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Theory of mind training causes honest young children to lie

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Abstract

Theory of mind (ToM) has long been recognized to play a major role in children's social functioning. However, no direct evidence confirms the causal linkage between the two. Here we addressed this significant gap by examining whether ToM causes the emergence of lying, an important social skill. We showed that after participating in ToM training to learn about mental state concepts, 3-year-olds who originally had been unable to lie began to deceive consistently. This training effect lasted for more than a month. In contrast, 3-year-olds who participated in control training to learn about physical concepts were significantly less inclined to lie than the ToM trained children. These findings provide the first experimental evidence supporting the causal role of ToM in the development of social competence in early childhood.

Keywords

Theory of Mind; Lying; Deception; Training; Social Behavior

The ability to reason about mental states and act in accordance with such reasoning is commonly known as the theory of mind (ToM; Wellman, 2014). It is widely accepted that this socio-cognitive ability plays a major role in children's everyday social interactions with others. Indeed, extensive research shows that ToM predicts children's social competences in such domains as prosocial behavior, interpersonal interaction, and popularity with peers (Astington & Jenkins, 1995; Davis-Unger & Carlson, 2008; Fink, Begeer, Peterson, Slaughter, & de Rosnay, 2015; Mizokawa & Koyasu, 2015; Slaughter, Imuta, Peterson, & Henry, 2015; Watson, Nixon, Wilson, & Capage, 1999). Impairments in ToM have also been associated with debilitating socio-cognitive deficits such as autism, severe conduct problems, and psychopathy (Baron-Cohen, Tager-Flusberg, & Cohen, 1994; Blair et al., 1996; Frith & Happé, 1994; Sharp, 2008). However, because these findings are correlational, they fall short of fully establishing a causal link from ToM to social competencies.

Training studies could establish such a link. Indeed, developmental psychologists have recently used training methods to improve children's ToM (e.g., Melot & Angeard, 2003; Mori & Cigala, 2015; Peskin & Astington, 2004; Rhodes & Wellman, 2013). ToM training has led to significant enhancement not only in ToM itself but also several collateral abilities, including executive functioning (EF; Fisher & Happé, 2005), meta-memory (Lecce, Bianco, Demicheli, & Cavallini, 2014), and language (Hale & Tager-Flusberg, 2003). However, to date, researchers have only reported the collateral effects of ToM training in the cognitive domain. Surprisingly, despite the longstanding acceptance of the idea that ToM plays a major role in the development of social competences, no causal evidence exists (Wellman, 2014).

The current study aimed to address this significant gap in the literature by focusing on children's verbal deception, an important social behavior that is sometimes adaptive and some other times maladaptive (Bok, 1989; Lee, 2013). Development of verbal deception or lying has received extensive research for over a century (Darwin, 1877; Hartshorne & May, 1928; Piaget, 1932). Recent research has shown that lying emerges normatively at 2 or 3 years of age and develops rapidly with increased age, in particular between the ages of 3 and 7 (Lee, 2013).

Traditionally, research has focused on the role of moral, social, and situational factors in the development of verbal deception. But in the last decade, researchers have shown that children's ToM understanding significantly correlates with their verbal deception in the preschool years for Western (Evans & Lee, 2013; Talwar & Lee, 2008) and Chinese children (Evans, Xu, & Lee, 2011; Ma, Evans, Liu, Luo, & Xu, 2015). Because ToM is typically thought of as contributing to prosocial development, one might surmise that improving ToM ability should potentially reduce children's tendency to lie. However, the recent correlational studies on the issue suggest that the opposite may be true: the greater the ToM ability, the earlier and better children lie (Chandler, Fritz, & Hala, 1989; Polak & Harris, 1999; Talwar & Lee, 2008). These findings taken together lead to the hypothesis that ToM may play an important role in engendering verbal deception in children (Lee, 2013). In particular, ToM may enable children to understand the similarities and differences between their own and others' mental states, which in turn allows children to make appropriate decisions about whether to lie and what to lie about (Lee, 2013). More specifically, telling a lie successfully requires deliberately creating a false belief in the mind of the lie-recipient, and ToM could provide an important cognitive tool to enable children to do so (Talwar & Lee, 2008). ToM training, thus, has the potential to cause children who do not know how to lie to begin to tell lies. Such a finding would provide intriguing data not only about the underlying mechanisms of the emergence of lying, but also about the over-arching hypothesis that ToM causally influences children's social competence.

To address these possibilities, we recruited 3-year-olds who were initially unable to lie. Half of the children were assigned to a ToM training condition where they learned to reason about various mental states in different situations, and the other half to a control training condition where they learned to reason about properties of physical objects. We controlled for IQ and EF ability of the two groups, because both factors have been shown to be related to the development of ToM (Carlson, Claxton, & Moses, 2015; Carlson, Moses, & Breton, 2002; Hughes, 1998) and deception (Evans et al., 2011; Ding et al., 2014). Our primary hypothesis was that ToM training would not only increase children's ToM understanding but also increase their tendency to lie. Furthermore, we expected that the effects of ToM training on lying, if they indeed exist, would be apparent not only a few days after training, but also would last weeks after training had stopped. This seemed reasonable, because two prior studies have found that ToM training effects can last for several weeks or more (Appleton & Reddy, 1996; Lecce et al., 2014).

Methods

Overview of the Study

Figure 1 provides an overview of the entire study. A pre-test identified children who consistently failed to lie as revealed on an existing Hide-and-Seek Deception task (Yi et al., 2014). Children's IQ, ToM and EF were assessed on appropriate standard tasks of these constructs. At this point, children who consistently failed to lie on the pre-test were assigned to either an experimental training condition or a control training condition by yoke-matching them on IQ, EF, and ToM scores.

Then, once every other day for 6 times, children in the experimental condition were trained on standard ToM tasks as well as stories rich in mental state vocabulary, while control children were trained using Piagetian conservation tasks (Gelman, 1969) and stories without mental states words.

Post-tests were conducted three days after the training. At post-test, children in both the experimental and control conditions received an equivalent version of the ToM task used before the training as well as the same Hide-and-Seek Deception task used in pre-test.

After the post-test, a short-term follow-up phase ensued. During this phase, all children received trials of the same Hide-and-Seek Deception task every day for 6 consecutive days. We reasoned that the effects of ToM training would be best revealed over multiple days through engaging children in the actual deployment of deception on a regular basis.

Finally, after the short-term follow-up phase, we waited for about one month and re-tested children in both conditions with the same deception task to examine whether the training effect would last.

Participants

We planned to recruit 60 children to participate in the study and successfully recruited 58. All were Han Chinese, native speakers of Mandarin, and came from two different kindergartens located in an eastern city of Mainland China. The children were from families with varying socioeconomic backgrounds. Informed consent was obtained from parents or legal guardians prior to the commencement of the study, and oral assent was obtained from all children. To ensure that children possessed the minimal verbal abilities necessary for completing our pre-tests, we also used an existing verbal control task (Gopnik & Astington, 1988; Slaughter & Gopnik, 1996). No child failed the verbal control task.

Two children were excluded from the study because they passed one or more deception trials at pre-test. An additional 14 children were excluded because they did not complete training due to sickness, travelling, or unwillingness to continue their participation. In the end, 42 children completed our procedures: 21 in the experimental condition (M = 3.08

years, range 2.83 to 3.33 years, SD = 0.14, 10 boys and 11 girls) and 21 in the control condition (M = 3.07 years, range 2.83 to 3.50 years, SD = 0.16, 6 boys and 15 girls).

Tasks and materials

1. Hide-and-Seek Deception task—The Hide-and-Seek Deception task is a frequent measure of verbal deception in preschool children (Chandler et al., 1989; Hala, Chandler, & Fritz, 1991; Peskin & Ardino, 2003; Sodian, Taylor, Harris, & Perner, 1991; Yi et al., 2014). During a warm-up, children began with a simple Hide-and-Seek game with the experimenter that involved no deception. The experimenter hid a candy in one of two cups and then asked children to guess where the candy was. If the child guessed correctly, they were declared a winner and received the candy. If they guessed incorrectly, they were declared a loser and the experimenter kept the candy. For each of these three warm-up trials, we explained the rules of the game to children.

After this warm-up, for the Hide-and-Seek Deception task itself, the experimenter showed children 10 candies and 10 stickers on the table, and asked them to pick their favorite sticker. The experimenter told children that they could keep this sticker only when they had won the 10 candies first. Then for each of the ten trials, the experimenter closed her eyes. After children announced that they had hidden the candy, the experimenter opened her eyes and asked, “Where did you hide the candy?” The experimenter always guessed the cup that children indicated to have hidden the candy. If children responded truthfully by indicating the cup where the candy was really hidden (counted as truth-telling), the experimenter took the candy from the cup, stating, “I won! It is my candy. Let’s do it again.” If the child responded untruthfully by indicating the empty cup (counted as lying), the experimenter displayed disappointment and stated, “I lost. It is your candy now. Let’s do it again.”

The lying score ranged from 0 to 10. To be conservative, only those children who received a zero lying score at pre-test went on to training. For some post-test and follow-up test analyses, and again to be conservative, only those children who received 10 on their lying score were considered to have passed the task. During pre-test, post-test or follow-up tests with the Hide-and-Seek Deception task, we never taught children how to misdirect the experimenter to win the candy.

2. Verbal control task—A verbal control task (see Gopnik & Astington, 1988; Slaughter & Gopnik, 1996), was used to ensure that children could understand and answer questions about the current and past state of affairs of the sort that would be essential to complete the ToM training tasks successfully. In the task, the experimenter put a car inside a box, then showed the box to children and asked them to open the box. After children did so, the experimenter asked: “What is in the box?” (Correct answer: a car). Then, the experimenter took the car out of the box, covered the car by hand, put a sticker inside the box, and asked: “What is in the box now?” (Correct answer: a sticker). After children answered this question, the experimenter asked: “When I first showed you this box, what was in the box?” (Correct answer: a car).

If children failed to answer the first two questions correctly, the experimenter gave them feedback and asked the questions again. No child failed the verbal control task.

3. Executive functioning task—Existing research has revealed that EF is significantly correlated with ToM understanding (Carlson, Claxton, & Moses, 2015; Carlson, Moses, & Breton, 2002) . Thus, to ascertain the specific role of ToM in engendering lying in children, we sought to to ensure children in both the experimental and control conditions to be the same initially before training. To assess (and control for) children's EF ability, we chose to use the Flanker Fish task. This specific EF measure is one of the gold standard measures for measuring EF in children, and is known to be appropriate for 3-year-old children (Diamond, Barnett, Thomas, & Munro, 2007; Röthlisberger & Neuenschwander, 2011).

The measure has two initial tasks (the blue fish and pink fish tasks) that lead to the focal EF task, the mixed fish task. We used the scores of the mixed fish task to match the children's EF abilities in the experimental and control conditions. After a practice session with four trials, children performed the blue fish task first. They saw five fish with the same color (blue or pink) on a computer screen. The blue fish task required children to respond based on the orientation of the central target, the blue fish, by pressing a key to indicate whether the fish was facing right or left. There were 17 trials in this task. Then, the pink fish task ensured. It required responding based on the orientation of the outside flanker fish. In the congruent condition of these tasks, the flanker fish were facing the same direction as the central target fish; in the incongruent condition the flanker fish faced in the opposite direction to the central target fish. Children completed 17 trials of the pink fish task. Finally, the crucial mixed fish task was administered that involved both blue and pink fish target fish, so children were required to remember the different rules according to the different fish colors and press the appropriate keys. There were a total of 45 mixed fish trials. Overall accuracy in percentage in the shifting trials (pink to blue or blue to pink fish) of the mixed fish task was recorded as children's EF scores (but not reaction time for these young children). There was no significant difference in the EF scores betweeen children in the experimental (*Mean* = 62.00, *SD* = 14.32) and control conditions (*Mean* = 60.63, *SD* = 14.19), $t(39) = .04$, $p = .97$, *cohen'd* = .01.

4. Intelligence test—Children were administered the Chinese Stanford-Binet Intelligence Scale Revised (Wang, 1982). Raw scores were converted to an IQ score according to the age-specific norms provided by the manual, with the mean of 100 and standard deviation of 15. The IQ scores were not significantly different between the experimental (*Mean* = 111.48, *SD* = 17.62) and control conditions (*Mean* = 107.33, *SD* = 17.00), $t(40) = .78$, $p = .44$, *cohen'd* = .25.

5. Theory of Mind Scale (pre-test and post-test)—We used a Chinese version of the Theory of Mind Scale (Wellman & Liu, 2004) that includes six sub-tasks: Diverse Desires (Repacholi & Gopnik, 1997; Wellman & Woolley, 1990), Diverse Beliefs (Wellman & Bartsch, 1989), Knowledge Access (Pillow, 1989; Pratt & Bryant, 1990), False Belief (Perner, Leekam, & Wimmer, 1987), Belief-Emotion (Harris, Johnson, Hutton, Andrews, & Cooke, 1989), and Hidden Emotion (Harris, Donnelly, Guz, & Pitt-Watson, 1986). See Wellman and Liu (2004) for details. Each task included a warm-up or control question along with its target questions, and if children answered both questions correctly, they received 1 point. Thus scores could range from 0 to 6. We used two equivalent versions of this scale

(Sets I & II) counter-balanced between participants. If children were tested on Set I in the pre-test, they received Set II in the post-test, and vice versa.

6.1 ToM Training (Experimental training)—Children in the experimental condition received direct training with feedback on two false belief tasks (Gopnik & Astington, 1988;Wimmer & Perner, 1983), and two appearance-reality tasks (Flavell, Flavell, & Green, 1983). We focused on these two types of tasks for ToM training because the false belief task is widely accepted to be the limus test of a representational ToM (Wellman & Woolley, 1990), and children's performance in the false belief task is strongly correlated with that in the appearance-reality task (Slaughter & Gopnik, 1996; Melot & Angeard, 2003) which also measures children's ToM (Flavell, et al. 1983). In addition, to reinforce the ToM training effects induced by the training on the ToM tasks, we further trained children via reading stories rich in mental-state vocabulary to children and asking them questions about the story content (Guajardo & Watson, 2002; Ornaghi, Brockmeier, & Gavazzi, 2011).

Here we will describe the false content task in detail to illustrate the direct training of false belief tasks. In one such false content task, children were shown a pencil box and asked what they thought was inside. Children were then shown that the box contained something other than what the box suggested. Children were asked three target questions: (a) Whether someone else who had not seen inside the box knew what was inside, (b) What they had originally thought was inside the box before opening the box, (c) What someone else who had not seen inside the box would think was inside. Children received one point for a correct response to each target question and so scores ranged from 0 to 3. In both belief tasks there were three target questions, and in appearance-reality tasks there were two, so in total, children received scores ranging from 0 to 8 for each training session.

For all the target questions, correct answers received feedback as follows. For example, for the false content task just illustrated, incorrect answers received feedback such as: "*No, you are incorrect. When he saw this box, before opening it, he thought there were pencils inside it", whereas* for correct answers the feedback was: "*Yes that's right. When he saw this box, before opening it, he thought there were pencils inside it*". In addition to the immediate feedback, at the end of the training session, children were told their total scores for that day.

To reinforce our ToM training, we provided children with six additional stories that were rich *with mental-state vocabulary* (see Text S1). For each training day, children further heard and responded to a short story rich with mental-state vocabulary. These stories were modified from popular children's picture storybooks. There were three target mental state words in each story. After hearing each story, children were asked to construct as many sentences as possible using the target mental-state words. The experimenter gave them feedback about whether the sentence was correct or not. Feedback training for each word took about 3 to 5 min, and the total time was about 10 to 15 min in each session. Thus, for the six training sessions, there were six different stories in total, each with similar lengths.

6.2 Non-Mental-State Training (Control training)—In the control training condition, paralleling ToM training, children were trained on three Piagetian conservation tasks

(Gelman, 1969)--number, length, and mass conservation--as well as stories without mental-state vocabulary.

Here we will describe the number conservation task in detail to illustrate the conservation training tasks. In this task, two sets of five Chinese checkers were used. At first, two sets of checkers were presented in one to one correspondence, so that they were perceptually and quantitatively equal. Children were asked if the checkers had the "same or different amount", and then watched the experimenter rearrange one row of checkers spread out to look longer. They were asked whether the stimuli had the same amount. Children received one point for a correct response.

Similar to ToM training, children were given immediate feedback about their correctness for each task. At the end of the training session, they were also told their total scores for that day. For each training session, the total score for the conservation tasks ranged from 0 to 3.

To parallel the experimental condition, in each training session, children heard a story but *without mental-state vocabulary* (see Text S2). After hearing the story, children constructed sentences using target non-mental-state words. There were six stories, one for each training session, that were very similar in length to the mental-state stories.

Procedure

Children were seen individually in a quiet room in their kindergarten. As shown in Figure 1, during pre-test children took pre-tests on the Hide-and-Seek Deception task, and the IQ, EF and ToM tasks. After the pre-tests, we kept in our sample children who could not lie at all in the Hide-and-Seek Deception task. They were ordered sequentially according to their scores on the IQ, EF and ToM in the pre-tests, and grouped into pairs. For each pair, one was randomly assigned to the experimental training condition and the other to the control training condition.

Next, during the training phase, every other day for six times and thus extended over 12 days, children received either the experimental or control training. Each training session took about 20 minutes per child.

Three days after the last training session, during the post-test phase, all children received post-tests on the ToM Scale (Set I or II) to ascertain whether their ToM had improved. Also, focally, to ascertain whether training led children to be more inclined to lie, children received the Hide-and-Seek Deception task.

In the short-term follow-up phase, after the post-tests, children again performed the Hide-and-Seek Deception task in the following six consecutive days.

Thirty-six days after the last day of ToM training, all children completed the Hide-and-Seek Deception task once more as a long-term follow-up.

Results

Preliminary analyses revealed no significant effects for gender, and thus data for this factor were combined in subsequent analyses.

To first determine whether ToM training improved children's ToM, we conducted a repeated measures 2 (testing phase: pre-test vs. post-test) × 2 (conditions: experimental condition vs. control condition) ANOVA, with testing phase as the within-subject variable and ToM score as the dependent variable. As predicted, the main effect of conditions and the interaction effect (testing phase × condition) were significant, $F(1,40)= 101.32$, $p < .001$, $\eta^2 = .72$, and $F(1,40) = 101.32$, $p < .001$, $\eta^2 = .72$. As shown in Figure 2, post hoc analyses (LSD) showed that ToM scores of children in the experimental condition improved significantly from pre-test to post-test, $F(1,20) =162.00$, $p < .001$, $\eta^2 = .89$, but ToM scores of children in the control condition did not.

Did children's lying correspondingly change? As shown in Figure 3, at post-test, children in the experimental condition became significantly more likely to lie in the Hide-and-Seek Deception task than those in the control condition, $t(40) = 4.42$, $p < 0.001$, *Cohen's d* = 1.40. This effect was apparent on the last day of the six daily short-term follow-up tests as well, $t(40) = 3.49$, $p <0.001$, *Cohen's d* = 1.10.

To further examine the relationship between ToM training and lying, we calculated a Pearson correlation between ToM score gains (the difference between the ToM pre-test score and the ToM post-test score) and lying scores at post-test for children in the experimental condition (i.e., the children who received ToM training). The correlation was not significant ($r(21) = .064$, $p = .782$). To further examine whether the training effect depended on the initial level of ToM ability, we correlated initial ToM scale scores at pre-test and lying scores at post-test for children in the experimental condition. This correlation was also not significant ($r(21) = .114$, $p = .622$). Thus, the ToM training improved children's lying scores significantly and this improvement did not depend on their initial ToM scores nor how much they had gained in the ToM scores due to the training. In other words, the ToM training worked for children generally, not just some of them who happened to have a higher initial ToM scores or were more sensitive to the ToM training.

Because children had one post-test and six daily short-term follow-up tests, we also conducted a survival analysis to assess how children's lying improved over the post-test and the short-term follow-up tests. For this analysis, we categorized children into either "pass" or "fail" groups according to their performance on the Hide-and-Seek Deception task for each testing session. To be conservative, in order to pass, children must score 10 of the 10 trials for a particular session.

We suspected (based on findings in Yi et al., 2014) that, given seven consecutive days of exposure to the lying task even children in the control condition could improve. Indeed, as shown in Figure 4, during the short-term follow-up phase after training, the number of children who passed the deception task increased systematically in both conditions. However, the rate in terms of number of sessions required for children to consistently pass the task (10 lying responses to the 10 trials per session) was significantly greater in the experimental condition than in the control condition, Log-rank test: $\chi^2 = 31.3$, $p < 0.001$.

It is possible that the changes and group differences we observed might be transitory, diminishing with still further time and without further training. The long-term follow-up data, 36 days after the last day of training, address this possibility. As shown in Figure 3, although the experimental children received no further ToM training nor further exposure to the deception task after the short-term follow-up phase, they were still significantly more likely to lie than those in the control condition (the right most bar), $t(40) = 3.77$, $p < .001$, *Cohen's d* = 1.19.

Discussion

The present study examined the causal linkage between ToM understanding and the emergence of verbal deception in young children. As predicted, ToM understanding for children in the experimental condition but not for children in the control condition improved significantly after training. More importantly, children in the experimental condition became significantly more likely to lie in the Hide-and-Seek Deception task, both in comparison to their pre-test and in comparison to children in the control condition. Moreover, this training effect lasted for more than one month. These findings support the specific hypothesis that ToM plays a causal role in the emergence of young children's lying behavior, and support the more general hypothesis that ToM causally impacts children's social competence.

As proposed by Lee (2013), lying can be seen as ToM in action. To lie, one must realize that (1) different people may have different beliefs about the true state of affairs, and (2) people can be misled to form false beliefs about the true state of affairs and act in accordance with their false beliefs. In particular, in our Hide-and-Seek Deception task, to successfully deceive (and thereby outcompete an adult in accumulating candies), children must know that false statements would mislead the adult to search for the candy in a wrong location. According to other ToM training research (e.g., Slaughter & Gopnik, 1996; Wellman & Peterson, 2013) false belief training allows children to become more sensitive to different mental states, to learn that people may have a false belief about reality that may differ from their own true belief. Also, as suggested by Guajardo and Watson (2002), false belief training coupled with mental-state training via story narratives rich in mental-state terms might be particularly effective in helping children reason about how people's false beliefs can mislead them to behave erroneously. What we show here is that such training causes children to become increasingly more inclined to use lying in a Hide-and-Seek Deception task and thereby increasingly win the game.

We do not know which of the various parts of our ToM training are necessary or sufficient to produce these effects, but it is notable that the impact of ToM training on verbal deception was evident not only immediately after the training but continued for at least one month afterward. Existing studies that have demonstrated the influence of ToM training have focused mostly on short-term effects. And to the extent that existing studies have examined ToM training's impact on collateral competences at all, they have focused on cognitive abilities such as EF and language (Hale & Tager-Flusberg, 2003; Melot & Angeard, 2003;

Slaughter & Gopnik, 1996). Of these existing studies, only two have examined ToM training effects beyond one week. One found that the false belief training affected children's ToM understanding on a closely related competence (i.e., understanding the appearance-reality distinction: Appleton & Reddy, 1996) 2 to 3 weeks post training. The other found that ToM training affects children's performance on meta-memory tasks 2 months past training (Lecce et al., 2014). To the best of our knowledge, our current study is the first to show that the ToM training can have an impact, and a lasting impact, on children's social behavior. By increasing their sensitivity to mental states and engaging them in reasoning about false beliefs, young children not only were able to quickly apply their newly acquired knowledge to solve a problem in a social situation, but also continued to do so more than a month later. Taken together, these two findings also suggest that children were not just mechanically memorizing what they were taught in the ToM training sessions; rather, they were able to consolidate the knowledge and use it adaptively to solve a social problem they were facing.

It should be emphasized that our ToM training induced children to become more inclined to lie. This provocative outcome helps underwrite the power of our finding, because lying is typically discouraged. But this may also be a concerning and unwanted outcome, because in all cultures, lying is considered an immoral behavior that has been eschewed by parents and teachers everywhere (Heyman, Luu, & Lee, 2009). Conceivably, ToM training may also have an unintended collateral effect in promoting dishonesty in children. We think this concern would be unwarranted and premature. Although research has shown chronic lying is consistently found in young children who eventually develop severe conduct problems and delinquency (Loeber, Stouthamer-Loeber, & White, 1999; Pedersen, Vitaro, Barker, & Borge, 2007; Rohrbach, Sussman, Dent, & Sun, 2005), research also demostrates that lying normatively develops with increased age in almost all children before 7 years of age. Moreover, all cultures also value at least some forms of lies, such as white lies (see, Talwar & Lee, 2002). Further, in our study the significant effect of ToM training on children's lying was shown in a special competitive game situation. It is unlikely, though of course possible, that children would generalize their lying in this relatively innocuous game setting to more serious real-life situations such as lying about a transgression, stealing, or cheating. Additional specifically designed studies are needed to examine this issue, however, as ToM training has increasingly been used not only by researchers but also clinicians and educators to promote children's social-cognitive competences. In this regard, one must still be mindful of the potential unwanted collateral consequence of such training. In addition, recent studies have shown that children with developmental disorders and delays may lie differently (e.g., Baron-Cohen et al., 1994; Blair et al., 1996; Frith & Happé, 1994; Li, Kelley, Evans, & Lee, 2011; Sharp, 2008; Yi et al., 2014). Thus, whether ToM training will have a significant effect on such children's deceptive behavior awaits further research.

In summary, the present study demonstrates that ToM training can cause young children who normatively do not lie to begin to do so. Thus, we confirmed the hypothesis that ToM plays a causal role in the emergence of young children's lying behavior. Moreover, we thereby provide evidence for the larger hypothesis that theory-of-mind increases cause changes in children's social competences.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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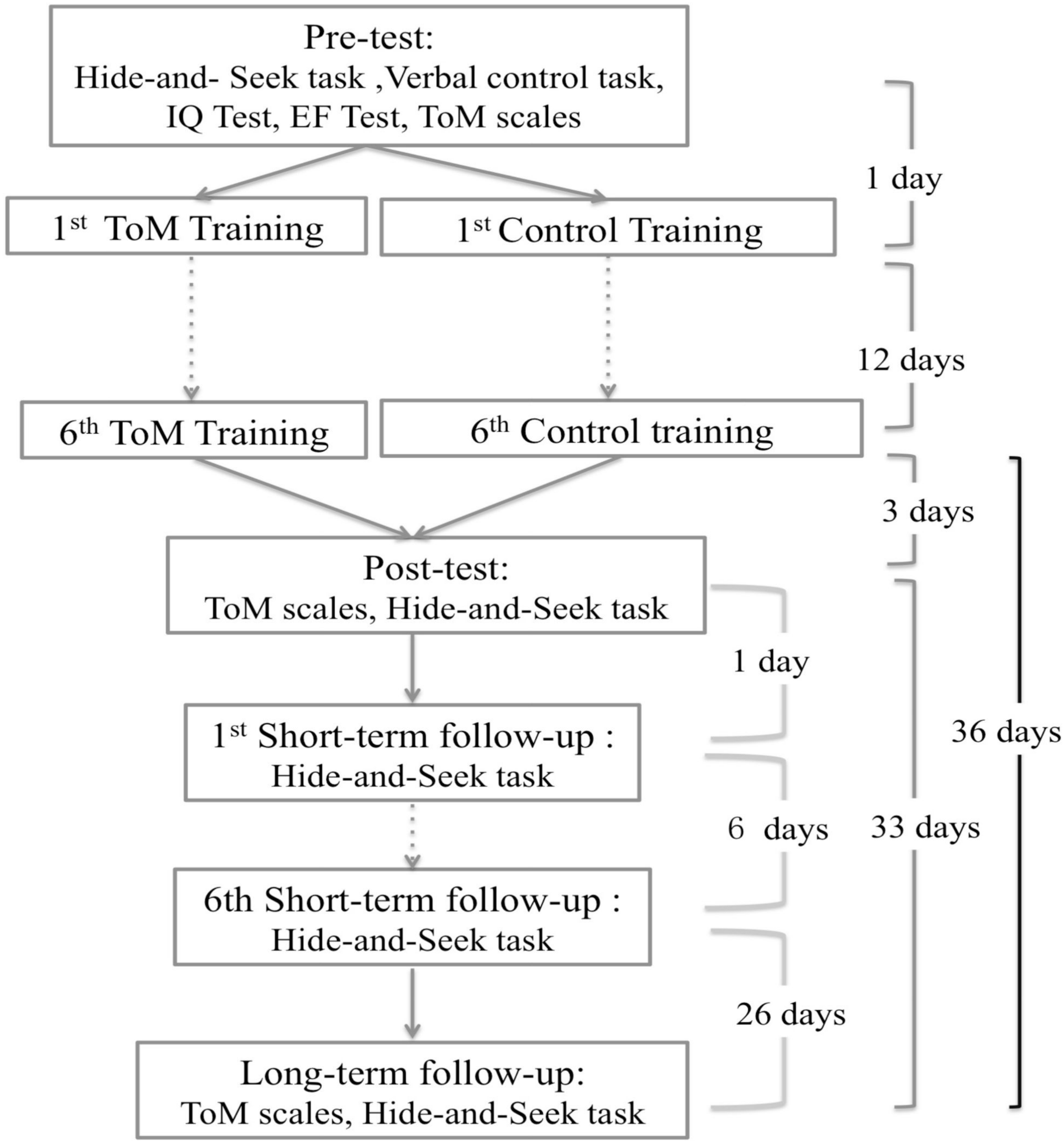

Figure 1.
Overview of the study procedures

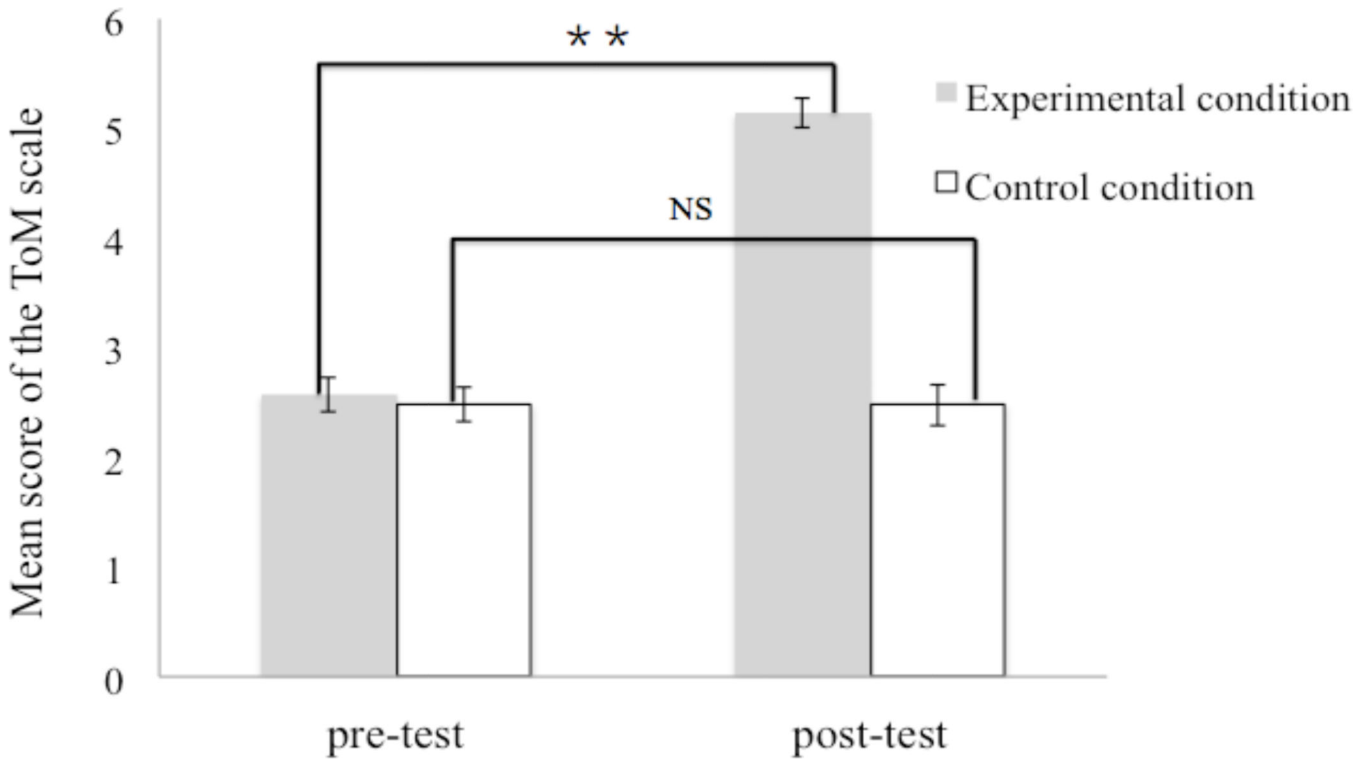

Figure 2.
The mean and standard errors of the pre-test and post-test ToM scores in the experimental and control training conditions (**: $p < .001$). Maximum possible score = 6.

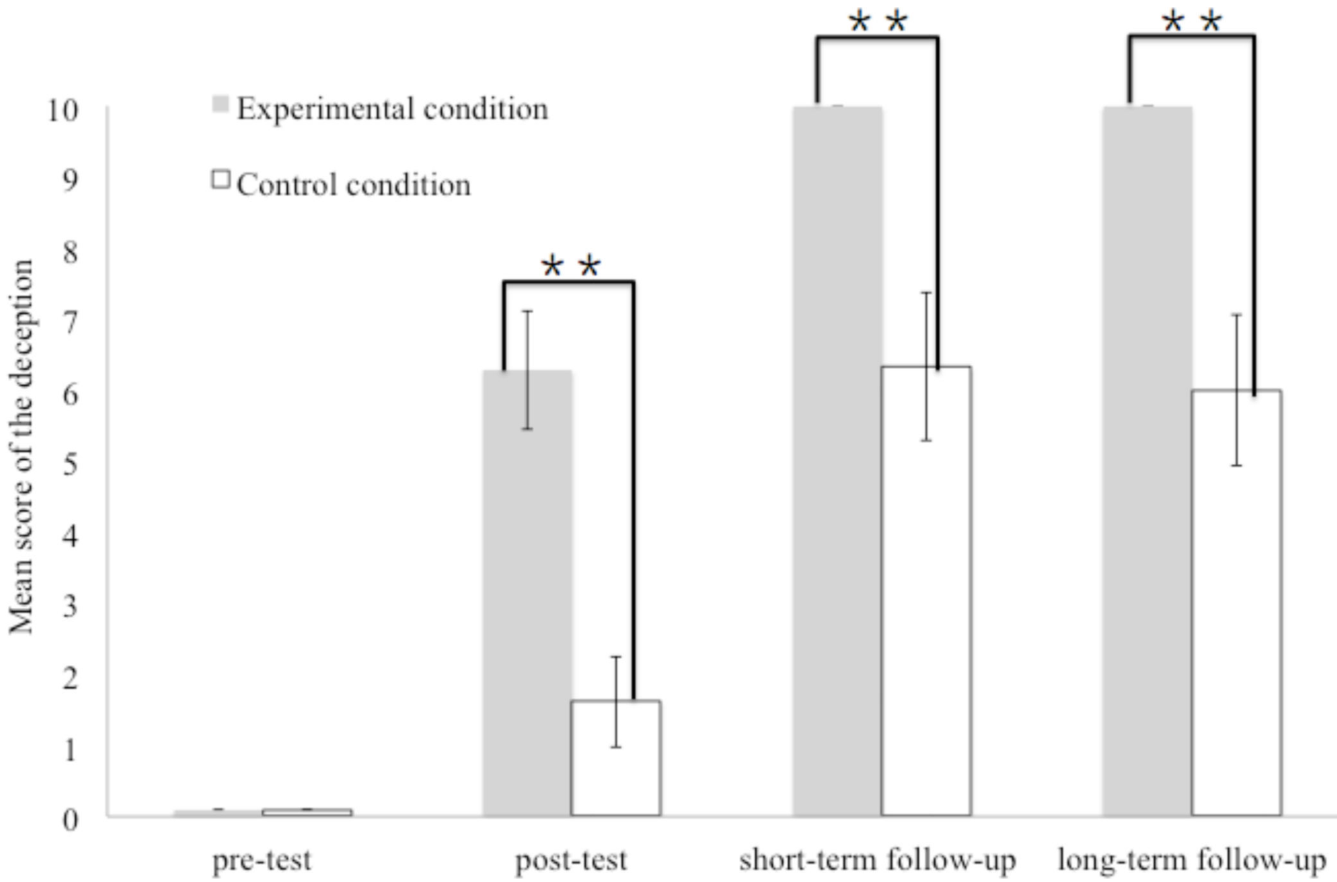

Figure 3.
The mean lying scores and standard errors of the pre-test, post-test, short-term follow-up (the 6th day of the short-term follow-up phase), long-term follow-up (**: $p< .001$). Maximum possible score=10.

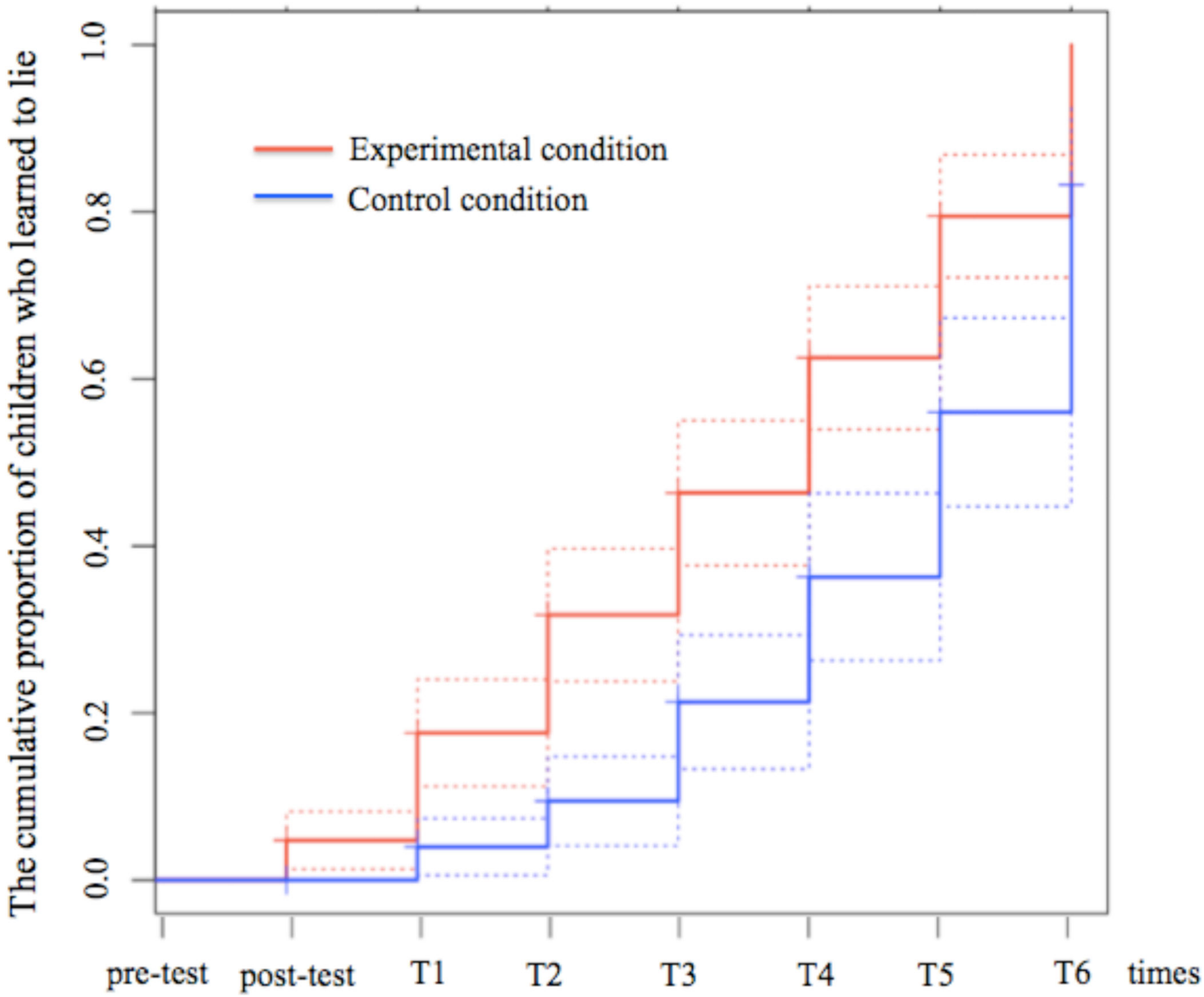

Figure 4.
Cumulative proportion of children who learned to consistently lie over time in the experimental (red) and control (blue) training conditions (dashed lines represent the 95% confidence intervals). Survival analyses more typically graphically show the number of individuals who did *not* change, in our case that continued not to lie. Here we show the inverse, the number who did change and so consistently lied (10 out of 10 trials on the Hide-and-Seek Deception tasks presented each session).