round. Now, every time the other player guesses correctly where I hid the candy only the other player will get a piece of candy. And every time the other player guesses wrong only you will get a piece of candy. Can you repeat back the rules? What happens when the other player guesses correctly/incorrectly? The other player also knows these new rules."

## 2.2. RESULTS

To evaluate participants' performance, every time participants collaborated (i.e., guessers endorsed witnesses' testimony, and/or witnesses shared truthful information), their response was coded as 1 (and 0 otherwise; maximum score = 10, per within-subjects condition). Preliminary analyses indicated no age differences within the child sample ($p >$ .10, for all comparisons), so 7- and 9-year-olds were combined into a single child group to increase statistical power.

Due to guessers and witnesses' responses not being normally distributed, I analyzed them using separate repeated-measures binary logistic regressions via the Generalized Estimating Equations procedure (GEE; see Hardin & Hilbe, 2003). Children's trial-by-trial responses served as the dependent measure, evaluated as a function of interest (within-subjects: common, conflicting), age (children, adults), and role order (guesser first, witness first). See Figure 2 for participants' trial-by-trial responses.

### 2.2.1. Selective learning

When in the guesser role, there were main effects of interest condition, Wald $\chi^2$ (1, $N$ = 96) = 91.93, $p < .001$, age, Wald $\chi^2$ (1, $N$ = 96) = 8.03, $p = .005$, and role order, Wald $\chi^2$ (1, $N$ = 96) = 11.84, $p = .001$, as well as interest x age, Wald $\chi^2$ (1, $N$ = 96) = 30.23, $p < .001$, and interest x role interactions, Wald $\chi^2$ (1, $N$ = 96) = 15.28, $p < .001$.

Regarding the first interaction, Bonferroni-corrected pairwise comparisons showed that children, $p < .001$, like adults, $p < .001$, believed the witnesses' messages more often in the common versus conflicting interest condition. However, children were

significantly less likely than adults to believe a partner with common interests, $p < .001$. There was a nonsignificant trend for children to endorse a partner's claims in the conflicting interests condition more frequently than adults, $p = .092$.

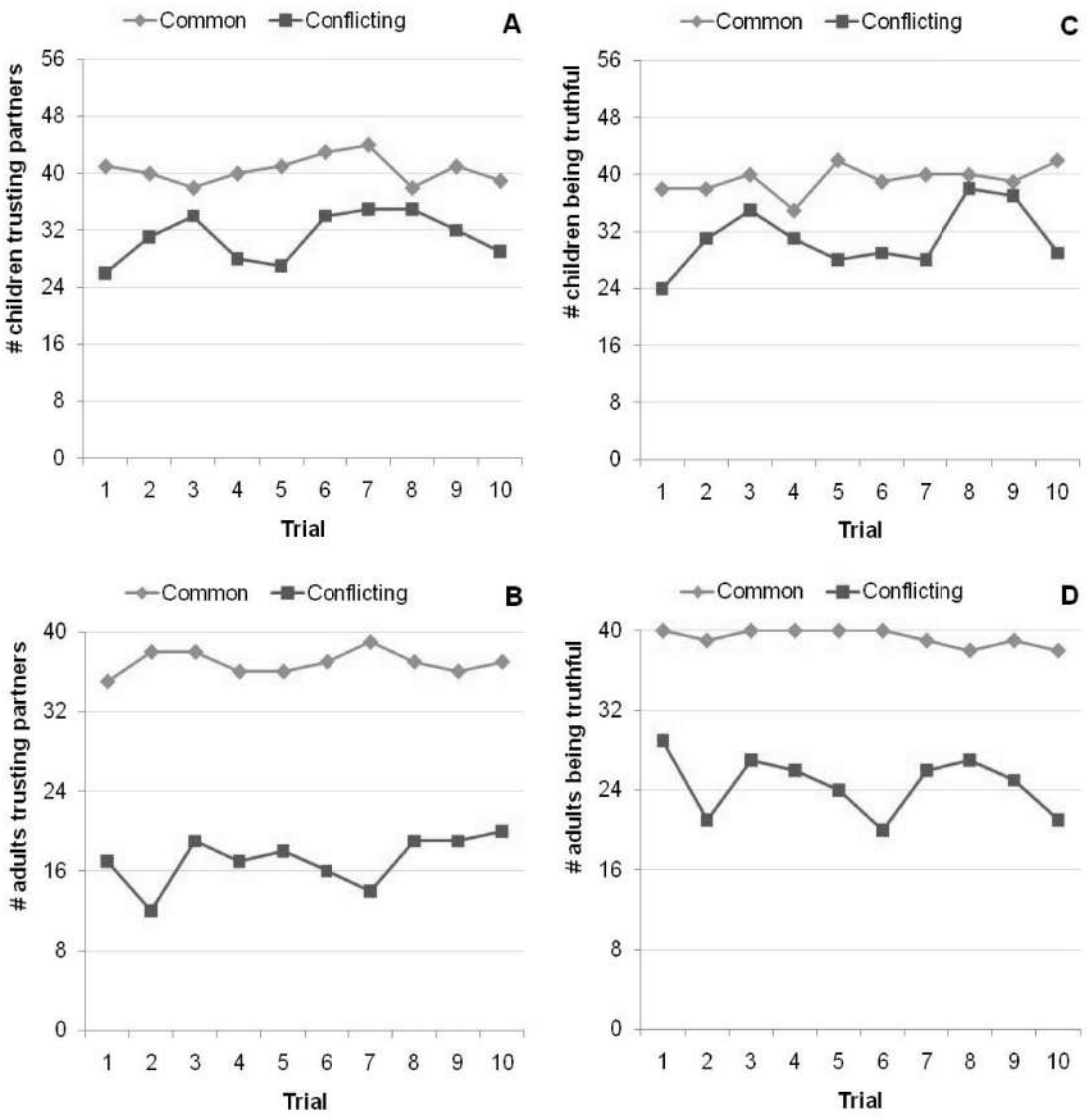



*Figure 2.* Number of guessers who believed their partner's messages each trial (panels A and B), and of witnesses who sent truthful messages to their partners (panels C and D).

Regarding the interest x role interaction, Bonferroni-corrected pairwise comparisons indicated that participants believed their partners' claims more often if interests were common rather than conflicting. This applied both when playing initially as witnesses (common: $M_{marginal}$ = .94, $SE$ = .018 vs. conflicting: $M_{marginal}$ = .48, $SE$ = .040), $p < .001$, and initially as guessers (common: $M_{marginal}$ = .76, $SE$ = .036 vs. conflicting: $M_{marginal}$ = .50, $SE$ = .036), $p < .001$. Further, when having common interests, participants believed their partners more frequently if playing initially as witnesses rather than guessers, $p < .001$. Their responses did not differ by role during conflicting trials, $p = 1$.

### 2.2.2. Truthful instructing

When in the witness role, there were main effects of interest condition, Wald $\chi^2$ (1, $N$ = 96) = 41.09, $p < .001$, and age, Wald $\chi^2$ (1, $N$ = 96) = 23.75, $p < .001$, as well as an interest x age interaction, Wald $\chi^2$ (1, $N$ = 96) = 19.05, $p < .001$. Bonferroni-corrected pairwise comparisons showed that both children, $p = .009$, and adults, $p < .001$, sent more truthful messages to the other player when having common versus conflicting interests. However, children sent truthful messages to a partner with common interests less frequently than adults, $p < .001$. There were no differences in children and adults' responses during conflicting trials, $p = 1$.

### 2.2.3. Relation between learning and instructing behaviors

When interests were common, trust and trustworthiness behaviors correlated positively for children, $r_s(56) = .70$, $p < .001$, but not adults, $r_s(40) = .066$, $p = .69$. When

interests conflicted, correlations were marginally significant for children, $r_s(56) = .23$, $p = .091$, but not adults, $r_s(40) = -.084$, $p = .61$.

### 2.2.4. Changes in behavior over time

We calculated differential scores for each condition and role by subtracting the first two trials from the last two (score range: -2 to 2). Then we compared each score to zero via *t*-tests, to determine any changes over time. Children's behavior did not change over time, either for common or conflicting interests ($p > .13$ for all comparisons). Adults' behavior changed only as guessers during conflicting trials: adult's trust increased as the experiment went on, $M = 0.25$, $SD = 0.74$, $t(39) = 2.13$, $p = .040$, $d = 0.34$.

### 2.2.5. Explanation probe results

After the game was over, the experimenter explicitly reminded participants about the conflicting reward rules. Then, the experimenter claimed to be "just curious" about participants' strategies during their last round of trials.

#### *2.2.5.1. Coding and reliability*

Participants' open-ended responses were initially classified by the first author into two groups: those in which participants spontaneously mentioned either their or the partner's deceptive intent (e.g., to trick, confuse, mislead) and those in which deceptive intent was not mentioned. The responses that did not mention deceptive intent were later classified into four general categories: personal strategies, generalized trust, morality-driven, and other (e.g., because the other player had good vision). The open-ended

responses of 32 randomly selected participants also were coded independently by two coders blind to condition and research question. Their choices demonstrated an average 92.2% agreement with the first author.

#### *2.2.5.2. Guessers' patterns of responses*

An examination of guessers' actual behavior during their last conflicting interests round revealed that: the majority of participants (children: 77%, adults: 88%) endorsed the partner's message at least once and discarded it at least once, followed by those who always (children: 21%, adults: 5%) or never did (children: 2%, adults: 8%). A minority of child guessers used easily identifiable strategies during conflicting trials such as color switching (e.g., red, blue, red, blue, etc.; $n = 3$) and partial endorsing (e.g., endorsing 1$^{st}$ and 2$^{nd}$ texts, choosing opposite for 3$^{rd}$ and 4$^{th}$, endorsing 5$^{th}$ and 6$^{th}$, etc.; $n = 1$, or, choosing opposite for initial 5 texts, endorsing last 5; $n = 1$). No child endorsed only one color (e.g., always blue) during the 10 trials.

#### *2.2.5.3. Guessers' justifications*

Endorsing the message of someone who benefits from one's errors, such as when playing with conflicting interests, could be explained by multiple reasons: confusion, wanting equal distribution of prizes, recursive thinking (i.e., player A thinking about what player B thinks player A is thinking), etc. After the game was over participants were *explicitly* reminded of the game rules, and then asked about the strategies they used during the last conflicting interest round. Half of the participants played their last conflicting round as guessers, and thus were asked about their choices in the guesser role. Participants were asked whether they sometimes believed the other player's message, and

whether they thought the other player was trying to trick them. Five children did not respond. Almost all adults, and about a third of children (adults: 18 out of 20; children: 8 out of 23) spontaneously justified endorsing the message as a product of the other player's intentions (e.g., "Sometimes, because the other player could send the right one to make me think it was the wrong one"). Children's other common responses included following their own strategies ($n$ = 5; e.g., "Sometimes, because I just followed my own pattern, and sometimes my pattern was the same as the player's message"), and generalized trust ($n$ = 5: "e.g., I believed it all the time, because I always told the truth to the other player").

When explicitly asked whether and why they thought the player sometimes tried to trick them, the majority of guessers (adults: 18 out of 20; children: 18 out of 23) expressed suspicions about the other player's intent (e.g., "Yes, the other player sometimes sent the wrong one to win more candy"; "Sometimes, because when I was sending messages I sent the right one sometimes thinking the player would not believe me"). The proportion of participants explicitly expressing suspicions differed from chance (i.e., 50%; Binomial tests, children: $p$ = .011, adults: $p$ < .001) when compared to the proportion who did not express any suspicion. There were no age differences; that is, children were as likely as adults to express suspicions as guessers, $U$ = 203.00, $p$ = .30.

#### *2.2.5.4. Witnesses' patterns of responses*

Participants' behavior in the witness-conflicting interests condition showed a similar pattern: the majority of participants (children: 73%, adults: 80%) sent the correct answer to the partner at least once, whereas the rest either always (children: 21%, adults:

18%) or never (children: 6%, adults: 2%) did. A minority of child witnesses followed specific patterns during conflicting trials such as color switching (e.g., red, blue, red, blue, etc.; $n$ = 2) and partial truthfulness (e.g., correctly reporting 1st and 2nd locations, then wrong location for 3rd and 4th, etc.; $n$ = 1). No child sent the other player only one color for all 10 trials.

#### *2.2.5.5. Witnesses' justifications*

Sharing truthful information with someone who, by guessing correctly, prevents one from winning is also subject to multiple potential reasons. Half of the participants played their last conflicting round as witnesses. These participants were explicitly reminded of the conflicting rules, and then asked whether and why they sent truthful messages. One child did not respond. The majority of participants (adults: 20 out of 20; children: 19 out of 27) described sending truthful information to confuse the guesser (e.g., "I sent a pattern of two red, two blue, to make it more difficult for the player"; "If I sent the right box, the other player would think it is the wrong one"; "If I only send the wrong box the player just has to choose the opposite"). The proportion of child participants who expressed intent to confuse marginally differed from chance (i.e., 50%; Binomial tests, children: $p$ = .052, adults: $p$ < .001) when compared against all other explanations that did not involve confusion intent. Those who did not express intentions to confuse the player ($n$ = 8) provided alternate explanations for sending truthful messages during conflicting trials (e.g., "I did not want to take all the candy from the other player"; "I am a bad liar"). Children were less likely than adults to express intent to confuse as witnesses, $U$ = 190.00, $p$ = .008, $r$ = .39.

## 2.3. DISCUSSION

The main goal of Experiment 1 was to determine if, without behavioral evidence of a partner's prior deception, children's learning and instructive behaviors were influenced by self-interest cues. Like adults, 7- and 9-year-olds endorsed messages (as guessers) and shared truthful information (as witnesses) more frequently if having common rather than conflicting interests. To my knowledge this is the first empirical demonstration of children's ability to flexibly vary their learning and instructive behaviors, grounded *exclusively* on self-interest based inferences. Specifically, in the current study children did not receive any details about their partner's prior or ongoing motives/behavior; they did not know if, by sending the right or wrong answer, they were effectively winning or losing. They had to take a leap of faith and hope that the other player believed or doubted them based solely on their common knowledge of the rules. On the one hand, these results of inference-driven selectivity complement research showing children's selectivity when epistemic (e.g., Birch, Vauthier, & Bloom, 2008; Koenig, 2010; Krogh-Jespersen & Echols, 2012) and social (e.g., Corriveau, Fusaro, & Harris, 2009; Kinzler, Corriveau, & Harris, 2011; Reyes-Jaquez & Echols, 2013) information is provided.

However, a potential implication of these findings is that even 9-year-olds have yet to fully master the art of selectively learning from—and cooperating with—others. Comparing children and adults' behaviors showed that children were less trusting/truthful than adults with partners who had common interests. These findings are important, for they advance the thesis that the developmental challenge of integrating motivational cues

into learning decisions entails not only becoming skeptical of those with conflicting interests, but also increasingly confident that people with common interests intend to help. This thesis is partly compatible with prior research evaluating children's selective learning: Vanderbilt et al. (2011) found that even when children received information from a source with an impeccable helping history (i.e., someone who had previously helped 2 out of 2 people), 4- and 5-year-olds' endorsement of that informant's claims was "not at ceiling" (p. 1376). Importantly, additional research is needed to discard potential alternate explanations for the findings that support the contention outlined.

A limitation that pertains to Experiment 1 and other studies is that there has been little exploration of mechanisms behind children's motive-based credulity and skepticism. This shortage represents a valuable opportunity for future research. A first step before exploring potential mechanisms is agreeing on what it means to be credulous or skeptical. As stated in the introduction, existing behavioral studies provide children with explicit information about cooperativeness such as a source's reputation or prior trickery. In these studies, children are expected to predict trait-like consistency in the source's behavior (e.g., once a liar, always a liar) and mistrust that source. Specifically, if a source is presented as a liar or mean (e.g., Mascaro & Sperber, 2009), or as someone who previously tricked (e.g., Jaswal et al., 2010; Vanderbilt et al., 2011), children should always mistrust it. Such a task requirement for skepticism can represent a challenge for younger children, who sometimes predict change in a person's future behavior, regardless of his or her past behavior (e.g., Kalish, 2002). This requirement in learning tasks may also explain some of the developmental differences in behavioral dissociations when

compared to inferential tasks. In particular, inferential tasks may not require person-specific associations; from the incentives alone it is possible to deduce that anyone who benefits from one's success is likely to cooperate.

Further, endorsing an ill-intended source at or above chance levels is typically considered indicative of credulity. However, as Experiment 1 shows, even adults consider it "sound" to endorse a proportion of claims made by someone who is expected to deceive due to a game's incentives. It has been documented that younger children struggle when playing as informants in learning tasks that require recursive thinking (e.g., Shultz & Cloghesy, 1981). There also is indirect behavioral evidence from a guessing task that younger children fail to employ a recursive strategy (Mascaro & Sperber, 2009). Still, it would be useful to directly test whether individual differences in younger children's nascent recursive awareness predict their performance as guessers in a limited resources game.

Based on the results outlined above it is also important to account for contextual factors in children's apparent credulity and skepticism. For instance, the means of transmitting information (e.g., spoken, written), the status of the source (e.g., an authority figure), and related social expectations (e.g., obedience, politeness) appears to play a role in children's trust behavior: Jaswal et al. (2010) found that children who received misleading testimony via arrows or an audio recording were more skeptical than those who received it from a person they could see and hear. Potentially, our participants in Experiment 1 benefited from playing with a peer, not being able to see the partner when sending misleading information, and of having received the testimony via text when

deciding whether to trust it. These methodological considerations should prove useful when interpreting existing work and designing future studies.

# 3. Experiment 2

## 3.1. RATIONALE

In Experiment 1, it was first documented that children could take into account motivational cues to inform their learning decisions. However, at least two central, interrelated inquiries remained unaddressed: (a) why are children not fully capitalizing on instances of common ground? and (b) what are potential socio-cognitive predictors of adult-like performance in children? In other words, what is it that develops that allows adults, but not some children, to deem a source as credible in situations where both parties benefit?

To address these questions I tested whether various socio-cognitive skills are potentially needed to detect and take advantage of common ground: participants' working memory, recursive awareness, interpretive theory of mind (ToM), and generalized mistrust. The first two were expected to potentially aid in the detection of common ground, whereas the latter two could arguably interfere with this goal. All four were measured during Experiment 2 to be used as potential predictors of performance.

### 3.1.1. Memory constraints

Participants in Experiment 1 had to store and manipulate multiple pieces of information: the game rules, current round, last/current box color, common knowledge between them and the partner, etc. Working memory (i.e., the ability to maintain and manipulate information) undergoes significant changes from childhood to adulthood (e.g., Huizinga, Dolan, & Molen, 2006). It is possible that memory constraints were hindering children's ability to learn selectively. Due to having to remember both the

game rules and the answer provided by the source, children may have been more prone to erring in their choices than adults, whose memory capacity is greatly developed. To account for this possibility, in Experiment 2 children's recall was measured both before and after each round. Additionally, children's working memory capacity was assessed.

### 3.1.2. Recursive awareness

Arguably, participants benefitted from thinking about partners' potential thoughts and intentions, such as entertaining the possibility that: "My partner is thinking that I am thinking that he is going to trick me, so he may send the correct box." Children eventually realize that people can infer other individuals' intentions—including other people being able to infer children's own intent. This understanding of recursive awareness tends to improve with age (e.g., Shultz & Cloghesy, 1981). Arguably, this ability is central in making use of self-interest cues to infer credibility; to the degree that children cannot conclude that the other player (or anyone else) is able to predict their intentions, they should be less likely to trust that s/he will believe and/or help them.

### 3.1.3. Interpretive theory of mind

When a stimulus is ambiguous, it is reasonable for different individuals to reach different interpretations of it. This appreciation of the interpretive nature of the knowing process appears around age 7 (e.g., Carpendale & Chandler, 1996). Recent findings suggest that, around the same age at which children begin to show an awareness that people can have diverse interpretations, they also tend to overlook that people can think alike. For example, Lagattuta, Sayfan & Blattman (2010) presented children with two characters, one of whom previously saw a full picture of an image. The image was then

occluded, leaving only a window revealing a small (but informative) part of the illustration (e.g., if a giraffe was pictured, the window showed the giraffe's head). When asked what each character would think the illustration was when they saw the occluded image, 7- to 9-year-olds often claimed that the characters would interpret the picture's identity differently. The authors argue that children of this age might have an over-interpretive ToM, which explains why they sometimes fail to recognize common ground (i.e., both characters could identify the picture by just looking at the non-occluded window).

It is possible that some children over-interpret what the other player might think when listening to the rules, reaching conclusions such as: "We both heard the same rules, but unlike me, he might not realize that cooperating is beneficial." In other words, some participants may suspect that, even though both they and the other player listened to the same rules, there is no guarantee that both are interpreting the rules similarly.

### 3.1.4. Generalized (mis)trust

Children often exhibit an over-reliance on their limited knowledge and experience when making judgments. For instance, when denying the existence of novel entities (e.g., a galah—a real but unfamiliar animal), children spontaneously justify these judgments by citing prior experience (e.g., "I've never heard of them before; I doubt they exist"; Woolley, Ma, & Lopez-Mobilia, 2011). In Experiment 1, adults may have overridden any prejudgment about their partner by integrating motivational information (e.g., self-interests). Conversely, children's documented over-reliance on prior knowledge and experience could have prevented them from doing so, leading some of them to

conclusions such as: “Regardless of the game rules, some people just like to have fun by tricking others.” Arguably, the more experience children have had with people benefiting them, the greater trust they might have in others, and vice versa. Thus, children’s generalized (mis)trust may have potentially affected their beliefs about an individual’s willingness to cooperate, even when both individuals might benefit.

### 3.1.5. Stimuli properties

A final modification to the procedure was made to the stimuli used. In Experiment 1 adults played the game to earn tickets. This prize is sensitive to quantity in that the more tickets one gets the higher the probability of winning the drawing. Children, however, played the game for candy—a concrete reward whose quantity did not affect the outcome of the game in the same way that tickets did for adults. To place children in a more comparable reward situation to that of adults, in Experiment 2 children earned tokens (as opposed to candy) exchangeable for various prizes. To motivate children to maximize their gains, the acquisition of toys at the end of the game was dependent on the number of tokens they had earned.

In sum, in Experiment 2 I investigated potential factors that could predict self-interest-based, adult-like inferences about an individual’s credibility. I measured children’s working memory, recursive awareness, interpretive ToM, and generalized mistrust. I expected that children’s ability to take full advantage of instances of common ground would be positively related to their recursive awareness and second order reasoning. Specifically, children who demonstrated high working memory and recursive reasoning would perform at comparable levels to adults in the finding game. In addition, I

expected that children who exhibited an over-interpretive ToM and/or generalized mistrust toward others would perform more poorly in the finding game than children who did not exhibit those characteristics.

## 3.2. METHOD

### 3.2.1. Participants

The final sample consisted of 40 children ($M_{age}$ = 8 years 8 months; range: 7 years 2 months – 10 years 9 months; 21 females) who were recruited using a university's participant database. The majority of participants were Caucasian and from middle-class families. An additional 11 children who participated were excluded either due to experimenter error (4) or because they did not complete all the measures (7).

### 3.2.2. Materials

Golden tokens were used as exchangeable prizes. Participants guessed about prizes' location via a computer keyboard with a blue and a red key, which matched the colors of two origami boxes that were used to hide the tokens. Additionally, the following measures were used for assessing potential performance predictors (see appendices for detailed descriptions and illustrations):

#### *3.2.2.1. Working memory*

Children's working memory was assessed via the Digit Span subtest of the second edition of the Wechsler Intelligence Scale for Children (WISC-Revised, Wechsler, 1974). Children heard a series of numbers, and then had to repeat back these numbers. In the first phase, children repeated the numbers in the order that they heard them. During a

second phase, they had to reverse the order of the numbers. The list increased in difficulty each round by adding additional digits.

#### *3.2.2.2. Recursive awareness*

Following a procedure by Oppenheimer (1986; see also Miller et al, 1970), children listened to descriptions of events (e.g., "The boy is thinking that he is thinking of the girl thinking of herself"). The experimenter then presented multiple pictures and asked the child to select which picture matched the verbal description. Note that only a subset of the items was used so as to decrease the time it took to complete this assessment (see Appendix). Some items measured general theory of mind, whereas others directly addressed children's reasoning of recursive loops.

#### *3.2.2.3. Interpretive ToM*

Following a procedure similar to Lagattuta et al. (2010), children were presented with pictures that were covered with "occluders" that still revealed identifiable parts of what was pictured (e.g., a giraffe's head). Participants then predicted how three characters—one character who had previously seen the full picture and two who had not—would interpret the "obstructed" drawings.

#### *3.2.2.4. Generalized mistrust*

Children's trust was measured via a subset of items taken from Rotenberg's trust scale (see Rotenberg et al., 2005; as well as Appendix). Children rated, on a scale from 1 – 4, how likely it was that people's statements were trustworthy. Some items presented neutral scenarios with no clear outcomes (e.g., "Lorraine's father said that he would take

her to the cinema on Saturday. How likely is it that Lorraine's father will take her to the cinema?") A second group of items more openly described negative outcomes (i.e., "Charlotte asks her father if she can borrow his fishing rod. Her father says he has lent it to someone else. How likely is it that her father has lent the fishing rod to someone else?")

### 3.2.3. Procedure

Participants played a game primarily consisting of two within-subjects conditions: guesser-common interests and guesser-conflicting interests (the order was counterbalanced). This decision of focusing primarily on the guessing role was made to keep the experiment from becoming unbearably lengthy for child participants. However, to provide participants with some practice with the rules, and to make the role of their partner (i.e., the witness) more concrete, initially all participants played the game as witnesses themselves. After playing very briefly as witnesses, participants learned that the other player would now observe the experimenter hide a token under a blue or red box, just like they had done. The other player would then be the one sending them a text message (via the computer) about the token's location. Participants had to decide—after receiving the other player's message—where they thought the prize was actually hidden. Participants learned that it was up to the other player to send true or false information.

Additionally, there were two reward rules/incentives: common and conflicting interests. When interests were common, every time the participants selected the correct box, both the participants and the other player earned an item. If participants selected the incorrect box, nobody earned an item. When interests conflicted, the item was contested,

so that the other player only earned an item if participants chose the wrong box, and participants only earned one when correct. Participants were asked to recall the rules of the game both before and after each round, including when practicing as witnesses. Participants were led to believe that they were playing, during each trial, with an unknown peer; in actuality, the stimuli were preprogrammed in the computer. Participants initially played five trials with common and five trials with conflicting reward rules as witnesses (10 total). Then, they played 20 trials with common and 20 trials with conflicting reward rules as guessers (40 total).

After the finding game was over, the experimenter explicitly reminded participants about the common reward rules. Then, the experimenter claimed to be "just curious" about whether and why participants thought that their partner tried to trick them: "Did you think the other player was trying to trick you or not really? Why is that?" These prompts were done to determine what expectations children had about others during common trials. Finally, children engaged in a series of tasks. Participants' performance in these tasks determined their working memory, recursive awareness, interpretive ToM, and generalized mistrust (see appendices, for a more detailed description of each task).

### 3.3. RESULTS

The coding method for each of the variables measured is presented below, followed by the statistical analyses.

### 3.3.1. Coding method

#### *3.3.1.1. Finding game*

Every time that participants endorsed the partner's testimony, their response was coded as 1 (and 0 otherwise; maximum score = 20, per reward rules condition). Then, a differential score was computed by subtracting their scores during the common trials from their scores during the conflicting trials (common – conflicting trials = differential score). Thus, a positive differential score would imply that children, like adults would, trusted the partner more often during common than conflicting trials. A negative differential score would reveal that children trusted the partner more frequently during conflicting trials. A score equal to or close to zero would suggest that children did not discriminate between reward rules conditions. A benefit of using differential scores was the option to model the data via a regression model that did not require a repeated-measures component. Please see Table 1 for descriptive statistics of each variable.

#### *3.3.1.2. Children's age*

Participants' age was treated as a continuous variable and measured in months.

#### *3.3.1.3. Rules recall and Working memory*

Every time participants repeated back correctly the rules to the experimenter (before and/or after each round, including practice rounds) they received 1 point and 0 otherwise (maximum score = 8). Also, after the hiding game was over, every time that participants repeated back a sequence of numbers from the digit span correctly, their response was coded as 1 (and 0 otherwise; maximum score possible = 14 for each forward/backward section, total combined = 28). A higher score in the digit span task

indicated higher overall working memory. Finally, to control for age effects children's raw scores were normalized via the WISC's scaled scores tables (maximum scaled score possible = 19). In order to use the latest available scaled scores provided by the WISC-IV, four additional points were added to children's WISC-R overall scores.

Table 1. *Average scores for each measure, along with standard deviations, minimum and maximum scores*

| Measure | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Differential Scores | 40 | .85 | 7.76 | -16 | 20 |
| Age in Months | 40 | 104.10 | 11.69 | 86 | 129 |
| Working Memory | 40 | 10.15 | 2.70 | 5 | 17 |
| Recursive Awareness | 40 | 8.05 | 1.11 | 4 | 9 |
| Interpretive ToM | 40 | 4.88 | 1.29 | 2 | 6 |
| General Trust | 40 | 31.63 | 5.25 | 21 | 44 |

#### *3.3.1.4. Recursive awareness*

Every time that participants correctly matched the description they heard with the corresponding picture, their response was coded as 1 (and 0 otherwise; maximum score = 9). A higher score in the picture matching task indicated higher overall recursive reasoning.

#### *3.3.1.5. Interpretive ToM*

Every time participants predicted that any individual who looked at the occluded but informative picture (i.e., due to a window) would know what was being depicted, their response was coded as 1 (and 0 otherwise; maximum score = 6). Higher scores were indicative of an "adequately" developed interpretive ToM, whereas lower scores suggested an over-interpretive ToM.

#### *3.3.1.6. Generalized (mis)trust*

For each story, participants' opinions of the likelihood that the character would keep his or her word were coded in the following way: very unlikely = 1, a little unlikely = 2, a little likely = 3, very likely = 4 (maximum score = 48). The higher the score the more generally trusting of others the participant was considered. Conversely, lower scores indicated higher generalized mistrust.

### 3.3.2. Children's selective learning

To determine what factors may have been associated with children's performance in the finding game, and between each other, all the measures detailed above were first evaluated via a correlation matrix. Then, to test for predictive power, participants' differential scores were entered in a linear regression model as the dependent measure, evaluated as a function of their age, interpretive ToM, recursive awareness, working memory, and generalized trust scores, as well as all the possible two-way interaction terms. In addition, children's differential scores were compared to zero (0) so as to determine whether, like in Experiment 1, children discriminated between reward conditions. Finally, participants' raw scores were compared to chance (i.e., 50% = 10) to test if children systematically (mis)trusted their partners during each reward condition. Note that there was a ceiling effect on children's recall of the reward rules (35 out of 40 children had perfect recall, and no child failed less than 6 out of 8 recall prompts). Therefore this variable was excluded from subsequent analyses.

#### *3.3.2.1. Correlates of participants' performance*

As seen in Table 2, the better working memory the children had, the more adult-like performance they exhibited (i.e., by trusting more often their partner during common than conflicting trials). There also was a non-significant tendency for children who showed more generalized trust to endorse partners' messages more often during common trials. Recursive awareness was another factor related to multiple variables. Specifically, as children's age and generalized trust increased, so did their ability to identify pictures illustrating recursive loops (e.g., dad is thinking that mom is thinking of him thinking of her).

Table 2. *Correlation matrix 1*

| Measures | Statistics | Differential Scores | Age in Months | Working Memory | Recursive Awareness | Interpretive ToM | General Trust |
|---|---|---|---|---|---|---|---|
| Differential Scores | Spearman | 1 | -.05 | .34 | .06 | -.02 | .25 |
| | *p*-value | | .75 | .03 | .72 | .89 | .12 |
| Age in Months | Spearman | -.05 | 1 | -.06 | .40 | .04 | .21 |
| | *p*-value | .75 | | .69 | .01 | .79 | .19 |
| Working Memory | Spearman | .34 | -.06 | 1 | .26 | -.11 | .22 |
| | *p*-value | .03 | .69 | | .11 | .51 | .18 |
| Recursive Awareness | Spearman | .06 | .40 | .26 | 1 | -.09 | .37 |
| | *p*-value | .72 | .01 | .11 | | .60 | .02 |
| Interpret ToM | Spearman | -.02 | .04 | -.11 | -.09 | 1 | .05 |
| | *p*-value | .89 | .79 | .51 | .60 | | .74 |
| General Trust | Spearman | .25 | .21 | .22 | .37 | .05 | 1 |
| | *p*-value | .12 | .19 | .18 | .02 | .74 | |

#### *3.3.2.2. Predictors of participants' performance*

Participants' differential scores were entered in a linear regression model as the dependent measure, evaluated as a function of their age, interpretive ToM, recursive awareness, working memory, and generalized trust scores. The interaction terms of the

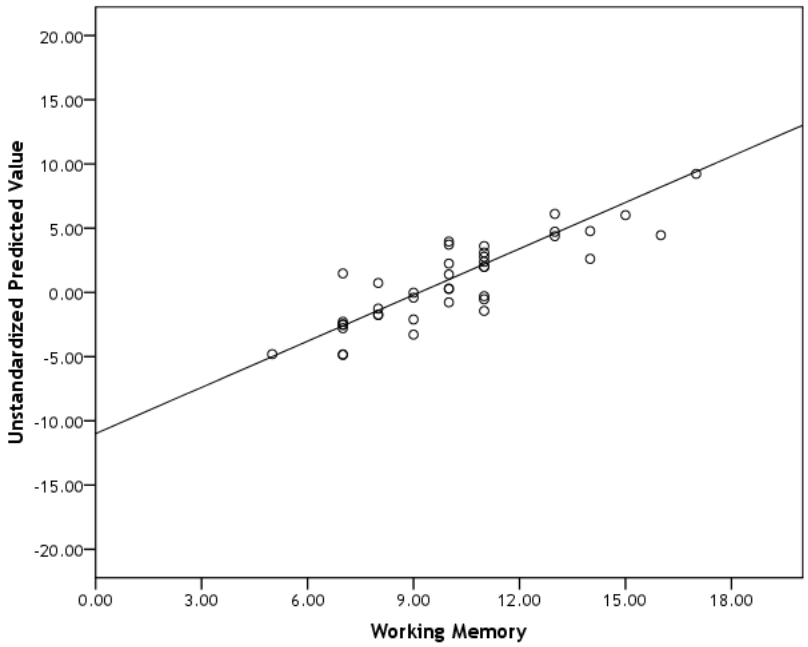
linear regression were not significant ($p > .25$ for all comparisons), and thus were removed from the initial model. The new model indicated that only children's working memory significantly predicted children's trust decisions (see Table 3) in the finding game. There also was a nonsignificant tendency for children's generalized trust to be predictive of their differential scores in the finding game. Figure 3 illustrates the relation between these variables.

Table 3. *Regression model coefficients, t-test, and confidence intervals*

| Variables | Unstandardized Coefficients | | Standardized Coefficients | *t*-test | *p*-value | 95.0% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | -12.42 | 13.83 | | -0.90 | .38 | -40.52 | 15.68 |
| Interpretive ToM | -0.02 | 0.95 | 0.00 | -0.02 | .98 | -1.95 | 1.91 |
| Recursive Awareness | -0.51 | 1.28 | -0.07 | -0.40 | .69 | -3.12 | 2.10 |
| General Trust | 0.35 | 0.25 | 0.24 | 1.41 | .17 | -0.16 | 0.86 |
| Working Memory | 0.97 | 0.46 | 0.34 | 2.11 | .04 | 0.03 | 1.91 |
| Age in Months | -0.03 | 0.11 | -0.05 | -0.29 | .77 | -0.27 | 0.20 |

#### *3.3.2.3. Effects of reward conditions*

Children's average differentials scores were compared to zero (0) via *t*-tests to determine whether, like in Experiment 1, children discriminated between reward rules when earning tokens instead of candy. As a group, children did not trust the partners more in one condition versus the other, $M = 0.85$, $SD = 7.76$, $t(39) = 0.69$, $p = .49$.



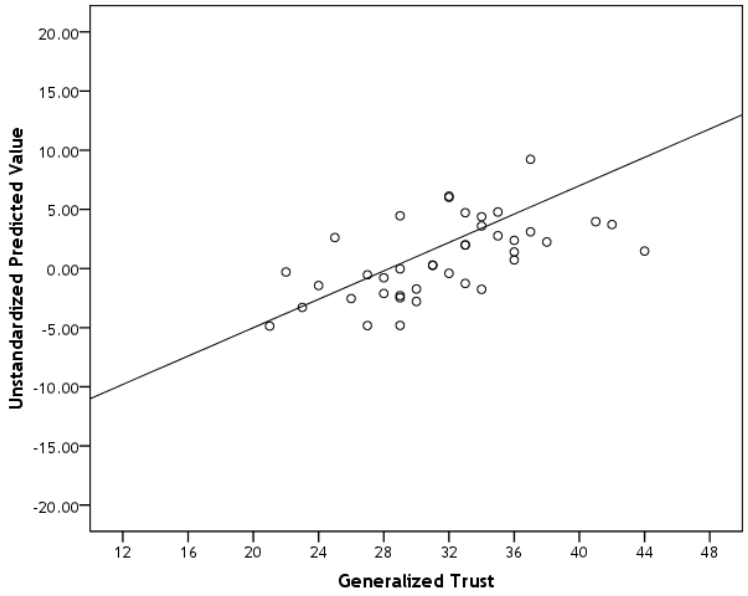




*Figure 3.* Unstandardized predicted values of children's performance, divided by their working memory (top panel) and generalized trust (bottom panel) scores

Additional analyses were conducted with children divided into two groups by performing a median split for the variables that affected (working memory) or potentially

tended to affect (generalized trust) their differential scores. Children with greater working memory appeared to have endorsed their partner's messages more often in the common than conflicting trials, as suggested by their positive average score ($M$ = 2.55, $SD$ = 9.87). The reverse seemed true for children with lower working memory (i.e., endorsing more messages during conflicting than common trials; $M$ = -0.85, $SD$ = 4.48). However, neither of these patterns were statistically different from zero ($t(19) = 1.16$, $p = .26$ and $t(19) = -0.85$, $p = .41$, respectively). The difference between the averages of the two groups was not significant ($t(26.50) = -1.40$, $p = .17$). A complementary result was found with children who demonstrated lower or higher generalized trust: Children with higher generalized trust endorsed messages significantly more frequently during common trials, $M$ = 4.30, $SD$ = 8.34, $t(19) = 2.31$, $p = .032$. Conversely, children with lower trust endorsed the partner's messages significantly less often in the common than conflicting trials, $M$ = -2.60, $SD$ = 5.38, $t(19) = -2.16$, $p = .044$. These two groups' scores differed significantly from each other, $t(38) = -3.11$, $p = .004$.

#### *3.3.2.4. Behavioral patterns in children's raw scores*

A limitation of the differential scores is that it "occludes" additional patterns in the data. For example, differential scores do not reveal whether children did not discriminate between conditions because they trusted partners at/above/below chance levels during both common and conflicting trials. To further explore the participants' decision-making, children's raw scores during both common and conflicting trials first were compared to a chance distribution (50% = 10) via $t$-tests.

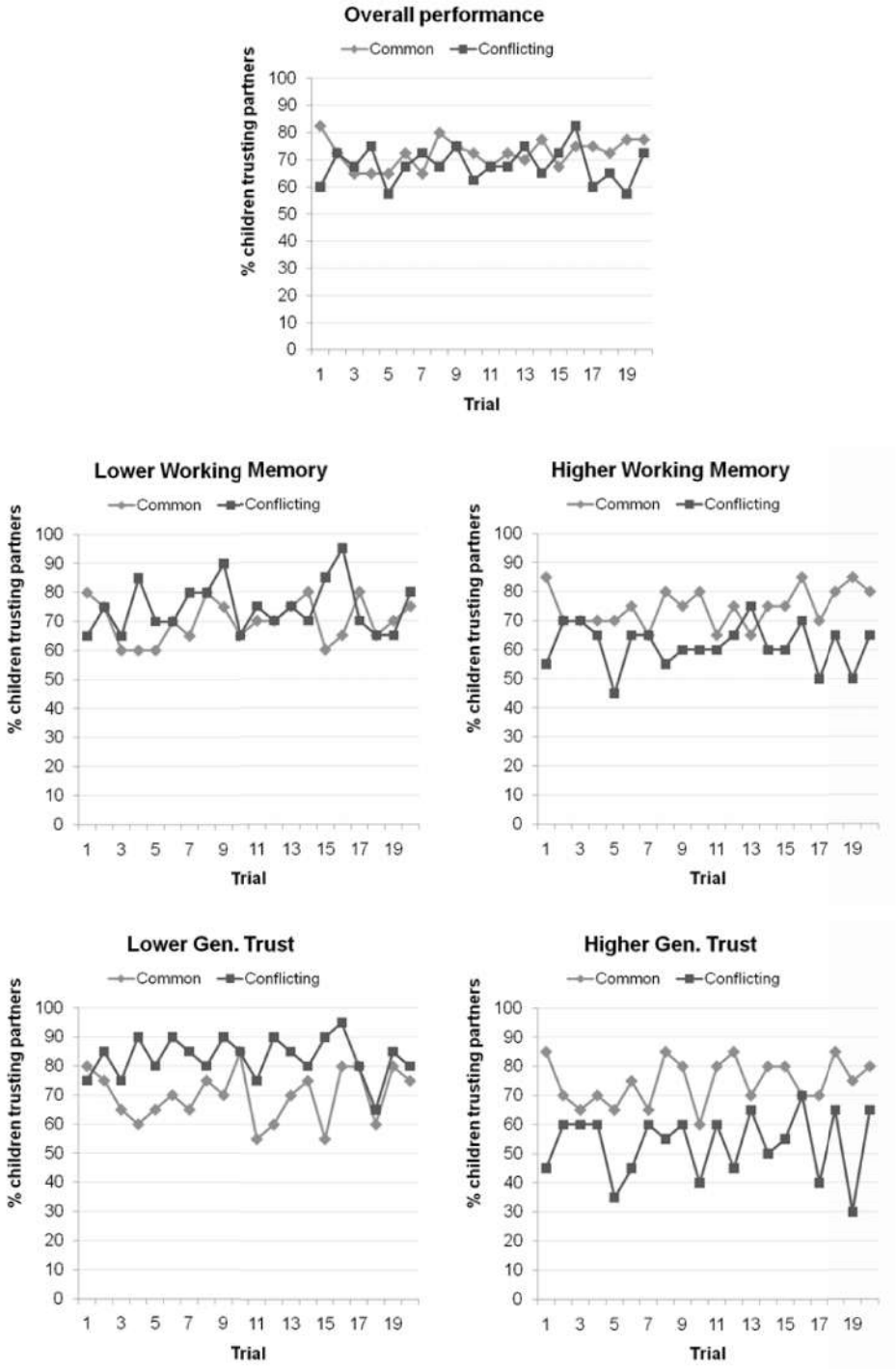



*Figure 4.* Percentage of children endorsing their partner's message per trial and reward condition

When interests were common, children endorsed their partner's messages more frequently than what would be predicted by chance, $M = 14.48$, $SD = 5.48$, $t(39) = 5.17$, $p < .001$. Children exhibited a similar behavior when interest conflicted, $M = 13.63$, $SD = 6.32$, $t(39) = 3.63$, $p = .001$. Figure 4 shows children's overall trial-by-trial responses, as well as their performance when split by the median memory and generalized trust scores.

#### *3.3.2.5. Children's expectations of partners*

When explicitly asked: "Did you think the other player was trying to trick you or not really? Why is that?" in reference to the common trials, 36 out of 40 children offered a response. As would be expected from identifying common interests, the majority of participants (27 out of 36) did not express any suspicions that the other player intended to trick them. This proportion of participants was above what would be predicted by chance (i.e., 50%; Binomial test, $p = .004$). When asked why they thought that about the partner's intentions, 19 out of 34 participants who offered an explanation cited the consequences of the game (e.g., "If they trick me, then they will have a good chance of not getting a coin"; "They also want coins"; "Judging by how many coins I got in the end, we can say he didn't trick me"). The remaining participants offered explanations not related to the game (e.g., "Some people try to trick you"; "They might be younger than me"; "Just didn't think so"; "The other player tricked me sometimes, but it's hard to explain"). The proportion of children offering these two types of explanations was statistically comparable (Binomial test, $p = .61$). Children's perceptions of whether or not the partner tried to trick them was not related to the explanation they provided (Fisher's

exact test, $p = 1$). The full list of children's explanations can be found in the Appendix section.

#### *3.3.2.6. Complementary Analyses*

As described in the Method section, some measures had subcomponents, such as items in the recursive awareness task that measured either general theory of mind or recursive awareness skills. To the extent that children are engaging in recursive thinking during conflicting trials, it is reasonable to expect that recursive awareness-relevant items may be associated with adult-like performance (whereas it may or may not be the case for general ToM items).

Table 4. *Correlation matrix 2*

| Measures | Statistics | Differential Scores | Common trials | Conflicting trials |
|---|---|---|---|---|
| Differential Scores | Spearman | 1.000 | .575 | -.521 |
| | p-value | . | .000 | .001 |
| Common trials | Spearman | | 1.000 | .270 |
| | p-value | .000 | . | .092 |
| Conflicting trials | Spearman | | .270 | 1.000 |
| | p-value | .001 | .092 | . |
| Recursive-relevant | Spearman | .083 | .218 | .098 |
| | p-value | .610 | .177 | .548 |
| Non-recursive | Spearman | .215 | .081 | -.212 |
| | p-value | .182 | .618 | .189 |
| Negative outcome | Spearman | .150 | .120 | -.123 |
| | p-value | .356 | .459 | .448 |
| Neutral/No outcome | Spearman | .254 | .088 | -.218 |
| | p-value | .113 | .591 | .178 |

Moreover, the generalized trust scale tested children's trustworthiness expectations for scenarios in which no immediate consequence was made available in the story, as well as in scenarios where the outcome was often negative for the story character. Arguably, children who may express skepticism in a trust scale for items with negative outcomes as much as for items with no outcomes may be more mistrusting than children who primarily showed skepticism during negative-outcome scenarios. If so, these two trust subscales might be associated differently with children's behaviors during common trials or overall selectivity. However, as Table 4 shows, none of these subscales were significantly associated with children's differential or raw scores.

Finally, in light of the failure to replicate an overall effect of reward rules on children's guessing behavior, their responses during the witness practice trials also were analyzed. These were coded following a similar methodology as described above to obtain differential scores (range: -5 to 5). Unlike when playing as guessers, witness participants systematically shared more truthful messages during common versus conflicting trials—as indicated by a positive mean that was significantly different from zero (0): $M = 0.93$, $SD = 1.90$, $t(39) = 3.08$, $p = .004$. In addition, comparing their raw scores (see Figure 5) to a chance distribution (50% = 2.5) indicated that children sent truthful messages to their partners more frequently than expected by chance. This was true both during common interests trials, $M = 4.28$, $SD = 1.04$, $t(39) = 10.82$, $p < .001$, and when interests conflicted, $M = 3.35$, $SD = 1.78$, $t(39) = 3.03$, $p = .004$.


*Figure 5.* Percentage of children sending the correct location of the reward to partners, per trial and reward condition

When children's differential scores were entered in a regression model with the measured psychological factors as predictors, none of the individual measures was significantly associated with children's behavior as witnesses ($p$ > .40, for all comparisons). Children's differential scores as witnesses were not significantly related to their scores as guessers, $r_s(40) = .16$, $p = .34$.

### 3.4. DISCUSSION

The main goal of this study was to evaluate potential socio-cognitive factors associated with children's motive-based selective learning from others. Positive differential scores (i.e., trusting more during common reward trails) was considered an indicator of children's understanding that people with conflicting motivations are more likely to deceive. Results showed that, as children's ability to remember and manipulate

information develops, there is an increase in the likelihood that they will take advantage of common (over conflicting) ground between them and an information source. Additionally, children's general intuitions about whether or not other individuals are likely to keep their word tended to predict the participants' adult-like discrimination between reward conditions when receiving information from others.

In this study there was evidence for the role that memory plays on children's motive-based learning. It is important to note that it was not just a matter of recalling, but also actively manipulating and/or integrating the rules (i.e., working memory) into their decisions, that was predictive of children's adult-like performance. Specifically, all children were typically able to recall, before and after each round, what the consequences of the game were per the reward rules. Nonetheless, only children with higher working memory succeeded at correctly trusting their partner more often during common versus conflicting trials. To my knowledge this is the first study that directly associates children's discerning trust to their working memory abilities.

In addition, a nonsignificant trend indicated that the more children believed that people would not actually keep their word the less they tended to trust partners during common over conflicting trials. Thus, in order for children to fully take advantage of common ground between themselves and a partner, it seems that children could benefit from having had positive experiences that lead them to perceive others as generally trustworthy. There is evidence that other types of generalized mistrust, especially those founded in racial differences, can affect older children's performance in learning environments. For instance, Yeager and colleagues (2014) initially assessed children's

perceptions of whether their school was fair to them and their racial group while assigning various groups to feedback interventions. The assumption was that children's mistrust in the educational system emerges, in part, due to children's uncertainty about teachers' intentions: when receiving critical feedback, racial minority children may interpret the criticism as driven by stereotypes, as opposed to high institutional standards. This mistrust in turn demotivates children from engaging with the feedback that teachers provide for their academic assignments. The authors found that an intervention that clearly emphasized the feedback as a product of the teacher's high standards had multiple positive effects, including raising African Americans' grades. These effects were particularly strong for participants who expressed great mistrust of the school system.

An unexpected result was that, unlike in Experiment 1, children as a group (i.e., without taking into account individual differences from other measures) did not discriminate between reward conditions when guessing, but effectively did so when instructing partners. Further, whereas in Experiment 1 there was an association between children's performances as guessers and witnesses, this was not the case in Experiment 2. Still, the fact that children in the witness role did distinguish between conditions indicates that they understood the task and its rules.

One of the main differences between the two experiments was the incentives used as reward: candy versus golden coins serving as tokens for prizes. It is important to acknowledge that the trust task in the present study was presented as a game, which could have triggered expectations in children that may have not been present otherwise. For example, even young children respond to questions differently based on whether they are

asked in a serious versus playful context (e.g., Grosse & Tomasello, 2012). It is possible that children in the present study were primed to adopt a generally competitive gaming mindset due to the framing that was used. This was particularly likely in Experiment 2, where the use of cumulative coins as rewards and the game being presented in a computer may have reminded children of comparable video game experiences (e.g., the Mario Bros franchise, a popular video game that includes collecting coins) and for the guessing role: Games typically include preprogrammed challenges and locations of collectables that dictate the overall pace (a role more similar to witnessing than guessing in the task). Conversely, players of the games are tasked with the decisions of how to approach these challenges and discover the rewards (a role more similar to guessing than witnessing in the task).

Arguably, children in the current study may have been better aware of their own goals and felt more in control as witnesses. Conversely, they might have been less certain about what the partner intended to do once he or she was the one sending the messages (e.g., help each other vs. challenge them in the game). In that regard, a future direction could be to label the partner as a "teammate" or even frame the task as an activity or test, rather than a game. These adjustments can help further verify whether the trust task used was sensitive only to children's selective learning or also to general problem-solving and "game-savvy" attributes.

# 4. General Discussion

The main goals of the dissertation were to examine whether: (a) children's selective learning from other individuals is influenced by self-interest-related incentives alone, and (b) there are potential socio-cognitive factors that predict children's inference-based trust decisions. Regarding the first goal, there was initial evidence in Experiment 1 that in the absence of prior cooperativeness information, both children and adults aligned their behavior to match self-interests. Specifically, in that experiment participants endorsed messages as guessers more frequently if having common rather than conflicting interests. However, this discerning trust exhibited in Experiment 1 was not replicated in Experiment 2, when children guessed the location of exchangeable tokens. Recently, we were able to document that when candy is used as a reward, even 4-year-olds can trust partners more often during common interests trials in a finding game. Thus, differences in performance between experiments could have been driven partly by the stimulus that was used, but also by broader contextual cues, such as the framing of the study as a game (see section 3.4).

Notably, even in Experiment 1 (where children discriminated between reward conditions as guessers) there were important developmental differences: comparing children and adults' behaviors showed that children were less trusting than adults with partners who had common interests. These differences in performance motivated the study's second goal: exploring potential socio-cognitive factors affecting children's inference-based trust decisions. Out of all the candidate variables—working memory, generalized trust, interpretive ToM, recursive awareness, and age—only the first variable

systematically exerted an effect on children's ability to learn selectively from their partners. Specifically, children with higher memory skills were more likely to demonstrate an understanding that motives can affect other individuals' reliability. This understanding was reflected in children's decisions to trust partners more frequently during common versus conflicting trials. Additionally, a nonsignificant trend suggested that children who were generally trusting of others tended to endorse their partner's messages more often when both benefitted from a successful guess.

The finding that working memory predicted adult-like performance in the task raises the question of whether this association is limited to experimental settings or is also representative of real-life decision making. On the one hand, when a child is presented with novel individuals and/or contexts it is central for the child to keep track of those individuals' reputations and/or cues associated with their reliability. Arguably, the greater the child's capacity to maintain and manipulate information (i.e., working memory), the more effectively can he or she navigate an unfamiliar scenario—allying with reliable partners and avoiding potential exploiters. On the other hand, if the reliability of a group of individuals already is well documented (e.g., individuals are part of safe and proven environments, such as parents at home or friends at school), it would be reasonable to expect that greater memory capacity may not exert much influence in whether or not children trust selectively.

It was rather surprising that children's ability to reason recursively (e.g., thinking about what the partner is thinking they are thinking) was not associated with performance in the game. One possibility is that, instead of thinking about the partner's own behavior

and thoughts, children might have focused only on their own experience in the game and deducted behavioral rules of what to do for each reward rule. However, children's explanations about why (or why not) partners may have tricked them during conflicting (Experiment 1) and common trials (Experiment 2) suggest that at least some of them reasoned about their partners, even if a posteriori. A potential complementary explanation is that the measure that was used may have not fully captured individual differences related to the trust task, as it was focused on what others thought of. In contrast, the trust task was about others' motivations. Thus, it is still possible that a measure that directly tests children's reasoning about what other individuals intend to do might be a better predictor of children's trust behavior.

Another unexpected outcome was the lack of association between children's over-interpretive ToM and their discerning trust. The premise was that children who showed an over-interpretive ToM could also be wrongly assuming that partners were interpreting the rules differently—and thus would exhibit lower trust during common trials than children with a "proper" ToM. When looking at the actual scores, it is possible that a ceiling effect masked any potential association between these two variables; overall, there were relatively few "over-interpreters" as only 5 out of 40 children scored 3 or less (out of 6 maximum points) on the task. Perhaps larger participant samples or a more difficult task could increase the possibility of capturing individual differences in these measures, as well as the detection of additional statistical associations.

It was expected that working memory would not be affected by age, as children's raw scores were normalized via the WISC-IV's scaled scores. Experiment 2 did

successfully replicate prior findings associating children's recursive reasoning with their age. However, there were no age differences in children's over-interpretive ToM. As described above, this failure to replicate any findings related to this ToM task (i.e., trust or age related) may have been a product of the lack of power and/or task difficulty. In addition, age not having an effect on children's performance in the trust game was a consistent outcome in both experiments—and accords with prior findings on the developmental trajectory of self-interest-based credibility judgments (i.e., in hypothetical scenarios, see Mills & Keil, 2005). This result opens the possibility that any additional cognitive maturation taking place between ages 7 and 10 may not be a significant factor in children's ability to succeed in the trust task.

Overall, the findings reported in the two experiments suggest that by the elementary school years children have some intuitions about the role that underlying motives can have on people's credibility. However, the facts that (a) children's performance was not consistent across experiments and (b) their performance was not on par with that of adults indicate that even at 10 years of age children's integration of self-interest information is still not fully matured. Much debate exists regarding the developmental trajectory that characterizes children's balancing of skepticism and credulity. On the one hand, a popular view portrays children as being: "…especially credulous, especially gullible…yet to master the intricacies of doubt" (Gilbert, 1991, p.111), and having "a specific, highly robust bias to trust [other individuals'] testimony" (Jaswal et al., 2010, p.1546). This view has been supported by young children's failure to trust selectively when person-specific information such as a partner's history of accuracy

is available (e.g., Jaswal et al., 2010; Mascaro & Sperber, 2009). On the other hand, past research has also shown that children can appear to be overly skeptical in other domains: when evaluating the possibility of improbable events like getting struck by lightning (Shtulman & Carey, 2007) or the reality status of novel entities such as a machine that tells you if there is metal nearby (Cook & Sobel, 2011).

A compelling thesis founded on recent empirical and theoretical contributions, along with the present findings, is that the developmental issue is not whether young children are inherently credulous or skeptical. Instead, the challenge that children face is to overcome generalized difficulties when reasoning about other people's knowledge, motives, and/or behavior. Two factors that appear to increase young children's selective learning from others are: (a) the opportunity to gain confidence in their predictions and (b) the presence of multiple cues associated with reliability. Contrasting findings on preschoolers' trust decisions best illustrate these claims: When evaluating statements from a lone unfamiliar individual, 3-year-olds fail to trust selectively; that is, they trust trickers (Vanderbilt et al., 2009), false labelers (Vanderbilt, Heyman, & Liu, 2014), and big liars (Mascaro & Sperber, 2009, Experiment 2b).

Notably, 3-year-olds' selectivity improves when provided with relevant experience; that is, having opportunities that increase their confidence when predicting reliability. For example, Nurmsoo and Robinson (2009) gave children an opportunity to provide information and experience first-hand situation-specific constraints (lack of visual access) of an informant before hearing his testimony. The participants then showed discriminating trust when playing a labeling game. Moreover, there is evidence that even

2- to 3-year-olds are more likely to mistrust a single unreliable individual when confident in their own judgments (Jaswal, 2010; Experiment 4; Krogh-Jespersen & Echols, 2012, familiar labels; Ma & Ganea, 2010; Experiment 2-3). In the present study, an additional difference between Experiments 1 and 2 was that children from Experiment 1 played as witnesses for half of the game. It is possible that, in addition to the simplicity of the rewards, having had that extensive experience as informants increased children's confidence in their predictions and facilitated selectivity about their partners' testimony. However, future research is needed to directly evaluate this argument.

A second factor that seems to influence children's selectivity is being presented with a combination of cues associated with reliability. For example, 3-year-olds mistrust a sole inaccurate individual if provided with behavioral (object mislabeling) plus situational (individuals' visual access) indicators of reliability (Nurmsoo & Robinson, 2009). Similarly, 3-year-olds trust selectively when an individual is associated with multiple reliability-related attributes (e.g., a familiar source portrayed as scary, mean, and tricky; Heyman et al., 2013, baseline vs. deception condition) or when being explicitly presented with multiple statements (e.g., two sources simultaneously provide contrasting novel names; Koenig et al., 2004). It would be interesting to determine whether, for example, manipulating the identity of the partner in the candy game would also aid children's performance (see Future Directions).

### 4.1. Future Directions

As mentioned in the introduction, a limitation that pertains to previous studies is that there has been little exploration of mechanisms behind children's motive-based

selectivity. This shortage represents a valuable opportunity for future research. In the present study the role of working memory was documented. However, it remains unknown whether other executive function components such as inhibition and switching skills also play a role in children's inferences from motives exclusively. For example, inhibition may have been critical for adults to restrain any preconceptions produced by playing with a stranger, and to favor the rational argument that partners who benefit from one's success are likely to be helpful. Similarly, shifting skills may have been useful for flexibly assigning the same individual to opposing categories such as partner-reliable or partner-unreliable, depending on the game rules.

This study also raised the possibility that social and experiential factors like children's generalized trust might play a role on their learning decisions. It would be interesting to investigate what early experiences could affect children's general intuitions about others' likelihood of keeping their word. For example, to my knowledge it is not clear if children's birth order, or even whether or not they have an older sibling, leads them to be overly mistrusting in limited-resources scenarios. It is also possible that children (and perhaps adults) with various attachment styles will approach tasks like the one presented in this study differently, with insecurely attached individuals being most mistrusting of their partners. More broadly, it would be useful to integrate feedback into the trust task so as to verify whether, even if children may not infer trustworthiness from rules alone, they can nonetheless become selective with feedback. An ongoing study with preschoolers using a modified version of this trust paradigm suggests that, with feedback,

even 4-year-olds can learn to trust partners more often during common than conflicting trials.

Finally, it would be interesting to determine the effect, if any, that affiliation cues have on children's trust in partners during common interest trials. When having an opportunity to assist other individuals with whom they are affiliated, children often behave helpfully: Children share more material resources with friends and (unfamiliar) in-group members than with non-friends and out-group members (e.g., Engelmann, Over, Herrmann, & Tomasello, 2013; Moore, 2009; Olson & Spelke, 2008). Further, children predict that people feel greater obligation to help (and are happier when successfully helping) members of the in-group versus out-group (e.g., Weller & Lagattuta, 2013). In the present study children played the game with unfamiliar partners. It is possible that when paired with in-group partners children will be more likely to take full advantage of common ground.

### 4.2. CONCLUSIONS

For societies to function properly, its members need to identify dependable partners with whom to exchange goods, services, and favors (Fehr & Rockenbach, 2003). If a potential collaborator is completely unfamiliar, trustworthiness often must be deduced. The ability to predict reliability from situation-specific cues to motives is invaluable in such circumstances. This study shows that elementary school children sometimes are proficient at predicting the motive-based behaviors of others. These predictions improve with development, aided by enhanced working memory skills and a greater ability to integrate multiple cues during complex experimental tasks (as well as,

potentially, positive experiences that increase children's generalized trust in others). Thus, as their social cognition develops, children may not simply transition from credulity to skepticism. Instead, children may become increasingly competent at deducing credibility from the underlying motivations of other individuals.

# Appendix A: Working memory task

Children were read a sequence of numbers and then asked to repeat them. In the first phase children had to repeat the sequence in the same order in which they heard it. During a second phase the sequences had to be repeated backward.

**DIGITS FORWARD**

**READ TO CHILD:**

I am going to say some numbers. Listen carefully, and when I am through, say them right after me.
SAY: "Ready" BEFORE EACH QUESTION.

***(One item is shown per screen; e.g., item 1A is shown on one screen, and item 1B on the next)***

| | | CORRECT | WRONG |
|---|---|---|---|
| 1. | **A. 3 - 8 - 6** | **1** | **2** |
| | **B. 6 - 1 - 2** | **1** | **2** |

*CAPI CHECK: IF BOTH A & B ARE CODED WRONG, SKIP TO DIGITS BACKWARD.*

**DIGITS BACKWARD**

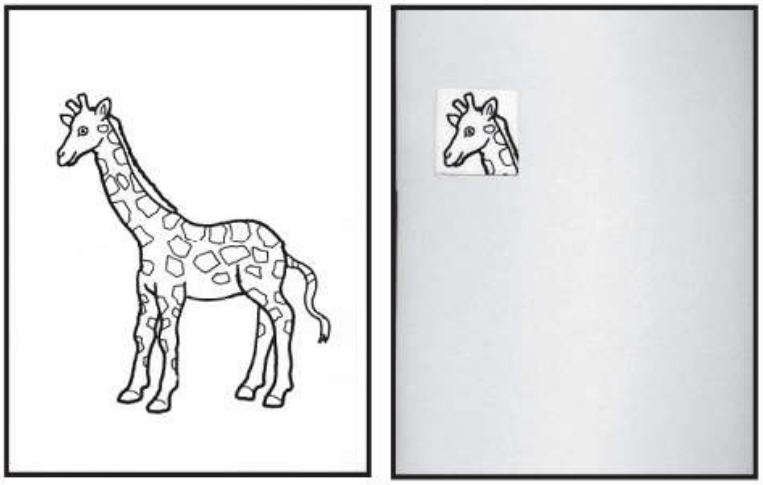
**READ**: Now I am going to say some more numbers, but this time when I stop, I want you to say them backward. For example, if I say 9-2-7, what would you say?

**PAUSE FOR THE CHILD TO RESPOND. DID CHILD RESPOND CORRECTLY (7-2-9)?**

YES ☐.(7-2-9) SAY: That's right. Let's go on with the rest of the numbers. **PROCEED TO 1ST ITEM**

NO☐. SAY: No, you would say 7-2-9. I said 9-2-7, so to say it backward you would say 7-2-9. Now try these numbers. Remember, you are to say them backward: 3-6-5.

## Appendix B: Interpretive theory of mind



Procedure (extracted from Lagattuta et al, 2010):

Participants watched one character (Sam or Alex, counterbalanced) come out of his or her house and view a black-and-white drawing. The character labeled the picture (e.g., “Ooh, a giraffe”) and went back inside the house. Then, the experimenter covered up the picture with a laminated opaque card that had a clear window revealing a small part of the picture. The experimenter then took both characters out of their houses to view the obstructed picture.

Participants were asked three test questions about the thoughts of Sam and Alex: (a) “Sam [has/has never] seen this picture before, what will Sam think this is?” (b) “Alex [has/has never] seen this picture before, what will Alex think this is?” (c) “Why [did/didn’t] they think the same thing?” (whatever the participant predicts). After children answered the questions about Sam and Alex, a third character, Joe, drove up in his/her car. The experimenter said, “Look, here comes Joe. He/she (gender matched to Sam and

Alex) did not see or hear what we were doing." Then, the last test question was: (d) "Joe has never seen this picture before; what will Joe think this is?" For each correct answer of questions a, b, and d, children got 1 point, for a total of 3 points per trial (two trials in total).

## Appendix C: Generalized mistrust

A trust index was formed by averaging children's responses to a subset of questions (listed below) extracted from Rotenberg's trust questionnaire (Rotenberg et al, 2005). The items were rated by participants on a scale from 1 – 4 (1 = Very unlikely, 2 = A little unlikely, 3 = A little likely, 4 = Very likely).

**Neutral/No outcome:**

A. *Sarah's* Mother said that if she cleans her room she can go to bed half-an-hour later. Sarah cleans her room. How likely is it that Sarah's Mother will let Sarah go to bed half-an-hour later?

A. *Lorraine's* father said that he would take her to the cinema on Saturday. How likely is it that Lorraine's father will take her to the cinema?

A. Louisa says that she will share her chocolate bar with *Claire* at lunchtime. How likely is it that Louisa will share the chocolate bar with Claire?

A. *Tina* tells her Mother that she held hands with a boy at school, but asks her Mother not to tell anyone. How likely is it that Tina's Mother will not tell others about it?

A. *Paula* made a present for her Mother for her birthday. Paula asked her Father not to tell her Mother what she had made. How likely is it that Paula's Father will not tell her Mother about the present?

A. *Lucy* tells her teacher that she saw two other children fighting in the playground. She asks the teacher not to let the other children know who told her about the fighting. How likely is it that the teacher will not tell the children?

A. *Gaby* brings some sweets to school. Gaby asks her friend not to tell anyone about the sweets so she does not have to share them with all of the other children. How likely is it that Gaby's friend will not tell the other children about the sweets?

**Negative/Additional outcome info:**

A. The teacher told *Suzy's* class they were going to watch a video instead of doing their maths lesson. The teacher said that the video was lost. How likely is it that the video was lost?

A. *Martha's* mother said she would lend her, her new music CD. However, Martha's Mother is enjoying having it whilst in the car. How likely is it that Martha'a Mother will lend the music CD to Martha?

A. *Charlotte* asks her Father if she can borrow his fishing rod. Her Father has said he has lent it to someone else. How likely is it that her Father has lent the fishing rod to someone else?

A. The school netball team has just been formed. *Michelle* volunteers to be part of the team but teachers and classmates know that Michelle is *not* good at netball. The games teacher tells Michelle that there are no longer any places left on the team. How likely is it that there are no places left on the team?

A. *Karen* asks Nicola to go to the cinema. Nicola says she can not go because she feels tired. How likely is it that Nicola is tired?

## Appendix D: Recursive awareness

Children saw pictures depicting a subset of scenarios (listed below) from Miller et al. (1970):

| Item type | Scenario |
|---|---|
| General ToM | The boy is thinking of the girl and father |
| | The boy is thinking of the girl |
| | The boy is thinking of the girl, father, and mother |
| | The boy is thinking that the girl is talking to father |
| | The boy is thinking that he is talking to the girl |
| Recursive loops | The boy is thinking that he is thinking of the girl |
| | The boy is thinking that the girl is thinking of father |
| | The boy is thinking that the girl is thinking of the father thinking of mother |
| | The boy is thinking that the girl is thinking of him thinking of her |

Then they were read each scenario (one at a time) and asked to point to the picture that depicted it. Some sample pictures have been include ed in the next page.

CONTIGUITY (Item no. 3)

ACTION (Item no. 9)

ONE-LOOP RECURSION (Item no. 14)

TWO-LOOP RECURSION (Item no. 15)

# Appendix E: Children's Explanations, Experiment 2

| Trick? | Why/Why not? |
|---|---|
| No | So we both could get a coin. |
| No | If they trick me, then they will have a good chance of not getting a coin. |
| No | Knew the answer. |
| No | Because he would say it might all the true, because he knows that if prove right he also gets a coin. |
| No | Because, of course, they want to get coins too, so they won't trick me. |
| No | Well the other player may not have tricked me, but you can never be sure, still, I don't know. |
| No | They probably sent me the correct message. |
| No | Looked what it says and got it right. |
| No | Because I didn't trick him, and I got some wrong. |
| No | I make quick friends. |
| No | Not really but sometimes; some people is not their thing to do like this. So, I personally don't follow them. |
| No | Judging by how many coins I got in the end, we can say he didn't trick me. |
| No | The other player sent the right messages so that we both could get coins. |
| No | He wouldn't get a coin and neither would I. So, he wouldn't trick me. |
| No | They might be younger than me. |
| No | Just didn't think so. |
| No | It would be rude if the other player tricked me. |
| No | Too many blue not many red. |
| No | So, he can also get coins. |
| No | If they did, I would get mad, but, I don't think they will try to trick me. |
| No | They also want coins. |
| No | Because we would have both lost. |
| No | I'm sure the other kid wouldn't be mean or try to trick me. |
| No | He wanted coins and he wanted us to get coins. |
| No | Both get coins. |
| No | Easy game? |
| No | Never played before. |
| Yes | Because maybe they might not want to get that many coins. |
| Yes | Maybe he was tricking me so he can get more coins than me. |
| Yes | Some people try to trick you. |
| Yes | Maybe once. |
| Yes | The other player told the truth because we both could get coins. |
| Yes | The other player tricked me sometimes, but it's hard to explain. |
| Yes | The other player tried to trick me. |
| Yes | Sometimes the other player tried to trick me. |
| Yes | The other player might have pressed the wrong button to get more coins than me. |
| Yes | I also tried to trick the other player, so, I thought he would do that, too. |

| | |
|---|---|
| Yes | They might have not wanted me to have lots of coins. |
| Yes | I had to depend on him because he can have lots of coins. |

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# Vita

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