

CHILDREN'S LIE DETECTION ABILITY

THE DEVELOPMENTAL COURSE OF CHILDREN'S LIE DETECTION ABILITY

A Thesis

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ABSTRACT

Previous research has investigated children's lie-telling behavior, and adults' lie detection abilities. Less work has examined children's ability to accurately identify a lie from others' statements, and the factors that may impact this skill. The current study aimed to investigate the developmental course of children's lie detection ability, and the role that a child's age, theory of mind comprehension, and exposure to socially conforming and authoritarian parenting may have on children's detection accuracy. Analyses revealed that children's accuracy in detecting lies within statements made by other children improved with age. Additionally, three to four-year olds held truth biases towards statements made by both other children and adults. This work highlights the importance of lie detection as a developmental marker in children's social cognition and can have significant forensic implications.

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BIOGRAPHICAL SKETCH

Vivian Rotenstein graduated with a Bachelor of Arts degree in Psychology from the University of Southern California in 2016. She is currently pursuing her PhD in Human Development at Cornell University, with a concentration in Law, Psychology, and Human Development. Her research explores areas which combine tenets of developmental and social psychology to inform legal issues. Specific topics of interest include children's deception detection, and children and adults' attitudes (implicit and explicit) about criminality and justice.

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Introduction

From telling a small white lie to making false statements that can have more serious consequences, the act of lying is an extremely common, normative human behavior.

A lie is a false statement made intentionally and knowingly by the liar, and without prior warning to its recipient. Additionally, a lie is inherently social in nature, always involving at least two individuals (Zuckerman, DePaulo & Rosenthal, 1981; Mahon, 2008). Lies can vary in their quality: they can be outright - statements which are entirely contrary to the truth, exaggerations – an overstatement of true facts, or subtle – statements which are intended to mislead the recipient and may omit some truthful details (DePaulo et al., 1996).

Regardless of the nature of the lie, the act of lying may be motivated by individual or other-oriented reasons. One may lie for personal, self-centered reasons - to avoid punishment or embarrassment, or to impress or gain respect from someone else. Lies may also be produced for more socially-oriented reasons – to be polite, to avoid tension within a social relationship, or to obtain a social advantage. (DePaulo et al., 1996).

Moreover, prior work has argued that from an evolutionary perspective, possessing the ability to lie and deceive others is in fact biologically advantageous and necessary for optimal survival. That is, the ability to deceive others allows for selective advantage, and is an integral skill in creating fluid social interactions and relationships (Bond & Robinson, 1988; McNally & Jackson, 2013).

Children's Lie-Telling Behavior

Prior research has demonstrated that from the age of two years old, children are able to tell a lie both consciously and intentionally (Ahern, Lyon, & Quas, 2009; Evans & Lee, 2013).

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Moreover, the types of lies children tell change with age. Around two years old, children can begin to tell primary lies - statements that are simply factually untrue. Around the age of four or five, children develop the ability to tell secondary lies - factually untrue statements made with the additional understanding that the recipient of the lie is unaware of the true reality. Lastly, around seven or eight years old, the ability to tell tertiary lies emerges. That is, children are able to tell a lie and also sustain the lie across follow-up statements and questions, a skill known as semantic leakage control (Talwar & Lee, 2002; Evans & Lee, 2013).

The types of lies children tell additionally change with age, but the motivations underlying their lies generally mirror those of adults. During early childhood, around two or three years old, children will tell lies for self-serving purposes, to achieve a personal goal such as avoiding punishment for a transgression. For example, employing what is known as a temptation-resistance paradigm, in which a child is told to not peek at a hidden toy while the experimenter leaves the room, multiple studies have demonstrated that starting at two or three years old, children will lie to the experimenter and tell them they did not peek at the hidden toy, when they in fact did (Lewis, Stanger, & Sullivan, 1989; Polak & Harris, 1999). Beginning at around five years old, children's lies become more socially-oriented (either pro-social or anti-social). They may tell a lie to be polite towards others or in order to flatter or please someone else (Fu & Lee, 2007; Talwar, Murphy, & Lee, 2007), or to improve another individual's mood (Warneken & Orlins, 2015).

Cognitive Skills Involved in Children's Ability to Tell a Lie

A large body of work has confirmed that children's ability to tell lies advances in parallel with the development of various social-cognitive skills such as theory of mind, working memory, and inhibitory control.

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Moreover, lie-telling requires inhibitory control skills - to be able to simultaneously make a false statement while also not revealing the truth, and working memory capabilities - to be able to simultaneously remember both the truth and falsehoods of a situation (Talwar & Lee, 2008; Alloway et al., 2015).

Additionally, the act of telling a lie inherently requires an understanding of false belief, a component of theory of mind involving the recognition that others can have intentions and beliefs different from one's own, and that those beliefs can be an inaccurate reflection of reality (Gopnik & Astington, 1988; Miller, 2009). Prior work has demonstrated that among normative populations, children's understanding of false belief and theory of mind capabilities as a whole are not solidified until four or five years old (Baron-Cohen, Leslie, Frith, 1985; Bigelow & Dugas, 2009), but that as this understanding develops, children's lie-telling ability and frequency increases accordingly (Ding et al., 2015; Ma et al., 2015; Lavoie et al., 2016).

Social and Ecological Factors Impacting Children's Lie-Telling Behavior

Despite a substantial body of work espousing that lie-telling is a common behavior that is part of a child's normative social-cognitive development, certain theories such as Hartshorne and May's Doctrine of Specificity (1930) - which holds that a child's tendency to lie or cheat is situationally-specific, rather than being a constant character trait - qualify the universality of children's lie-telling behavior.

Moreover, prior work has argued that children's lie-telling is a socially-learned behavior, that can be prompted or influenced by cultural norms (Choi, Park, & Oh, 2011), observations of parents' own lying behavior (Hays & Carver, 2014), or the level of strictness and authoritarian parenting children are exposed to (a factor which can also in turn dictate to what extent parents condone lying in their household).

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For example, several studies have found that a child's exposure to a highly authoritarian and socially-conforming parenting style can subsequently lower their lie-telling frequency, namely by limiting the child's willingness to question the authority, veracity and trustworthiness of a parental figure's statements (Ma, Evans, Liu, Luo, & Xu, 2015; Talwar, Lavoie, Gomez-Garibello, Crossman, 2017).

Lie Detection in Adults

Given the ubiquity of lie-telling in both children and adults, being able to detect when someone else is lying is of primary importance. Interpersonal lie detection requires the ability to decipher either subtle, non-verbal cues and behavior (e.g. a liar's lack of smiling, gaze aversion, body language and movements, their physiological arousal) or a liar's more overt, verbal behavior, such as their speech content, pitch, rate, and fluency (Vrij, Edward, Roberts, & Bull, 2000).

Most experimental work in the lie detection domain has limited its scope to examining this ability in an adult population. Prior work has yielded mixed findings in searching for clear, stable individual differences in lie detection ability (Frank & Ekman, 1997; Frank & Ekman, 2004; Bond & DePaulo, 2008), but has argued that in assessing statements made by either other adults or children, adults are generally poor lie detectors.

Moreover, across multiple studies, adults of varying expertise level (from judges and expert forensic interviewers to novices), were shown to perform at or below chance level in their lie-detection judgments of children's statements (Nysse-Carris, Bottoms, & Salerno, 2011; Shao & Ceci, 2011; Gongola, Scurich, & Quas, 2017).

Additionally, even individuals with prior interrogation experience, such as law enforcement officials or customs officers, have been shown to not necessarily be more accurate

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in their lie detection of children's statements than the lay public (Leach, Talwar, Lee, Bala, & Lindsay, 2004). For example, in a 2006 meta-analysis of 206 studies examining judges' lie-detection accuracy, judges who had not received any prior training in specific deception detection strategies achieved an overall lie/truth detection accuracy rate of only 54%, slightly above chance level (Bond & DePaulo, 2006).

Factors Contributing to Poor Lie Detection

Multiple explanations have been proposed to try to account for adults' consistently sub-par lie detection abilities, including deficient social-emotional skills (Riggio, Tucker, & Throckmorton, 1987), or a general hesitancy to call out others' deceptive behavior, given the possible aggressiveness of doing so (O'Sullivan, 2003).

Additionally, various truth or deception biases may be at play in making veracity judgments, which can subsequently lower accuracy rates. For example, a lie bias - the tendency to consistently believe others are lying - has been seen in police officers' judgments of statements (Ekman, O'Sullivan, & Frank, 1999).

Alternatively, a truth bias, or the tendency to believe someone is consistently telling the truth, has been identified in certain studies of adults' veracity assessments. For example, parents are likely to hold a truth bias towards their own children's statements, diminishing their lie detection accuracy (Talwar, Renaud, & Conway, 2015; Evans, Bender, & Lee, 2016).

Lie Detection in Children

Beyond children's lie-telling behavior and adult's lie detection abilities, one area which has been understudied and has yielded mixed findings is a child's ability to detect a lie, and the factors that may affect this capacity.

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Past work has identified that from the age of three or four, children take a speaker's level of intentionality into account in evaluating if a statement is a truth or a lie (Bussey, 1999). Beginning around five or six years old, a statement's factuality (Strichartz & Burton, 1990), its plausibility (Lee, Cameron, Doucette, & Talwar, 2002), and whether the lie is anti-social or pro-social in nature (Eskritt & Lee, 2016) become important factors in a child's identification of a lie.

Beyond the impact of qualities of the statement being assessed on lie detection, findings have been mixed as to age-related changes in lie-detection ability. Some work has demonstrated that sixth graders (DePaulo, Jordan, Irvine, & Laser, 1982) and four through nine-year olds (Talwar, Crossman, Gulmi, Renaud, & Williams, 2009) were all below chance level in their lie detection, whereas other work has found that four through seven-year olds (Bussey & Grimbeek, 2000) were above chance level in their identification of lies.

Moreover, very few studies have examined individual and situational factors specific to the child lie-detector, beyond age, that may affect their lie detection accuracy and expressed trust in a lie-teller.

Present Study

The present study aimed to investigate the developmental course of children's ability to accurately detect lies in statements made by other children and another adult, specifically an adult mother figure. Statements by both children and an adult were included in order to examine the impact that the age and status of a lie-teller may have on children's lie detection ability.

Expanding upon previous literature, the study additionally sought to examine the role that other individual and situational factors, beyond age, may play in a child's ability to accurately detect a lie. Namely, the current study examined the impact of a child's theory of mind comprehension and their degree of exposure to authoritarian and socially-conforming parenting.

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It was hypothesized that compared to older children (categorized in the current work as five to eleven-year olds), younger children (categorized here as three to four-year olds) would be less accurate in their lie detection of both other children and mothers' statements. Moreover, it was posited that this lowered ability would be driven by a lower theory of mind comprehension level in younger children (three to four-year olds), compared to older children (five to eleven-year olds).

It was additionally hypothesized that across age groups, those participants who were exposed to a higher degree of authoritarian parenting, and whose parents endorsed socially-conforming attitudes to a greater extent, would subsequently have lower lie detection accuracy in their assessments of both other children's and a mother's statements. This finding would be in line with prior work in the lie-telling literature which has found that exposure to highly authoritarian and socially conforming parenting lowered a child's lie-telling frequency (Ma et al., 2015; Talwar et al., 2017).

Driven by prior work demonstrating various truth and lie biases in adults' lie detection, the present study additionally sought to examine whether or not children also hold implicit truth biases in their own lie detection. Moreover, if a bias is present in children, at what age might this bias emerge, and for whom (other children or other adults) might this bias be towards? Stemming from a large body of work confirming the importance and significant impact of the early mother-child relationship (Ainsworth & Bell, 1970; Corriveau et al., 2009), it was hypothesized that participants in the younger age group (categorized here as three and four year olds) would hold a truth bias towards statements made by an adult mother -- that is, to consistently believe that the mother's statements would be true.

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Lastly, the current study sought to explore children's perceptions of trust towards other children and adults who may be telling a lie.

Methodology

Participants

Approximately one hundred and seven preschool and elementary school aged children completed all tasks associated with the current study. Participants were recruited from demographically similar schools in the Ithaca and Los Angeles area. Within the one hundred and seven total participants, there were forty-six preschoolers (aged three to four years old), and sixty-one elementary-school aged children (aged five to eleven years old). An a-priori power analysis revealed that approximately forty-two participants per age group (total $N = 84$) would be needed to achieve 80% power, assuming a 30% difference in proportions among the two age groups.

Participants' age ranged from three to eleven years old ($M_{age} = 6.27$, $SD = 2.82$). Participants were 54.2% female (58 participants), 44.9% male (48 participants), and there was one trans female participant (0.9%). The participants were 63.6% White, 4.7% Black, 11.2% Asian, 5.6% Indian, 4.7% Hispanic, and 10.3% were mixed race.

Materials

Story Presentation:

All participants were presented with a hypothetical story about two boys named Zach and Adam, who sit down at a playground to play a card game with Zach's set of cards. Participants were told that after some time the two boys get into an argument about the game and start to yell at each other. Later on, Zach goes home and tells his Mom what happened to him on the playground.

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Experimental Manipulations:

For the subsequent story information, participants were randomly assigned to one of four experimental conditions. A 2x2 between-subjects design was implemented, wherein Zach either tells the truth or a lie to his Mom about what happened to him with Adam, and Zach's Mom goes to a police officer and either repeats or changes Zach's statement. Zach's Mom's statements are either an accurate or inaccurate reflection of the reality of the playground conflict.

Each condition is explained in further detail below.

In *Condition 1*, Zach states the truth to his Mom about what happened to him on the playground— that Adam yelled at him. Next, Zach's Mom goes to a police officer and repeats Zach's statement (that Adam yelled at Zach), which is an accurate reflection of the reality of the situation.

In *Condition 2*, Zach tells his Mom what happened to him on the playground and states the truth – that Adam yelled at him. Next, Zach's Mom goes to a police officer and changes Zach's statement (stating that Adam hit Zach), an inaccurate reflection of the reality of the situation.

In *Condition 3*, Zach tells a lie to his Mom about what happened to him on the playground – stating that Adam hit him. Next, Zach's mom goes to a police officer and repeats Zach's statement (that Adam hit Zach), an inaccurate reflection of the reality of the situation.

In *Condition 4*, Zach tells a lie to his Mom about what happened to him on the playground – stating that Adam hit him. Zach's mom then goes to a police officer and changes Zach's statement (stating that Adam yelled at Zach), which is an accurate reflection of the reality of the situation.

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Overall, regardless of condition, Zach's Mom never knows what actually happened to her son since she was not present during the initial playground argument; she only knows what Zach told her about the situation.

Sally-Anne Task (Baron-Cohen, Leslie, & Frith, 1985)

The Sally-Anne task (Baron-Cohen, Leslie, & Frith, 1985) is a standard assessment of second-order Theory of Mind ability and children's understanding of false belief, the notion that someone may hold incorrect beliefs that diverge from the true reality. In this task, participants were introduced to a character named Sally, who has a basket and a red marble, and Anne, who has a box. They were told that Sally puts her red marble into the basket, and then leaves. While Sally is gone, Anne takes Sally's red marble out of the basket, puts it into her box, and leaves. At the end of the story, Sally returns and is unsure where her marble is. Following this scenario presentation, participants were asked a series of recall questions: to identify each story character, where the red marble was at the beginning and end of the story, and where they think Sally will look for her marble.

Authoritarianism Scale (Feldman & Stenner, 1997)

Feldman & Stenner's Authoritarianism Scale (1997) includes a set of four questions, each containing a pair of opposing child-rearing related values – independence or respect for elders, obedience or self-reliance, curiosity or good manners, or being considerate or being well-behaved. The scale has an estimated reliability of 0.66. Participants' parents were asked to indicate which item from each pair of values they felt was most desirable and important for their child to possess. Authoritarian responses given (selecting independence, self-reliance, curiosity, or self-reliance) were coded as a 1, and non-authoritarian responses given (selecting having

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respect for elders, obedience, good manners, or being well-behaved) were coded as a 0.

Responses were then summed to create a total score out of four, per respondent.

Social Conformity - Autonomy Beliefs Scale (Feldman, 2003)

Feldman's Social Conformity – Autonomy Beliefs Scale (2003) includes a set of seventeen total paired items, with each pair of items including two contrasting values relating to the contrast between social conformity and personal autonomy. The seventeen items are subdivided into five categories – conformity versus autonomy, freedom versus fear of disorder, respect for common norms and values, social cohesion, and socialization and child-rearing values. These subcategories each reflect different components of the conformity versus autonomy construct. The additive scale has a reliability (alpha α) of 0.80. Participants' parents were asked to indicate which item from each pair of values they agreed most strongly with. Socially-conforming responses selected from each pair of items were coded as a 1, and non-socially conforming responses selected were coded as a 0. Responses were then summed to create a total score out of seventeen, per respondent.

Design

The current study employed a 2 (Zach truth-telling status) x 2 (Zach's Mom either repeats or changes Zach's statement) fully randomized between-subjects design. Namely, participants were randomly assigned to one of four experimental conditions (see Table 1).

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Table 1:

Experimental Conditions

	Mom Repeats What Zach Says	Mom Changes What Zach Says
Zach Tells the Truth	<p>CONDITION 1: {N = 26}</p> <p>-Zach tells the Truth -Mom Repeats Zach's Statement & is <i>Accurate</i></p>	<p>CONDITION 2: {N = 20}</p> <p>-Zach tells the Truth -Mom Changes Zach's Statement & is <i>Inaccurate</i></p>
Zach Lies	<p>CONDITION 3: {N = 32}</p> <p>-Zach Lies -Mom Repeats Zach's Statement & is <i>Inaccurate</i></p>	<p>CONDITION 4: {N = 29}</p> <p>-Zach Lies -Mom Changes Zach's Statement & is <i>Accurate</i></p>

Procedure

All participants were first presented with the aforementioned story content about Zach, Adam, and Zach's Mom through story board images on a laptop screen. The storyboard images were created using Pixton software.

Next, participants were asked a series of questions to assess their memory of the story details – what game Zach and Adam were playing, and who Zach's Mom went to talk to after Zach spoke with her. They were then asked if Zach and his Mom told the truth when they stated what happened to Zach on the playground. They were also asked to provide a rating of the extent to which they trust Zach and his Mom, on a scale of 1 (Not At All) to 3 (A Lot).

Afterwards, participants were given the Sally-Anne task (Baron-Cohen, Leslie, & Frith, 1985), to assess their comprehension of false belief. After the story concluded, participants were asked a series of story recall questions: to identify each story character, the location of the red

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marble at the beginning and end of the story, and where they thought Sally would look for her marble when she returned.

Separately, participants' parents were given two aforementioned questionnaires to assess the degree to which they endorsed authoritarian parenting attitudes (Feldman & Stenner, 1997), and their attitudes towards social conformity (Feldman, 2003).

Lastly, participants were thanked for their participation and given a sticker as a reward.

Data Analyses and Results

Theory of Mind

In order to test the hypothesis that three to four-year children would perform more poorly on assessments of second-order theory of mind compared to five to ten-year-old children, a binary logistic regression was conducted. The regression tested participants' theory of mind accuracy (0 = Incorrect, 1 = Correct), as predicted by age group – a categorical variable composed of younger, preschool-aged children (aged three to four years old), and an older group composed of five to eleven-year olds. {see *Table 2*}.

Age group was found to be a significant predictor of participants' theory of mind accuracy ($\beta = 1.023$, $SE = 0.44$, Wald (1) χ^2 , 5.32, $p = 0.02$). The odds ratio indicates that going from a preschool aged participant group (aged three to four), to participants aged five to eleven years old, the odds of participants being accurate on the Sally-Anne task increased by a factor of 2.78.

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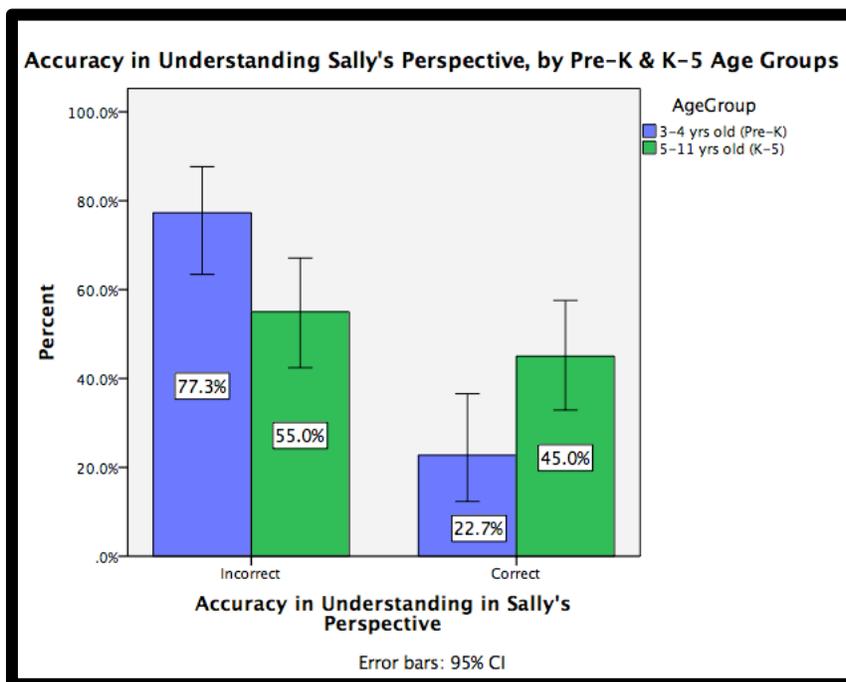
Table 2: Binary Logistic Regression Predicting Participants' Theory of Mind Accuracy by Age Group

Variable	β	SE	Wald χ^2	p	Odds Ratio	95% CI Odds Ratio
Age Group	1.023	0.44	5.32	0.02**	2.78	[1.17, 6.64]

Targeted chi-square tests of independence were run to disaggregate the significant effect of age group on theory of mind accuracy $\{\chi^2 (1, N = 104) = 5.49, p < 0.05\}$. {See *Figure 1*}.

More specifically, the proportion of three to four-year-old children who answered the theory of mind assessment incorrectly was significantly different than the proportion of five to eleven-year-old children were incorrect (77.3% of 3-4 year olds $\{N = 44\}$ vs. 55% of five to eleven year olds $\{N = 60\}$).

Figure 1: Participants' Theory of Mind Accuracy, by Age Group



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Lie Detection Accuracy

Analyses were conducted to assess the influence of age group, theory of mind accuracy, and parents' expressed degree of authoritarian and socially-conformity attitudes, on participants' lie detection accuracy in evaluating Zach and Zach's mother's statements.

Lie Detection Accuracy in Evaluating Zach's Statements

A binary logistic regression was run to evaluate participants' lie detection accuracy in evaluating Zach's statements (0 = Incorrect, 1 = Correct), as predicted by age group (three-four year olds, or five-eleven year olds), theory of mind accuracy (0 = Incorrect, 1 = Correct), parents' authoritarianism score (out of a total of four), and parents' social conformity score (out of total of seventeen). {see *Table 3*}.

As *Table 3* demonstrates, age group was the sole variable found to be a significant predictor of participants' lie detection accuracy in evaluating Zach's statements ($\beta = 1.81$, $SE = 0.59$, $Wald(1) \chi^2, 9.44$, $p = 0.002$). The odds ratio indicates that in going from a preschool aged participant group (aged three to four), to participants aged five to eleven years old, the odds of participants being accurate in detecting lies from Zach's statements increased by a factor of 6.14. Neither participants' theory of mind accuracy nor their parents' scores on the authoritarianism or social conformity assessments were found to be significant predictors of participants' lie detection accuracy for Zach.

Table 3: Binary Logistic Regression Predicting Participants' Lie Detection Accuracy for Zach's Statements, by Age Group, Theory of Mind Ability, and Parents' Authoritarianism & Social Conformity Scores

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Variable	β	SE	Wald χ^2	p	Odds Ratio	95% CI Odds Ratio
Age Group	1.81	0.59	9.44	0.002	6.14	[1.93 – 19.51]
Theory of Mind Accuracy	0.50	0.55	0.81	0.37	1.64	[0.56 – 4.83]
Parent's Authoritarian Score	0.14	0.26	0.29	0.59	1.15	[0.692 – 1.92]
Parent's Social Conformity Score	-0.08	0.11	0.52	0.47	0.93	[0.75 – 1.14]

A mediation model (via the Barron & Kenney 1986 approach) was employed to further examine the relationship between participants' age (causal variable), theory of mind ability (hypothesized mediator variable), and lie detection accuracy for Zach's statements (the outcome variable). {see *Figure 2*}

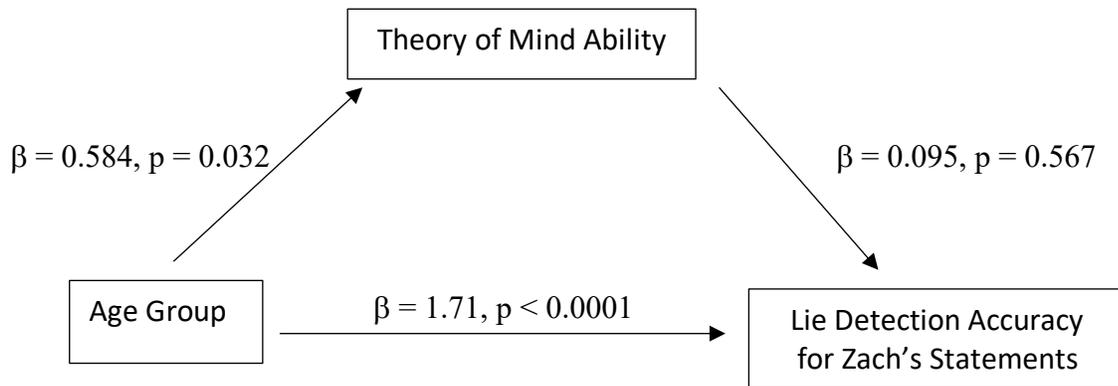
In Step 1 of the mediation, the regression of age group on lie detection accuracy for Zach's statements, ignoring the mediator (theory of mind), was significant: $\beta = 1.71$, $t(97) = 3.50$, $p < 0.0001$. Step 2 of the model demonstrated that the regression of age group on the mediator, participants' theory of ability, was also significant: $\beta = 0.584$, $t(97) = 2.143$, $p = 0.032$. Step 3 of the mediation, however, revealed that controlling for age group, theory of mind ability (the hypothesized mediator) did not significantly predict participants' lie detection accuracy for Zach's statements: $\beta = 0.095$, $t(97) = 0.573$, $p = 0.567$.

Altogether, the mediation analysis affirms that age group is a significant predictor of participants' theory of mind ability and their lie detection for Zach's statements. The mediation

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additionally disconfirms the hypothesis that theory of mind ability mediates or drives the relationship between participants' age group and their lie detection accuracy for Zach's statements.

Figure 2: Regression coefficients for the relationship between participants' age group, theory of mind ability, and lie detection accuracy for Zach's Statements.

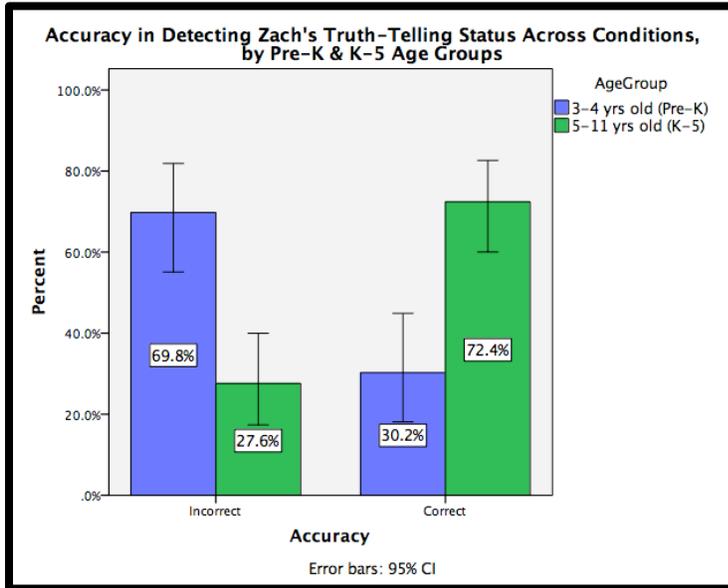


Next, a series of targeted chi-square tests of independence were conducted to disaggregate the significant effect of age group on participants' lie detection accuracy for Zach's statements $\{\chi^2(1, N = 101) = 17.72, p < 0.0001\}$. {see *Figures 3, 4, and 5*}.

Specifically, across experimental conditions, the proportion of preschoolers who answered incorrectly in detecting Zach's truth-telling status was significantly different than the proportion of five to eleven year-old participants who gave incorrect responses (69.8% of preschoolers $\{N = 43\}$, compared to 27.6% of five to eleven year-olds $\{N = 58\}$). {see *Figure 3*}.

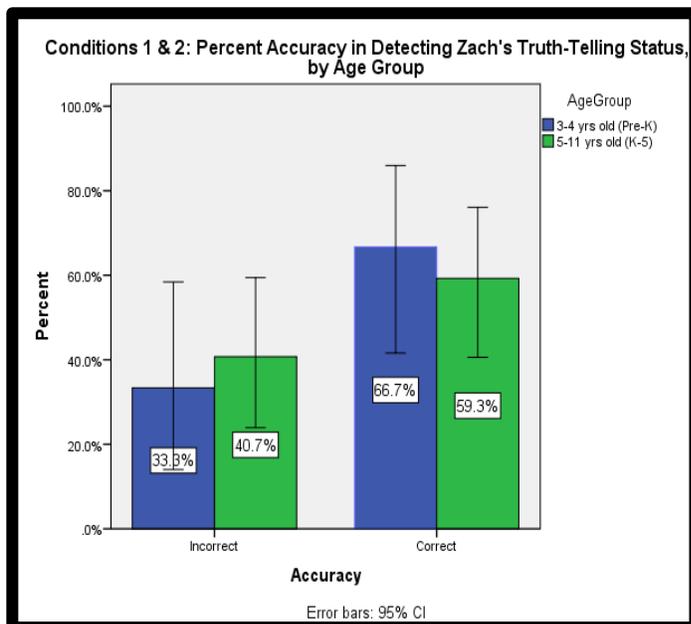
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Figure 3: Participants' Lie Detection Accuracy for Zach Across Conditions, by Age Group



When examining Conditions 1 and 2 separately, two conditions in which Zach tells the truth to his Mom, there was no longer a significant association between participants' age group and their lie detection accuracy for Zach ($\chi^2(1, N=42) = 0.22, p = 0.746$). {see Figure 4}. That is, the proportion of preschoolers who answered incorrectly in detecting Zach's truth-telling status was not significantly different from that of five to eleven year olds (33.3% of preschoolers {N = 15}, compared to 40.7% of five to eleven year olds {N = 27}).

Figure 4: Participants' Lie Detection Accuracy for Zach in Conditions 1 & 2, by Age Group

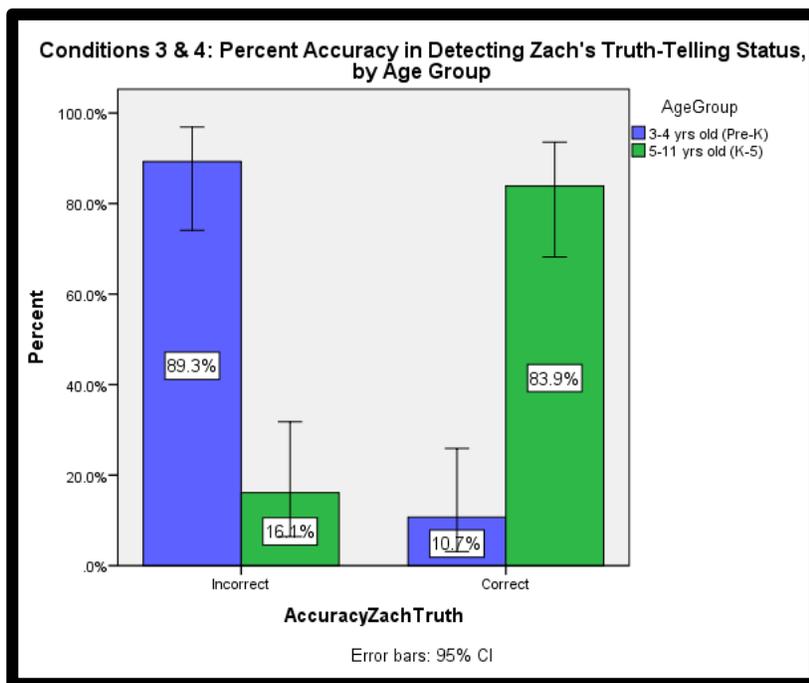


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When examining Conditions 3 and 4 separately, two conditions in which Zach lies to his Mom, a significant association between participants' age group and their lie detection accuracy for Zach was present ($\chi^2(1, N=59) = 31.51, p < 0.001$). {see Figure 5}.

That is, the proportion of preschoolers who answered incorrectly in detecting Zach's truth-telling status (stating that Zach told the truth when he was in fact lying) was significantly different from that of five to eleven year olds (89.3% of preschoolers {N = 28}, compared to 16.1% of five to eleven year olds {N = 31}).

Figure 5: Participants' Lie Detection Accuracy for Zach in Conditions 3 & 4, by Age Group



Lie Detection Accuracy in Evaluating Zach's Mom's Statements

A binary logistic regression was run to examine participants' accuracy in detecting Zach's Mom's truth-telling status (0 = Incorrect, 1 = Correct), as predicted by age group (three-four year olds, or five-eleven year olds), theory of mind accuracy (0 = Incorrect, 1 = Correct), parents' authoritarianism score (out of a total of four), and parents' social conformity score (out of total of seventeen). {see Table 4}.

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As Table 4 demonstrates, none of the variables significantly predicted participants’ accuracy in evaluating the truthfulness of Zach’s Mom’s statements to the police. Moreover, a targeted chi-square test of independence determined no significant differences in participants’ accuracy across conditions, by age group ($\chi^2(1, N=99) = 0.126; p = 0.84$).

Table 4: Binary Logistic Regression Predicting Participants’ Lie Detection Accuracy for Zach’s Mom’s Statements, by Age Group, Theory of Mind Ability, and Parents’ Authoritarianism & Social Conformity Scores

Variables	β	SE	Wald χ^2	p	Odds Ratio	95% CI Odds Ratio
Age Group	0.932	0.58	2.56	0.11	2.54	[0.81 – 7.96]
TOM Accuracy	-0.44	0.54	0.68	0.411	0.64	[0.49 – 1.22]
Parent Authority Score	-0.26	0.23	1.23	0.27	0.77	[0.83 – 1.22]
Parent Social Conformity	0.01	0.10	0.002	0.96	1.01	[0.54 – 4.43]

Beyond participants’ lie-detection accuracy for Zach’s Mom’s statements, raw responses to Zach’s Mom’s truth-telling status (i.e. stating that she told the truth or did not) were also evaluated. A series of chi-square tests of independence were conducted to examine the association between age group and participants’ responses to Zach’s Mom’s truth-telling status (0 = Didn’t Tell the Truth, 1 = Told the Truth). This association was examined for each experimental condition.

A significant association between participant age group and truth-telling response emerged in Condition 3, during which Zach tells a lie to his Mom, his Mom repeats the statement to the police officer, and her statement is an inaccurate reflection of the two boys’ conflict

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(Fisher's Exact Test, $p = 0.008$, $N = 30$). Participants' age group and truth-telling response were also significantly associated in Condition 4, during which Zach tells a lie, his Mom changes Zach's statement, and her statement is an accurate reflection of the two boys' conflict (Fisher's Exact Test, $p = 0.03$, $N = 26$).

Lastly, a chi square test of independence was run to examine the relationship between participants' theory of mind accuracy, and their lie detection accuracy in evaluating both Zach and his Mother's statements, across age. No significant association emerged, neither between theory of mind accuracy and lie detection accuracy for Zach's statements ($\chi^2(1, N=98) = 1.78$, $p = 0.21$), nor between theory of mind accuracy and lie detection accuracy for Zach's mother's statements ($\chi^2(1, N=96) = 0.27$, $p = 0.67$).

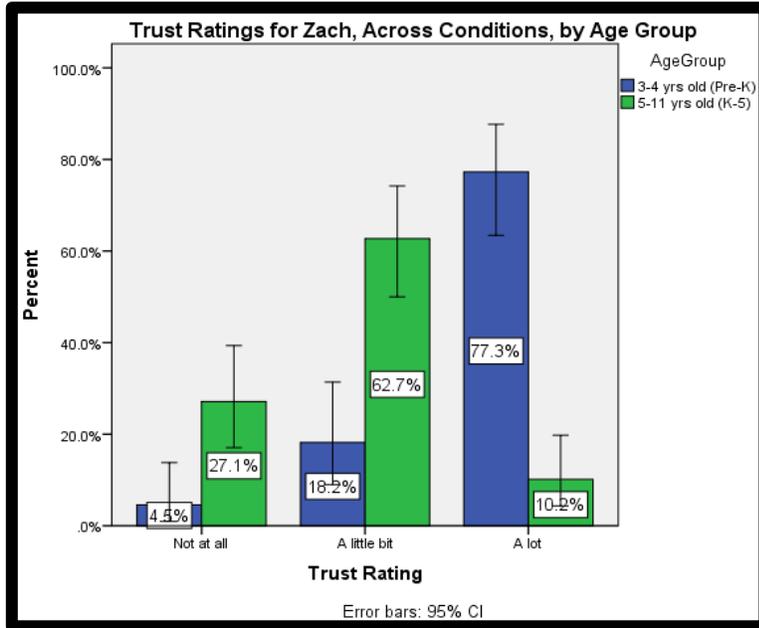
Trust Ratings

Chi-square tests of independence were run to assess the association between participants' age group and the trust ratings they gave towards Zach and his mom (0 = Not At All, 1 = A Little Bit, 2 = A Lot). As Figure 6 illustrates, participants' age group and trust ratings given for Zach, across conditions, were significantly associated ($\chi^2(1, N=101) = 48.01$, $p < 0.001$).

Namely, the proportion of participants who responded that they trusted Zach "Not At All", and those who responded that they trusted him "A Little Bit", differed significantly by age group. 27.1% of five to eleven year olds vs. 4.5% of three to four year olds gave a "Not At All" trust rating, and 62.7% of five to eleven year olds vs. 18.2% of three to four year olds gave a trust rating of "A Little Bit". The proportion of preschoolers who responded that they trusted Zach "A Lot" was also significantly different from that of five to eleven year olds (77.3% of preschoolers vs. 10.2% of five to eleven year olds).

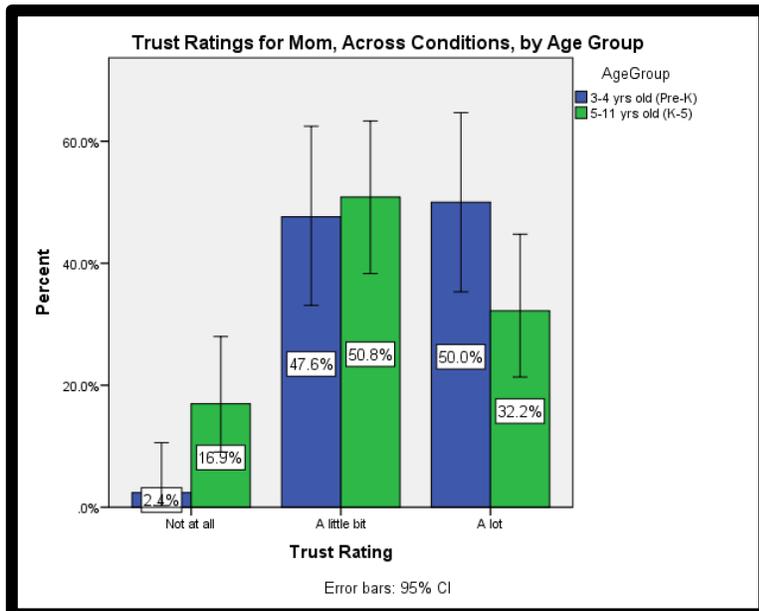
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Figure 6: Trust Ratings Given for Zach Across Conditions, by Age Group



Additionally, a significant association between participants' age group and trust rating given for Zach's Mom emerged (Fisher's Exact Test, $p = 0.03$, $N = 101$). Namely, as Figure 7 demonstrates, the proportion of three to four year olds who responded that they trusted Zach's Mom "Not At All" was significantly different from that of older participants who did so (2.4% of preschoolers, vs. 16.9% of five to eleven year olds).

Figure 7: Trust Ratings Given for Zach's Mom Across Conditions, by Age Group



Discussion

The current study aimed to expand upon the limited prior work in the domain of children's lie detection, by examining the developmental course of this ability, as well as multiple ecological factors that may affect this important social-cognitive skill in children.

Lie Detection Accuracy

Results demonstrated that as predicted, age matters in children's ability to accurately detect lies in statements made by other children. Namely, compared to their younger counterparts (aged three to four), older study participants (five to eleven years old), were significantly more accurate overall in their lie detection of Zach's statements, irrespective of experimental condition. However, contrary to the initial hypothesis, this effect was not driven by more advanced theory of mind comprehension in older participants. Given that lie-detection requires sufficient ability in all components of theory of mind (beyond just false belief), as well as working memory, future studies should include additional measures of theory of mind, working memory, and general executive function. Doing so may help disentangle the relationship between a child's age, cognitive skills, and their lie detection ability. Overall, this set of findings demonstrated that children's ability to detect a lie, specifically in statements made by other children, may follow a similar developmental trajectory to children's ability to tell a lie.

In contrast to the initial hypothesis, age did not significantly predict participants' lie detection accuracy for a mother's statements. However, given that the mother character in the story simply repeats or changes Zach's statement (never actually telling a clearly intentional, "traditional" lie), participants may have been uncertain or unclear in making their lie detection judgments for the mother's statements, subsequently lowering their accuracy rates across age groups.

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The attitudinal measures given to participants' parents, assessing their degree of authoritarian parenting and ascription to socially conforming attitudes, were not ultimately significant predictors of participants' lie detection accuracy, for statements made by either Zach or his mother. This finding did not uphold the initial hypothesis that greater authoritarian, socially-conforming parenting would lower lie-detection accuracy rates. However, this finding may have been swayed by a relatively homogenous sample, resulting in overall quite low scores on both parental measures (an average response of 1.13 out of 4 on the authoritarian parenting measure, and mean score of 5 out of 17 on the social conformity measure). Future studies should aim towards a more heterogenous sample of parenting attitudes, to more accurately assess the influence of this ecological factor on a child's lie detection accuracy.

Truth Biases and Trust Ratings

It was initially hypothesized that three and four year old participants would demonstrate a truth bias solely for the mother character in the story. However, results indicated that the younger, preschool-aged children demonstrated a truth and trust bias towards Zach. That is, irrespective of the actual truth-status of his statements to his mother, three and four-year-old participants were consistently more likely than children aged five to eleven years old to state that Zach told the truth, and to express a high degree of trust towards him.

The existence of this truth bias could be explained by young children's potentially undifferentiated conception of harm – specifically, in contrasting someone being hit versus someone being yelled at, as the current study scenario presents. While prior work has demonstrated that children, starting even from infancy, can recognize and evaluate harm as a morally negative behavior (Hamlin, 2013; Jambon & Smetana, 2014), perhaps the young participants in the current study did not feel there was a strong difference (in valence and/or level

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of moral infraction) between hitting someone and yelling at them. Thus, they may not have conceptualized Zach's statements to his mother that Adam hit versus yelled at him as a true lie, but rather perceived the statement as being truthful. The presence of a truth bias towards Zach is additionally in contrast to previous work documenting a "wrongdoing bias" in children, such that children tend to label all negatively-valenced, "bad" acts as a lie, and all positively-valenced, "good" acts as being truthful (Wandrey, Quas, & Lyon, 2012). Rather, participants' truth bias may be illustrative of a positivity bias previously identified in children, to maintain an overall positive and optimistic view of others (Boseovski, 2010), and in the context of deception, a general hesitancy and unwillingness of children to classify others' negative acts as a lie (Lyon, Quas, & Carrick, 2013).

Young participants' tendency to trust Zach to a high degree, irrespective of the veracity of his statements to his mother, is also of interest. Past work has indicated that children younger than four years old are sensitive to an informant's level of accuracy and their level of negativity in making decisions of who to trust; for example, children have been shown to be more trusting of those who are accurate and nice. However, in the absence of information about these cues, children tend to trust others, even strangers, as a default response (Mills, 2013). Given the low lie detection ability of preschool-aged participants in the current study (i.e. participants' limited ability to use an informant's accuracy level as a cue for trust), participants in the current study may have defaulted to expressing high levels of trust towards Zach.

Additionally, three and four year olds demonstrated a truth bias towards the mother story character, but surprisingly, the presence of this bias was dependent on the story content they heard. Moreover, preschool-aged participants were more likely to state that the mother character had told the truth in Condition 3, during which Zach tells a lie to her and the mom repeats this lie

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to the police officer, and in Condition 4, during which Zach tell her a lie, the mom changes Zach's statement to the police, and her statement is ultimately an accurate reflection of the reality. The presence of younger participants' truth bias just for these two experimental conditions is unexpected, and contrary to the initial hypothesis that three and four year olds would hold a truth bias towards the mother, regardless of the content of her statements.

In terms of trust ratings, preschool-aged participants were less likely compared to their older counterparts to give the mother character a low rating (of "Not At All"), but there were no significant age group differences in ratings of high trustworthiness given to the mother.

Younger participants' more indiscriminate evaluation of the mother character's statements may be explained by the lack of clear intentionality and valence behind the mother's actions in the experimental scenario. Given that prior work has shown that a speaker's intentionality (Bussey, 1999) and the valence of a speaker's actions or statements (Wandrey, Quas, & Lyon, 2012) are important factors children use in making veracity assessments, the ambiguity of these elements in the current study may have impacted participants' responses. Moreover, the additional absence of any clear verbal or non-verbal cues to deception (given the non-video format presentation of the story), may have further limited children's ability to make accurate evaluations.

Implications

The current study highlights the notion that in parallel with the ability to tell a lie, a child's ability to detect a lie is an important developmental milestone, and a marker of their budding social cognition. Just as children become more skillful in crafting complicated lies and getting away with telling those lies with age, children's ability to detect deceit in other children and adults correspondingly advances with age.

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Additionally, information regarding children's lie detection ability can have important forensic implications, by affecting how competent, believable, and accurate children are perceived to be as possible witnesses in a trial. Moreover, evidence that young children at the age of three or four cannot yet accurately discriminate between a truth and a lie without the presence of clear verbal or non-verbal cues, and that they are susceptible to various truth and trust biases, can altogether perpetuate the notion that young children are gullible and less credible court witnesses.

Limitations and Future Directions

The current study examined age-related changes in detection ability across two age groups - a younger (three and four year olds) and older (five to eleven year olds) group. However, increasing the sample size across future studies will allow for a more robust examination of age trends in this ability.

Additionally, while the parental measures implemented in the current study did not ultimately predict children's lie detection ability, future studies should examine the impact of other ecological factors including parents' own lie-telling frequency or how many siblings a child lie-detector has. Children with a greater number of siblings, for example, may have more experience detecting deceit in other children, and subsequently could have more advanced lie detection capabilities.

Lastly, children's lie detection in the current study was examined solely for statements made by an adult mother, not father, character. While no participant gender effects on lie detection were identified in the current investigation, future studies should explore children's lie detection for statements made by both a mother and father character, as well as any participant gender effects that may result.

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