‘The Friendly Professor’: Does supernatural oversight influence ritualistic actions and normative behavior in children?

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Wordcount: 10,254

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Abstract

In the present experiment children aged 4 and 6 years ($N = 112$) were read a story describing a novel supernatural agent called *The Friendly Professor*, who had magical powers of omniscience for behavior of those ‘*in his room*’ while doing ‘*his experiments*’. Half of the children were led to believe that this story was real, while half were told the story was fictional. Children responded to two tasks, either with a researcher present in the room, or while alone in the room. Experiment 1 comprised a two-phase overimitation task: children twice observed a series of actions on a puzzlebox modelled only at T1, then they acted on the box both immediately (T1) and again after 30-minutes (T2). Rates of overimitation did not significantly decrease over time, and overimitation was not predicted by belief/non-belief, nor by the presence/absence of the researcher. In Experiment 2 children were instructed on the rules of a ball-throwing task in which cheating was implicitly incentivized. Children were not more likely to cheat in any condition. These findings highlight the pervasiveness and persistence of overimitation, and demonstrate children’s consideration of social pressure when provided the opportunity to cheat, but not a sensitivity to the presence of supernatural figures. Our results suggest that generating supernatural belief in children - and assessing that belief - calls for more careful attention to the existing literature on children's developing understanding of special minds.

Keywords: Supernatural belief; belief; overimitation; cheating; morality; culture.

Introduction

Childhood (ages 2 to 6 years) is unique to our species (Bogin, 1997; Keenan et al., 2016; Macchiarelli et al., 2006; Nielsen, 2012). It is proposed to be an adaptive period of growth in which sexual development is delayed in favor of cognitive development (Thompson & Nelson, 2011) and the acquisition of necessary cultural information (Henrich & McElreath, 2007; Muthukrishna et al., 2018; Nielsen, 2012; Volk & Atkinson, 2008). However, as not all cultural information is equally accurate or veridical, children must evaluate the quality, content, and consequences of this information. Some developmentally relevant information is culture-specific, such as the reality-status of supernatural agents and the roles they play in governing behavior and policing norms. Here, we focus on how children's belief in supernatural agents affects their behavior in two domains: First, whether or not belief in the presence of a supernatural agent influences a child's engagement in social learning (that is, do they treat a supernatural agent as a meaningful social presence), and second, will the presence of a supernatural agent influence children's cheating behavior?

Why is belief in supernatural agents in childhood interesting? Whether or not children are 'intuitive theists' (Banerjee & Bloom, 2013; Kelemen, 2004), it is *prima facie* true that children in different cultures learn of different supernatural agents according to religious and spiritual context. And while it is difficult to characterize the commonalities of all the world's belief systems, it is often the case that these systems include supernatural agents or forces that impinge upon the physical world to varying extents. Depending on where children are raised, they must

learn about figures of faith and supernatural power - their interests, concerns, and limitations - and navigate the social conditions in which supernatural expectations are relevant.

Contemporary scholars have argued that a ‘supernatural watcher’ is culturally useful in regulating and policing the behavior of individuals, particularly in large, anonymous societies (Atkinson et al., 2014; Boyer, 2007; Brazil & Farias, 2016; Galen, 2016; Geertz, 2014; Gervais & Norenzayan, 2012; Norenzayan, 2014; Shariff, 2011; Shariff & Norenzayan, 2007; Wade, 2015; Watts et al., 2016). Whether or not supernatural oversight is teleologically *‘for’* behavioral and social regulation, it seems tenable that, at an individual level, a sincerely held belief in a supernatural agent can influence a believer’s behavior consistent with the desires or doctrines of the agent (Laurin, 2017). Moreover, some scholars believe that *Homo sapiens* ‘supernaturalized’ the world around 75,000 - 70,000 year ago, as it was socially adaptive to entertain concepts of supernatural agency (Rossano, 2015). True or not, children are enculturated about the values, beliefs, and reality-status of supernatural agents. Thus, children, in the course of development, must operate in a world that may include supernatural entities and their behavioral prescriptions.

For the purposes of the current work we follow Legare et al. (2012) in defining ‘supernatural’ in contrast to the natural, where the ‘natural’ is “*observable and empirically verifiable phenomena of the physical or material world*”. While the supernatural is “*phenomena that violate, operate outside of, or are distinct from the realm of the natural world or known natural law*” (p. 5) which are not empirically verifiable and may be contrary to typical physical and material understanding. We define ‘belief’ as an epistemic state in which the contents of one’s mind are ‘*supposed to accurately represent reality*’ (Rossano, 2012; Woolley, 1995).

Children are canny and nuanced when evaluating the validity and value of evidence for supernatural entities. They derive information about things they cannot directly experience from testimony (Woolley & Ghossainy, 2013), and are capable of drawing on peripheral and secondary information in order to evaluate and justify supernatural claims. They can determine the credibility of a source providing testimony (Lane & Harris, 2014) and are sensitive to patterns of speech used by others when discussing such entities, including the amount of detail provided, their confidence (Canfield & Ganea, 2014), the context of the testimony (Woolley & Van Reet, 2006), and consensus information (Corriveau et al., 2009). Children are also sensitive to implicit assumptions inherent in the speaker's claims (Dore et al., 2018; Woolley et al., 2011). Impossible entities that are more easily imagined are perceived as more real than cognitively challenging entities (Harris et al., 1991; Woolley & Van Reet, 2006). As a child accumulates knowledge, they draw more on their own intuitions and experiences to evaluate supernatural claims (Lopez-Mobilia & Woolley, 2016). A child's evaluation relies on many factors, which ultimately allows the child to produce a 'sensible hierarchy' of belief, such that figures like Santa Claus and the Tooth Fairy are endorsed as more real than dragons and unicorns (Kapitány et al., under review). Thus, children are capable of evaluating the reality-status of various entities judiciously, while remaining more susceptible to false beliefs than adults. And while this is an incomplete review of children's acquisition and evaluation of impossible entities (but see: Harris & Corriveau, *forthcoming*), it is the case that children have a variety of strategies available when determining claims within their own culture. The question that remains for the child, after determining whether belief is justified, is how they ought to act.

In the current study we focus on two domains of behavior in response to a supernatural presence. The first is social learning, specifically a child's tendency to overimitate, that is, to imitate steps of an observed action sequence including those that are easily recognized as being causally redundant and instrumentally irrelevant (Hoehl et al., 2019). Overimitation appears to be uniquely human (Clay & Tennie, 2018; Horner & Whiten, 2005; Whiten et al., 2009), early developing (Lyons et al., 2007; Nielsen, 2006), culturally-conserved (Berl & Hewlett, 2015; Nielsen, 2012; Nielsen et al., 2014; Nielsen & Tomaselli, 2010), and robust to contextual changes (Hoehl et al., 2019; Lyons et al., 2007). While there are competing and complementary theories as to why children overimitate, it is clear that interpersonal, social, and normative concerns are weighted heavily and that overimitation is sensitive to social and contextual cues (Hoehl et al., 2019; Keupp et al., 2013, 2015; Over & Carpenter, 2012). The type of verbal instructions, the absence or presence of ostensive communication, and the degree to which some actions are perceivably irrelevant all affect whether children interpret an action sequence as mainly instrumental (a focus on achieving a specific outcome) or conventional (a focus on the behavioural means), which in turn influences children's imitative behavior (Hoehl et al., 2019; Keupp et al., 2013, 2015; Legare & Nielsen, 2015).

When children are aware of the irrelevance of parts of an observed action sequence they may perceive the actions as conventional and so choose (more or less consciously) whether or not to copy those actions (Hoehl et al., 2019; Schleihau, 2018). The decision to copy will depend on the relative strength of the perceived goal(s) of the behavior: if an instrumental goal prevails (such as learning an object's affordances) children will likely omit the irrelevant action, but if a normative stance, an affiliative, or an entertainment goal prevails, they are likely to copy

the demonstrated actions with high fidelity (Hoehl et al., 2019; Over & Carpenter, 2009, 2012; Schleihau, 2018; Uzgiris, 1981; Wilks et al., 2016). Which goals are most salient can be manipulated experimentally: it has been shown that children draw normative conclusions about a demonstrated action when strong social pressures to copy are created via normative language (Clay et al., 2018; Clay & Tennie, 2018; Clegg & Legare, 2016; Keupp et al., 2013; Lyons et al., 2011; Nielsen & Blank, 2011). Children adhere to and enforce these norms in others, even at personal cost (Kenward, 2012; Keupp et al., 2013; Lyons et al., 2011). Furthermore, children imitate redundant actions in a causal sequence if the adult who modelled those actions is present, but will omit redundancy if a modeller who did not perform such actions remains present instead (Marsh et al., 2019; Nielsen & Blank, 2011). For these reasons we have chosen to examine overimitation in the context of supernatural agency as a child's tendency to overimitate seems to be calibrated within the social domain. If a supernatural agent can play a causal role in motivating a child's behavior, it seems sensible to begin with a task that reveals whether or not children believe the agent is socially relevant (see: Nielsen, 2018). If children believe that they are being observed by a supernatural agent, who is explicitly concerned with behavior then we expect that their behavior on an overimitation task would be consistent with that of a real social presence. Thus, the overimitation paradigm is an ideal measure to investigate whether one can generate belief in a supernatural agent among children, and to determine whether children treat such agents as meaningfully social.

Our second focus is the normative rule-following of children's non-compelled behavior - in this case, the choice to cheat for personal gain. This focus is motivated by a desire to re-examine and clarify effects that have been published previously, such as the 'Princess Alice'

studies (Bering & Parker, 2006; Piazza et al., 2011), and the 'Candy Witch' studies¹ (Boerger et al., 2009; Woolley et al., 2004). Bering and Parker (2006) used a testimony-based procedure to experimentally introduce Princess Alice to children (3 - 9 years): Children were shown a picture of a cartoon princess and told that she could make herself invisible, and was going to help the child make an important decision. Later in the experiment, the children made an A/B decision, at which point a picture fell from the wall. This unexpected event was anticipated to be understood as a 'sign' from the Princess. The authors found that children - particularly older children - were more likely to revise their original decision when they were in the Princess Alice condition (60% revised their decision suggesting that the Princess was responsible for the 'sign'), compared to children in a condition in which there was no princess (the falling picture was not readily attributed to supernatural intervention). This task, however, was not so much about belief as about the interpretation of unexpected events. A second instantiation of the Princess Alice methodology (Piazza et al., 2011) employed an almost identical induction method, but did not include showing children a picture of the Princess. The authors investigated whether belief in the presence of Princess Alice would decrease children's cheating behavior in a ball throwing game. Children were asked to toss balls at a target in order to win rewards (when alone), but told that crossing a line to throw the ball was against the rules. Piazza et al. (2011) claimed that children cheated less and waited longer before cheating in the 'belief' condition (compared to control), though none of the pertinent analyses reached conventional significance.

¹We choose to focus on the 'Princess Alice' studies in the introduction as we are attempting to replicate those findings. We will discuss the 'Candy Witch' studies in the general discussion.

If such an effect exists, why might it not replicate? First, 'Princess Alice' was described as being 'invisible' while being present in the room. Invisibility is not the same as immateriality: invisible figures can be falsified with touch even when unseen (in Piazza et al., 2011, children appeared to actively test the researchers' claims by waving their hand through the purported location of the Princess' body). Second, in all Princess Alice studies the induction method was testimony-based and limited to a single researcher asserting that the Princess was real. Thirdly, in neither experiment did the researchers state that Princess Alice was concerned with the child's behavior: In the 2011 paper the researchers did not make it clear that Princess Alice was concerned with the child's behavior despite their hypothesis explicitly resting on this assumption. For the sake of transparency, we have included Piazza et al.'s (2011) induction method in its entirety in Supplementary material A.

Our induction method was devised so as to introduce a supernatural agent (hereafter, 'the Friendly Professor') who was unfalsifiable, who was concerned with the child's behavior, and who was 'minimally counterintuitive' (MCI; Barrett, 2017; Fondevila et al., 2016). We committed considerable time to the induction (~3 to 4 minutes) and - as belief in novel entities is greater in realistic contexts - we grounded our induction to elements inside the testing room. The induction phase was based on a custom storybook entitled *The Friendly Professor*: the storybook described The Friendly Professor as important, smart, kind, and concerned with whether or not people followed the rules. Importantly, in terms of supernatural and MCI qualities, The Friendly Professor could always see what happened inside a specific room, that is, he could always tell whether someone was following or breaking the rules when inside his room (a kind of bounded omniscience). Our storybook was custom-illustrated in such a way as to show that the room the

child was tested in, was in fact, the The Friendly Professor's room: several key illustrations in the storybook depicted the testing room (pages 5, 6, 9, 11, 12) and the university (page 7; see Supplementary material B). Importantly, The Friendly Professor is an unfalsifiable figure, who is specifically concerned in specific features of a child's behavior² in a relevant environmental context.

In Experiment 1 - the overimitation study - we expected that the presence of the researcher would positively predict overimitation due to social pressure. We predicted that the belief condition would positively predict overimitation behavior, and that there would be an interaction between the belief condition and the researcher's presence: while we expected the belief condition to influence overimitation when the child was alone, we did not expect belief to influence overimitation when the child was in the presence of a research assistant; in the 'present' conditions, we expected high rates of overimitation irrespective of whether the child believed or not. We expected this pattern would also be evident, if somewhat diminished, during the second overimitation trial. In Experiment 2 - the cheating study - we adopted the explicit hypotheses of prior work: we anticipated an interaction between belief and presence, in that children who were alone and did not believe would cheat more than children who were alone and believed. We also expected the researcher's presence to reduce cheating behaviour, but that we would not be able to distinguish cheating rates between the belief and non-belief conditions when the researcher was present. As with previous studies, we also examined the latency until the child cheated, anticipating a corresponding pattern of results.

²We believe that these features (pseudo-omniscience, concern over behavior, and being located elsewhere) make The Friendly Professor conceptually similar to Santa Claus, a figure widely believed by children in many cultures to exist (Kapitány et al., 2018).

The Induction

Both studies relied on the same method of belief induction, and included the same manipulations. Our design was a 2 x 2 (belief / non-belief, and [child] alone / [researcher] present) between-participants design. In all conditions children were read the story of The Friendly Professor (see Supplementary material B). In the 'alone' condition, the child was alone in the room during the focal tasks, while in the 'present' condition, the RA remained in the room. In the 'belief' condition, the story of The Friendly Professor was presented as real, (and we anticipated that the children would believe they were being observed by The Friendly Professor), while in the non-belief conditions, the story was presented as fictional, and exclusively limited to the storybook (thus, we did not anticipate children to believe in the supernatural agent, or that he was observing them). We measured overimitation rates at two timepoints: one immediately following the induction and the modelled behavior (T1), and one was 30 minutes later (T2). The cheating task was examined during the interval between T1 and T2.

For ease of communication, and because imitation and moral reasoning have been found to be dissociated (Wilks et al., 2019), we present the overimitation and the cheating task as two separate experiments.

Experiment 1: Overimitation

Outline and predictions.

The overimitation literature has shown that when children observe a demonstrator carry out both causally relevant and irrelevant actions on a puzzlebox they often interpret the irrelevant actions as normative and thus copy them faithfully, despite being aware of their causal irrelevance (Hoehl et al., 2019; Keupp et al., 2013). It is also argued that believing in a watchful supernatural agent has a regulating effect on an individual's behavior (Atkinson et al., 2014; Boyer, 2007; Brazil & Farias, 2016; Galen, 2016; Geertz, 2014; Gervais & Norenzayan, 2012; Norenzayan, 2014; Shariff, 2011; Shariff & Norenzayan, 2007; Wade, 2015; Watts et al., 2016). Here, we investigated whether a similar effect could be aroused in children: Specifically, whether children would treat a supernatural character as though it were a meaningful social agent, as revealed by the tendency to overimitate on a standard puzzlebox task.

We measured overimitation at two timepoints separated by 30 minutes (T1 and T2). We were motivated to take two measurements as - at the time of testing - there had been limited research into deferred overimitation. Kline et al. (2019) tested adults and 9-year-old children from two traditional societies on a two-action puzzlebox: participants were allowed to manipulate the box immediately after the demonstration phase and then again 30 days later. The researchers found that adults and children from both communities had lower overimitation scores at T2 relative to T1. However, it is unclear whether such a finding translates to shorter latency. While we know that infants as young as 6-months of age are able to imitate instrumental actions after a 24h delay (Barr et al., 1996; Collie & Hayne, 1999) and 14-months-old can do so after a

2-month-delay (Jones & Herbert, 2006; Meltzoff, 1995), knowledge about the stability of *overimitation* remains sparse.

Thus, we attempt to answer three questions using the overimitation paradigm: 1) Do children treat supernatural characters as if they are meaningful social agents, as determined by their rates of overimitation, 2) If there is an effect of a supernatural character, how comparable is it to a real person, and 3) At what rates do children overimitate after a delay (and what influence do belief and/or presence have on this behavior)?

Method

Ethics.

This research was approved by the Institutional Review Board at the University of [redacted], under the title "Supernatural oversight and its influence of overimitation and cheating behavior" (#2014000667).

Participants.

A total of 112 children (53 girls, 56 boys, 3 unreported/indeterminate) constituted the final sample for each study. We recruited children who were 4 years ($n = 57$; $M = 4.08$; $SD = .11$) and 6 years old ($n = 55$; $M = 6.07$, $SD = .17$), though we treated age as a continuous variable in subsequent analyses unless stated otherwise. Thirty children were in the ‘alone/non-belief’ condition, 27 in the ‘present/non-belief’ condition, 29 in the ‘alone/belief’ condition, and 26 in the ‘present/belief’ condition. A total of six additional children also

participated, but were not included in the final analysis due to corruption of the raw video footage, non-compliance or recognition that they were being observed. Another four participants were excluded because it was not possible to associate the video data with their participant number.

Materials.

Materials for this study included the The Friendly Professor storybook (see Supplementary material B) and an overimitation puzzlebox (per Horner & Whiten, 2005). The box was made of transparent plexiglass and consisted of two separate compartments. The upper compartment could be accessed through an opening at the top of the box which was blocked by two bolts which could be pushed to the side. The lower compartment could be reached through a rectangular opening at the front of the box which was covered by a door that could be pushed to the side. A sticker was used as a reward which was put into a small bucket and placed into the lower compartment. The sticker could be retrieved from the box by sliding the door open and inserting a magnetic wand which would stick to the bucket.

Design and Procedure.

Children were tested by trained research assistants (RA). Upon arrival at the University, children (and their families) met the RA. Then, the RA asked the child if they would like to '*read a book and play a game*' in another room (the testing room). The child and the RA entered this room together, while parents were free to watch the interaction from behind a one-way mirror. The RA sat down with the child, and read to them the The Friendly Professor storybook. In all conditions, the text of the book was read to the child as it appeared on the page. As described in

Supplementary material B, there was a parallel script which the RA recited to the child from memory. This scripted dialogue with the child was designed to appear impromptu and natural, but was actually part of the induction method. The script included asking the child questions about the content of the book (such as *'Do you know what a professor is?'*, *'Do you know what an experiment is?'*, *'Do you think The Friendly Professor can see inside the room?'*). This script served the dual purpose of ensuring the child was paying attention as well as ensuring the child understood the book's content. In the conditions in which The Friendly Professor was a 'real' supernatural agent in the same realm as the child, this parallel text (for pages 7, 12, and 13) reinforced the information that The Friendly Professor lived in the University (that the child was visiting), that the room in the book was the same room the child was sitting in, and that The Friendly Professor had the power to observe what was occurring inside the room. In the two conditions in which The Friendly Professor was regarded as a work of fiction limited only to the book, the RA explicitly declared the fictional nature of the professor and the similarities of the book and the physical location were not made salient.

In every condition, the book included actual depictions of the puzzlebox. After the belief induction, the child was invited to 'do an experiment' on the puzzlebox. For this, the RA and the child went to a child-sized table ~ 1.5m away on which the puzzlebox had been on display since the start of the experiment. The RA said: *"Do you want to do The Friendly Professor's experiment? This is his favourite experiment. And remember, when we do an experiment we have to follow the rules. [Stated on the first presentation only: I'm going to show you how to do his experiment two times, then it'll be your turn]."*

The RA then twice modelled a standard overimitation action sequence consisting of causally relevant and irrelevant actions. The procedure consisted of 1) sweeping the end of the wand from the bottom to the top of the left side of the box three times, 2) pushing both bolts with the wand so that the top entrance was completely open, 3) inserting the wand into the top compartment and gently hitting the plexiglass ceiling that separating the compartments three times, 4) pushing the door at the front to the side using the wand until completely open, 5) inserting the wand into the lower compartment to retrieve the reward. (note: only actions 4 and 5 have any causal relevance to the goal of retrieving the reward). The child observed this process; thereafter, the RA handed the wand and apparatus to the child and simply said '*your turn*'. Depending on the condition (alone/present), the RA further said that they were going to leave the room for 2 minutes to do some work (alone) or sit on a nearby couch (present). Then the child was given the immediate opportunity to open the box (T1). At T2 (after 25 minutes) the storybook was re-read to the child (according to condition) before the child was given a second opportunity to act on the box for 2 minutes (again, according to condition, the RA was either absent or present during these 2 minutes). At this time, the RA did not model the actions.

Coding and analysis.

R.K. and E.R. coded each child's behavior on the overimitation task offline using the video recordings. Krippendorff's alpha between both coders for overimitation scores at T1 was $\alpha = .972$ and at T2 $\alpha = .938$, respectively³.

³In addition to the modelled behavior, R.K. and E.R. coded instances of replacement behavior (using one's hand instead of the tool), and instances in which additional actions were made. These, however, were not analysed, but were accounted for in the reliability score.

Overimitation scores were based on whether the child performed (1) or did not perform (0) demonstrated actions. A child's overimitation score was the sum of all actions that the child performed: 1 point for each stroke (3), 1 point for opening each bolt with the tool (2), 1 point for each tap inside the box opening (3), 1 point for open the chute door with the tool (1), 1 point for probing the chute with the tool (1), and 1 point for retrieving the toy (1)⁴. Children were able to score a maximum of 11. The maximum score of 11 was based on the common scoring method for over-imitation, which included relevant and irrelevant actions. We also calculated an overimitation score in which the final three *relevant* actions (open the chute door, probing the chute, and retrieving the toy) were excluded from the overimitation score. Naturally, the means varied (as the scores were now computed with a maximum possible score of 8, rather than 11). This alternative metric changed neither the direction, magnitude, nor significance of the differences. We thus retain our comprehensive score, and note that our data is publicly available <https://osf.io/tns7a/>.

Results

Manipulation check.

First, we examined whether our experimental manipulation (i.e., the belief induction) was successful. The manipulation check was performed after reading the book, and before any data was collected on either focal tasks, by asking children '*Do you think The Friendly Professor is real?*'. We analysed whether children were more likely to affirm that The Friendly Professor was

⁴If the child attempted an action with the tool but then gave up and used their hand, they were awarded .5 marks for the unsuccessful attempt.

real when we were attempting to generate belief compared to the conditions in which The Friendly Professor was described as being fictional. Of the 55 children who were in a condition in which The Friendly Professor was 'real', 40 (72.73%) *affirmed* his existence. Of the 57 children in a condition in which The Friendly Professor was fictional, only 12 (21.05%) did likewise.

We conducted a logistic regression on children's responses to our manipulation check. The Dependent Variable (DV) was whether the child affirmed (1) or denied (0) the 'realness' of The Friendly Professor, the Independent Variable (IV) was whether The Friendly Professor was presented as real (1) or fictional (0), while age (continuous) was used as a covariate (note that the manipulation of RA presence/absence had not yet occurred). The model fit was significant, $\chi^2(2) = 24.7, p < .001$. Age did not predict affirmation, $b = -.24, 95\%CI = -0.715 - 0.214, p = .307$, yet the belief condition did, $b = 2.35, 95\%CI = 1.457 - 3.321, p < .001$.

Overimitation rates at T1 and T2.

Figure 1 shows the overimitation scores at both timepoints by condition. Across the sample, the mean score on overimitation at T1 was 8.95 (SD = 2.05), and at T2 it was 8.58 (SD = 1.83). Using a two-tailed paired-samples t-test, these scores were not significantly different, $t(101) = 1.49, p = .139, 95\% CI = -0.11; 0.79$. This was true for both the 4-year-old ($M_{T1} = 8.60, SD_{T1} = 2.02; M_{T2} = 7.95, SD_{T2} = 2.00, t(49) = 1.49, p = .14, 95\% CI = -0.18; 1.24$) and the 6-year-old group ($M_{T1} = 9.29, SD_{T1} = 2.05; M_{T2} = 9.17, SD_{T2} = 1.56, t(48) = 1.66, p = .103, 95\% CI [-0.12; 1.26]$). Thus, rates of overimitation across the 30 minute period were not significantly different (Fig. 2).

Figure 1. *Overimitation scores at T1 and T2 by condition.*

Figure 2. *A raincloud plot of overimitation scores at Time 1 (left/red) and Time 2 (right/blue).*

Note: *It is not the case that low performing children at T1 did not complete T2, and thus are influencing the analyses. The children with the lowest three scores at T1 scored 8, 10, and 10 respectively at T2.*

Effects of belief induction and researcher's presence.

Overimitation at Time 1. We conducted a multiple regression, in which we entered overimitation score at T1 as a DV, age as a covariate⁵, and as IVs we entered whether the child was alone or not, whether The Friendly Professor was presented as real or fictional, and an interaction term. We found this model did not have a significant fit, $F(4,98) = 2.10, p = .086$, $R_{Adj}^2 = .042$. One should avoid interpreting values in a non-significant model, we present them here for completeness: age was associated with a non-significant positive slope, $b = .38, t(98) = 1.90, p = .060$; while the presence of the RA was associated with null slope, $b = .01, t(98) = .011, p = .991$, as was the reality-status of The Friendly Professor, $b = -0.12, t(98) = .233, p = .817$. The interaction was not significant, $b = -0.98, t(98) = 1.20, p = .234$.

Overimitation at Time 2. We conducted a multiple regression, in which we entered overimitation score at T2 as a DV, age as a covariate, and as IVs we entered whether the child was alone or not, whether The Friendly Professor was presented as real or fictional, and an interaction term. We found this model had a significant fit, $F(4,95) = 3.403, p = .012, R_{Adj}^2 = .088$. We found that age was associated with a significant positive slope, $b = .60, t(95) = 3.44, p < .001$; while the presence of the RA was associated with a non-significant positive slope, $b = .14, t(95) = .281, p = .779$, as was the reality-status of The Friendly Professor, $b = 0.27, t(95) = .562, p = .575$. The interaction was not significant, $b = -0.79, t(95) = 1.12, p = .267$. We also ran the same analyses including as an additional predictor the participant's overimitation score at T1 as a predictor of overimitation at T2. This model, too, was significant: $Overimitation_{T1}$ was a

⁵ Predictor variables in multiple regressions need not be normally distributed, and so doing this does not violate any assumptions of the analyses.

significant predictor of Overimitation_{T2}, and age remained significant. However, none of the other predictors changed. Thus, while we found that rates of deferred overimitation increased with age, we did not observe any effect associated with the belief induction nor the presence of the RA, even after controlling for a child's baseline ability to overimitate.

Discussion.

We were interested in determining whether a supernatural agent was interpreted as a meaningful social presence by children. We found that 40 out of 55 children in the belief condition affirmed The Friendly Professor's existence, while only 12 of 47 did so in the fiction condition. Yet, critically, we failed to find evidence that the belief induction affected children's overimitation rates. However, we did not find any effect associated with the presence of the RA either. Thus, we have insufficient variance to interpret whether overimitation behavior is influenced by belief in The Friendly Professor.

We found the same null results for T2; even after controlling for a child's baseline (T1) ability to overimitate ($\beta = .22$), no effect of belief and/or social presence uniquely or significantly explained overimitation behavior.

We replicated previous findings that children overimitate at high rates, and do so even when social pressure is reduced (i.e., when they are left alone in the room; Hoehl et al., 2014). This effect has been explained as children interpreting the demonstrated actions as normative, copying all of the demonstrated actions because that is "what is done" (Hoehl et al., 2019). Alternatively, children may have found the irrelevant actions simply entertaining (Schleithauf, 2018). We also showed that deferred overimitation increases with age. A novel contribution of

the present study, however, is the finding that the fidelity of deferred-overimitation did not diminish after a 30 minute delay for either age-group, though the older group had, on average, higher fidelity performance.

Studies examining children's overimitation rates after a delay are scarce. Kline et al. (2019) tested 9-year-old children in two non-industrialized societies on a two-action overimitation box immediately after demonstration (T1) and after a delay of 30 days (T2) and found that overimitation of the irrelevant actions at T2 were significantly lower than at T1, while imitation rates for the causally relevant actions stayed stable. The authors concluded that imitation of the irrelevant actions served a short-term, social/affiliative function which was salient at T1, but which was diminished or absent at T2. Though we examined a younger sample than Kline et al. (2018), it seems likely that our null results are due to the difference in duration (even after re-calculating our overimitation scores to only include redundant actions).

Experiment 2: Cheating behavior

In Experiment 2 we investigated whether an experimentally induced belief in a supernatural agent would affect children's cheating behavior. Our task required children to toss ping-pong balls into a bucket with a narrow opening at a distance of two meters. Prior research has suggested that when children believe they are in the presence of a morally concerned supernatural agent they are less willing to cheat (Piazza et al., 2011), though attempts to replicate this work have not reproduced this finding (King, 2011). We report a p-curve analyses of the original paper in Supplementary material C.

Children from experiment 1 were invited to play the ball-throwing game during the inter-trial interval of the overimitation task previously discussed. Children were told they would receive a prize based on the number of balls they could successfully throw into the bucket, with more balls earning a greater prize (in reality all children were awarded the same number of stickers regardless of performance). While appearing superficially simple, the task is very difficult, and thus ideal for incentivizing cheating behavior. Children were instructed that the task had only one rule: *The child could not cross the line when throwing balls*; this line was positioned 2m from the bucket. The only time they could cross the line was to retrieve balls if they depleted their supply. As in experiment 1, during the test phase children were either in the presence of the RA or not, and had been led to believe that The Friendly Professor was either real or fictional.

Following Piazza et al. (2011), we hypothesized that there would be an interaction between belief and presence, in that children who were alone and did not believe would cheat more than children who were alone and believed. We also expected the presence of the RA to reduce cheating behaviour, but that we would not be able to distinguish cheating rates between the belief and non-belief conditions when the RA was present.

Methods.

Materials.

We used a small colorfully decorated bucket that had a lid with a small opening with a diameter twice that of the ping-pong ball. A piece of tape two-meters from the bucket served to

mark the boundary that children could not cross while throwing balls. Children were provided with a transparent bucket containing 30 ping pong balls, which was placed next to the child (and behind the line). We provided 30 balls in the hope that the child would not end up throwing all balls during the two-minute period (and thus, would not need to cross the line to retrieve the balls). Children were told they may cross the line to retrieve balls if they ran out.

Procedure

After the child finished the first round of the overimitation task in experiment 1, they were invited to play another - ostensibly unrelated - game. The RA explained the rules of the game. Children were told three times that they could not cross the line on the floor while throwing the balls (but could cross the line to retrieve the balls if they had thrown all that were provided; all children understood this). Children were given the opportunity to have three practice throws in the presence of the RA, who ensured that the child did not cross the line; children were gently reminded of the rule if they transgressed. Depending on the condition, the RA then left the room, or sat down on a chair in the testing room. The RA neither encouraged nor admonished the child's behavior, even when queried directly. During this period, the RA appeared disengaged, either reading a book or attending to their phone. Children had two-minutes to throw balls. When the time was over the RA returned to the room or stood up from the couch, praised the child for their efforts and rewarded them with a small set of stickers.

Coding and analysis.

A two-minute timer was started from when the child threw the first ping-pong ball or when the RA closed the door; the coding of behavior was extracted from video, and coding

ceased even if the RA accidentally allowed the session to last longer than two-minutes (note: while several instances occurred of a prolonged testing session, no instances of relevant behavior were observed after the two-minutes threshold). We conducted analyses on the following variables, but coded more than is reported here (see Supplementary material D for full details; reliability statistics are reported in full in Supplementary material D, but in all cases were $\geq .85$). If the child allowed any part of their body to cross the line *and* touch the ground in front of the line, it was coded as a *cheat* ($\alpha = .85$). Many children leaned over the line, but this was not coded as a cheat. When a cheating action was observed, the coders recorded how much time had elapsed since the child began (this value is known as *cheat latency*). We coded for both 'minor' and 'major' cheats, where a major cheat involved the child crossing the line by (more than) the length of their own foot (for full details see Supplementary material D). As the reliability on the latency value for 'major cheat' was high ($\alpha = .93$) relative to the 'minor' cheat (.85), we opted to analyse the more reliable, more obvious instances of 'cheating' when analysing cheating latency.

Results.

Of the 112 children who engaged in this task, a total of 57 cheated. In the 'alone/non-belief' condition, 22 out of 30 (72.33%) children cheated, in the 'present/non-belief' condition it was 10 out of 27 children (37.04%), in the 'alone/belief' condition 15 out of 29 (51.72%), and in the 'present/belief' condition 10 of 26 (38.46%) children cheated.

We conducted a logistic regression on whether children cheated, in which we entered age (continuous) as a control variable and whether The Friendly Professor was presented as real or fictional, and whether the RA was present or absent, and an interaction term. Our model was not

significant, $\chi^2(3) = 8.1, p = .314$. We found that a child's age did not predict their tendency to cheat (OR = .855, $p = .444$, 95% CI = -0.56; - 0.24, nor did the reality-status of The Friendly Professor (OR = .39, $p = .104$, 95% CI = -2.12; - 0.17); nor did we find that when an RA was present in the room, children were less likely to cheat (OR = .35, $p = .088$, 95% CI = -2.27; - .13; nor did we find a significant interaction (OR = 2.85, $p = .204$, 95% CI = -0.56; -2.69). Thus, we did not find an effect associated with whether the Friendly Professor was presented as real or not⁶.

Piazza et al. (2011) also tested whether or not children waited longer before cheating in the condition in which Princess Alice was ostensibly real. Thus, we tested the same claim in our overall model: regarding time elapsed until a major cheat, the median and mode were 120 seconds, with a skewness of -.486 and a kurtosis of -1.56. Visual inspection of a scatterplot suggested that the assumption of homoscedasticity was violated - specifically because those who did not cheat lasted the full 120 seconds, while those who did cheat tended to have quite low scores (of those children who cheated, over half did so in the first 60 seconds). Thus, we used a Kruskal-Wallis test (the non-parametric equivalent of an ANOVA) and found that the model was significant, $\chi^2(3) = 8.830, p = .032$. Using Tukey's HSD analysis revealed that 'alone/non-belief' was significantly different from 'present/non-belief' ($p = .035$), but not different from 'alone/belief' ($p = .182$) nor 'present/belief' ($p = .389$); no differences were observed between the other conditions (Fig. 4).

However, a score here of 120 seconds is qualitatively different from a score of 119 seconds, as in the former case no cheating took place at all. Thus, we conducted an analyses

⁶We also conducted an exploratory analysis in which we substituted the condition associated with belief in The Friendly Professor for the child's response on the manipulation check. This model did not fit the data.

excluding those who didn't cheat at all. We found that latency did not vary in any condition, $F(3,46) = .584, p = .628$.

Fig. 4. *Scatterplot of latency scores for major cheats with overlaid violin plot and median value by condition.*

Discussion.

We examined whether children who were led to believe in a supernatural agent would cheat less than their counterparts when given the opportunity to profit by doing so. We found that across conditions, children's cheating rate was rather high, with 57 of 112 children cheating, and 10 of 27 cheating when an RA was present in the room. We did not identify any factor that predicted whether a child would cheat, that said, children who were left alone and who did not

believe The Friendly Professor was real, on average cheated much faster than children in all the other conditions (as also reported by Piazza et al. 2011), though no effect of the supernatural agent was observed. Thus, we failed to replicate the core claims of Piazza et al. (2011).

General Discussion

We investigated two research questions: whether an experimentally induced belief in a supernatural agent would affect children's behavior 1) in the domain of overimitation and 2) in the normative domain of cheating. We tested children aged 4 to 6 years in two experiments, at the beginning of which we executed an elaborate belief induction. We used a 2 (belief / no belief) x 2 (RA absent / RA present) between-participants design. Experiment 1 showed that children readily overimitate, and do so even when alone. Crucially, being told The Friendly Professor was real had no statistical effect on copying behavior (almost certainly due to low variance in all conditions). We also found that performance after a 30-minute delay remained stable when children performed the actions exclusively from memory. Age significantly predicted overimitation rates at T2. Thus, we found no evidence to support the hypothesis that belief in a supernatural agent would influence overimitation behavior, but nor did we find any evidence to the contrary. Perhaps the most striking finding is that overimitation did not decline over a 30-minute period. We believe that this is the first study to show that overimitation - whether alone or not - occurs after such a delay. This suggests children are capable of remembering each of the demonstrated actions and that the motivation to replicate the actions

remains strong after a considerable interval (which, from the point of view of the child, involved a totally unrelated task).

Our second experiment re-examined claims made by Piazza et al (2011) who employed a testimony-based model of belief induction. They qualitatively claimed that cheating decreased, though their statistics suggested otherwise. A p-curve analysis of their work indicates that there was no apparent evidentiary value in their claim (see Supplementary material C), and a replication by King (2011) failed to find the effect. We, too, failed to find the effect, and argue that one cannot easily experimentally induce supernatural belief among children such that it influences normative behavior. We did, however, find that children - when left alone in a room - were *faster* to cheat (however, this is not particularly meaningful as the binary value of cheating was confounded with speed to cheat, and so this finding ought not be over-interpreted). We feel confident in claiming that - to date - there is no compelling evidence that the normative behavior of children, in experimental contexts, is influenced by the 'presence' of a novel supernatural agent.

There are multiple reasons why our manipulation (and by extension, those of other scholars) may have been insufficient to produce the expected effects. First, let us discuss the most elaborate and potentially most successful belief induction described in the developmental literature.

Woolley, Boerger, & Markman (2004) created a fictional agent called 'The Candy Witch' and an elaborate induction process that involved consensus, time, behavior, and reward. In order to instil belief, two different experimenters, on two separate occasions (one and two weeks before Halloween, respectively) arrived at a school to describe the Candy Witch to a class of

children. Children were told that the Candy Witch is a friendly witch who trades toys for Halloween candy. To summon the Candy Witch a child needed to refrain from eating some of their candy, while the child's parent needed to phone the witch to arrange for her visit. Then, on a specific night, the candy witch visited and exchanged a toy for the candy. Across experiments this induction method led a majority of children to report that the Candy Witch was real (Boerger, Tullos, & Woolley, 2009; Woolley et al., 2004). Among older children, participation in the behavioral aspects significantly increased endorsement of the reality of the Candy Witch compared to those who only heard about the witch, with some weak evidence suggesting that those who were visited recalled more details about the Candy Witch one year later. Here, we do not learn if the Candy Witch changed children's behavior, but rather, those who (were required to) behave as if the Candy Witch was real had stronger belief and recollections of her one year later. The work is not without its weakness, however, and the small N and non-randomized approach limits the generalizability of the finding. Nonetheless, it is our opinion that Woolley, Boerger, & Markman (2004) set a high bar for belief induction, one that strikes us as necessary in this line of enquiry.

In our study, our verbal manipulation check showed that children were many times more likely to endorse belief in The Friendly Professor when he was presented as real as compared to when he was presented as fictional. Children in the belief condition were given stimuli for a prolonged period, contextually grounded The Friendly Professor in their immediate surroundings (the room) and location (university), and his profession (a professor). The Friendly Professor was also unfalsifiable. That said, there are several reasons - theoretical and practical - for why our manipulation might not have been successful (which apply to other similar works).

The first is that children may have ‘passed’ the manipulation check because they were responding in a socially desirable manner; though there was no punishment or reward supporting their response, children are highly motivated by such factors. While we do not believe that our manipulation had *zero*-effect on *all* children, we cannot empirically rule out this argument in all cases, and so must tentatively entertain this possibility. Further, affirmation may not immediately lead to an acceptance of his special powers. Hoping to avoid provoking suspicion, we did not measure these beliefs, instead, we hoped that this belief would be captured by focal behavior. Unfortunately, children’s performance was consistently high in the overimitation task, preventing meaningful inference.

Second, the manipulation - while strong - may not have been strong enough. It is possible that too few extrinsic factors were involved in generating belief. In contrast to The Friendly Professor, the Candy Witch required children to abstain from eating all their Halloween candy, a difficult task that forms the basis of the famous marshmallow test (Shoda et al., 1990; T. W. Watts et al., 2018). The Friendly Professor made no such demands on the child. Indeed, the supernatural figures that are most highly endorsed by children all require behavior on the part of the child (Kapitány et al., under review): For example, Santa requires children to be nice (and not naughty), to erect trees inside their house, to buy and wrap gifts, and the Tooth Fairy requires children to hide body parts in their own bed while they sleep. Moreover, the Friendly Professor did not reward (or punish) children: Santa gives gifts, the tooth fairy gives money, and the Easter bunny gives chocolate; even the Candy Witch promised toys. There exists no empirical evidence that receiving such rewards generates belief, but it seems plausible. Thus, The Friendly

Professor, and by extension, other experimental supernatural entities, may have been unsuccessful as they failed to account for required behavior, and potential reward.

Third, children are nuanced and discriminating in their belief. One important facet of this is consensus and (by extension) awareness. Children can ask anyone about Santa and will receive broadly similar answers. Children in the Candy Witch study had two RAs consensually describe the figure in depth (Canfield & Ganea, 2014; Corriveau et al., 2009), in a pedagogical context (Woolley & Van Reet, 2006), and were able to discuss the Candy Witch doctrine with each other - that is, they shared awareness. While information regarding The Friendly Professor was provided by an authoritative source and was broadly similar to the more familiar figure of Santa, The Friendly Professor was unknown to children prior to arriving at the lab. Thus, they had no preconceived awareness of the figure, nor even a nominal sense of consensus. And while we expect that it is possible to convince a child using only testimony that a novel supernatural figure exists, we expect factors such as credibility and familiarities are increasingly important.

The weight of evidence generally suggests that experimentally inducing belief in supernatural figures, in such a way as to motivate normative behavior is not easily achieved. Moreover, assessing that belief calls for careful attention to the existing literature on children's developing understanding of special minds. Though it is self-evident and empirically true that children can, and do, believe in supernatural figures, and these beliefs may influence behavior, much more empirical work is required to identify exactly *how* such a supernatural belief is created. Supernatural belief systems are a major component of the vast majority of societies and maybe considered a core feature of the human mind. Investigating the developmental origins of these systems and their potential functions are critical to any understanding of what it is that

makes us who we are. While the lack of positive findings here do not provide significant leaps in our understanding, we hope we have presented a sound framework by which the field can continue to move forward.

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Supplementary Material A. The induction method of Piazza et al.'s (2011) in full:

To introduce the invisible person [Princess Alice], children in the invisible agent condition received the following information from the experimenter: Before we begin the game, I would like to introduce you to someone very special. Her name is Princess Alice. Have you ever heard of Princess Alice? [No child said “yes”.] Well, let me tell you about her. Princess Alice is a friendly magical princess with a special ability. [She was described as “friendly” to reduce the risk of frightening children.] Do you think you know what her special ability is? [No child guessed right.] Well, let me tell you. Princess Alice can make herself invisible. Do you know what invisible means? [Most children said, “It means you can’t see her.”] That’s right—it means that you cannot see her even though she’s there! And guess what? Princess Alice is in the room with us right now and she is sitting in that chair. [The experimenter pointed to an empty lab chair...]. (p. 313).

Supplementary Material B. The 'Friendly Professor' Story Book used for the belief induction.

The following shows each page of the story book (on the left), and the corresponding protocol for actively involving the child in the storytelling, maintaining their attention, and inducing belief (on the right). On all pages, the RA first read to the child the text written on the page and then - if applicable - followed the protocol for that page. Note that the protocol was conditional on the experimental group children were assigned to (i.e., Friendly Professor stated to be real or fictional).

Story book page

Conditional protocol

Title Page.

[No explicit instructions]

Page 2.

RA: Do you know what a University is? [Child Answers]

Ans: It's a school for grown-ups who want to keep learning.

RA: Do you know what a professor is? [Child Answers]

Ans: He's like a teacher for grown-ups.

Page 3.

[No explicit instructions]

Page 4.

RA: Can you think of any other questions a scientist might ask?

[Child Answers]

Ans: Ad lib an answer, based on the child's responses.

Page 5 (left).

Because the friendly professor's joy to do science experiments, it was very important that all the rules were followed.

If people broke the rule his experiments didn't w

RA: Do you know what an experiment is? [Child Answers]

Ans: An experiment is a way to try and figure out an answer to a question. In an experiment you start with a question and some measurements. You might do an experiment to see which of us is a faster runner, and we could run a race and see who wins ... Do you think it would an experiment if I cheated and ran before you said go? [Child answers]. That's right, in an experiment, you have to follow the rules, just like you do in a race!

RA: So why do you think it's important to follow rules in an experiment? [Child Answers]

Ans: So we can know if something is right or wrong! The rules have to be followed so we know we're right!

(For Pages 5 and 6) RA: Can you see the difference here. In which picture is the FP happy?

Ans: [left picture; page 5]

Does he look happy in this picture [indicates right picture; page 6]?

Page 6 (right)

Instruction as described above.

The Friendly Professor was a very kind professor and never got angry...

But it always made him ver when people followed th

Page 7.

If child is in a *belief* condition -

RA: Did you know that this is a picture of this university! The Friendly Professor lived and worked right here where we are now

If child is *not* in the belief condition -

RA: Do you know what this place is? It's a picture of a university, like where we are right now.

The Friendly Professor live at the university, where he work, and teach, and look after his students.

He was a very nice man.

He loved his work.

And he loved his

Page 8.

[No explicit instructions]

The Friendly Professor might be a way away, or even asleep... and he could always see if someone was breaking the rules when they did one of his experiments!

Page 9.

RA: Do you think someone like The Friendly Professor could see things happening a long way away? [Child Answers]

Ans: [Correct child if necessary]. Well, most people can't; you and I can't. But The Friendly Professor could. He was special that way.

Because the Friendly Professor was so smart and knew so much always knew when someone was breaking the rules.

His students used to say that he could always see them!

...Even when he wasn't in the

Page 10.

[No explicit instructions]

The Friendly Professor never go if the rules were broken, but eve knew that it made him very happy when he saw them follow the rule

Page 11.

[No explicit instructions]

The Friendly Professor used to work in this

Everybody knew that when they were working in this room they to follow the rules to make The Friendly Professor happy, he could always see them... no matter

Page 12.

Identify the images to the child as a table, a chair, a couch, and a pillow

If in a *belief* condition, point to the *objects in the room*.

If not, point to the objects *on the page*.

The Friendly Professor is still alive and is very old. And everybody who works in his room, and does his experiments knows that he can still see them...

Page 13.

RA [If in a *belief* condition look at the room and say]: I guess The Friendly Professor can see us right now. Since we're in his room. That's pretty cool, hey?

RA [If not in the *belief* condition say]: I guess The Friendly Professor had magical powers. But then he's just made up. Did you like the story?

Supplementary Material C. Results for p-curve analysis

In an effort to clarify potential biases for these conflicting outcomes, we conducted a p-curve analysis (Simonsohn et al., 2015) using <http://www.p-curve.com/app4/> (Fig. 3; S4). A p-curve analysis takes into account published p-values (as reported from their distribution statistics, like t , F , and χ^2) and reports whether or not the reported values correspond to expected distributions of a real effect, or whether the distribution is distorted in some way. If an effect is real, p-values should be low, clustering below .01; but if the p-values tend to cluster between .03 and .05, this suggests that something other than a real effect can explain the values. The 'half p-curve' analysis does not reach significance (of $< .05$), $Z = 0.21$, $p = .583$, nor does the 'full p-curve', $Z = 0.94$, $p = .827$, and their combined values (which together might suggest evidential value if both $< .1$) do not fall below significance thresholds. In addition, the 33% power test was significant, $Z = -2.97$, $p = .001$, suggesting that the work has 'insufficient or absent' evidential value (Simonsohn et al., 2015). These values suggest that the evidence presented by Piazza et al. (2011) does not support the interpretation of a real effect, but rather reflects something like sampling bias, undefined stopping rules, or selective reporting of analyses. Taken together, it suggests a direct replication is unlikely to yield positive results. We thus aimed to examine this question using a more powerful induction method in order to yield more insight into the proposed effect.

Figure 3. A *p*-curve analysis of Piazza et al., 2011.

Values extracted from Piazza et al. 2011 for use in the *p*-curve app. Note that negative correlation (*r*) values were converted to their absolute (i.e., positive) value for analysis. These values can be cut-and-paste into <http://www.p-curve.com/app4/> to reproduce our stated results, and for more analytics.

$$\chi^2(2) = 5.58$$

$$F(2, 61) = 3.44$$

$$t(64) = 2.58$$

$$t(64) = 1.61$$

$$\chi^2(2) = 8.63$$

$$t(16) = 2.25$$

$$\chi^2(1) = 7.48$$

$$t(57) = 2.53$$

$$r(23) = .24$$

$$t(5) = 2.41$$

$$F(1, 61) = 9.00$$

$$F(2, 61) = 1.65$$

$$F(2, 61) = 3.48$$

$$t(26) = 2.06$$

$$t(26) = 2.12$$

$$t(35) = 2.07$$

$$t(35) = 1.23$$

$$F(1, 18) = 9.01$$

$$r(67) = .26$$

$$r(67) = .27$$

$$r(67) = .24$$

$$r(23) = .16$$

$$r(23) = .43$$

$$r(23) = .29$$

Supplementary Material D. Full coding values.

The full list of values coded by RK and ER.

Minor cheat: If children allowed their foot (or some part of their body that was in contact with the ground) to pass beyond the foremost part of the line, but crossed the line to an extent less than the length of their own foot. The amount of time that had elapsed between the beginning of the session and the minor transgression was recorded. The reliability for this value was $\alpha = .85$

Major cheat: If a child crossed the line to an extent greater than the length of their own foot. Only the first instance of cheating was recorded for the 2-minute period, not the total number of times a child committed a minor and/or major cheat. If a child committed a minor *then* a major cheat two instances of cheating were recorded. However, only one instance of cheating was recorded if the child first committed a major offence. Coders recorded the amount of time that had elapsed between the beginning of the session and the major transgression. The reliability for this value was $\alpha = .93$.

Deliberate cheat: We also coded whether the cheating instance appeared to be willful and deliberate or rather an accident due to a lapse in concentration. This value was based on the coder's interpretation of the event, primarily for quality control. It was not part of any subsequent analyses.

Cheat latency: Following Piazza et al. (2011) we also conducted analyses on the latency until a child cheated, coded as the time elapsed between the start of the period and the first

incidence of a minor or major cheat, respectively. The latency score ranged from 0 seconds (the child cheated immediately) to 120 seconds (the child did not cheat at all).

Number of balls: We coded the *number of balls* children put in the bucket (either through skill or deception). This number was not used in any analyses.