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Children selectively demonstrate their competence to a puppet when others depict it as an agent

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ABSTRACT

Young children care what others think of them, but are these concerns specific to interactions with humans? Here we ask whether 4-year-old children engage in self-presentational behaviors even with a puppet. After failing to activate a toy in the presence of a puppet, children selectively demonstrated their success on the toy when the puppet was absent during their final success. This pattern was found when the puppet was treated as an agent capable of holding mental states (Exp.1), but not when it was treated as an object (Exp.2); we further explore the role of indirect, linguistic cues to the puppet's agency (Exp.3). These results highlight the importance of social contexts, particularly how an entity is depicted by others, in eliciting self-presentational behaviors. We discuss how depiction of puppets may influence their effectiveness in developmental research, and the possibility of self-presentational concerns in children's interactions with social robots and AI agents.

Humans are motivated to present themselves in the best light. As adults, we care about what other people think of us and routinely engage in behaviors to impress others or promote our reputations (Baumeister, 1982). Research suggests that such self-presentational concerns emerge early in life. For example, 3-year-olds cheat less when they are told they have a reputation for being "smart" (Zhao, Heyman, Chen, & Lee, 2017); by age 5, children selectively modulate their prosocial behaviors in the presence of others (e.g., Engelmann, Herrmann, & Tomasello, 2012; Engelmann & Rapp, 2018; Silver & Shaw, 2018) and are less likely to engage in cheating behaviors when they are told they have a positive reputation (e.g., being "a good kid"; Fu, Heyman, Qian, Guo, & Lee, 2016).

However, despite the early emergence and importance of self-presentational motivations in shaping our social interactions, we still do not fully understand the necessary conditions that give rise to self-presentational motivations and behaviors. One particularly relevant and timely question is whether self-presentational behaviors appear uniquely in interactions with our human conspecifics. Although most developmental research on reputation management has studied children's behaviors in their interactions with human observers (e.g., Asaba & Gweon, 2018, 2022; Engelmann et al., 2012; Engelmann, Over, Herrmann, & Tomasello, 2013; Fu et al., 2016; Leimgruber, Shaw, Santos, & Olson, 2012; Shaw *et al.* 2014; Zhao et al., 2017), the rapid growth of non-human "social" entities in children's lives (e.g., interactive toys, social robots, AI systems; Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018; Crompton, Gregory, & Burke, 2018; Sheridan, 2020; also see United Nations Children's Fund, 2020) raises a question about whether children's self-presentational behaviors arise only in human-to-human interactions or manifest even in interactions with non-human

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entities.

To explain why humans care about their reputation, existing theoretical proposals have appealed to both motivational and cognitive factors; humans are not only motivated to be seen as desirable social partners, but also have the cognitive capacities for representing how others might think about and evaluate the self (Engelmann & Rapp, 2018; Silver & Shaw, 2018; Sperber & Baumard, 2012). In light of these accounts, we can consider two possibilities. First, given the importance of the motivation to be chosen as a real-world social partner (Engelmann & Rapp, 2018), one might predict that self-presentational behaviors are specific to interactions with our human conspecifics, where failing to manage one's reputation can have real negative social consequences. Thus, young children may not modulate their behaviors depending on the presence or absence of non-human entities such as puppets because these entities are unable to influence their real-world reputations.

An alternative possibility, however, is that self-presentational behaviors are not necessarily constrained to human-to-human interactions. Along with motivational factors, prior literature has also appealed to Theory of Mind (ToM)—the ability to represent and reason about others' mental states—as a key cognitive capacity that underlies the development of reputation management (Asaba & Gweon, 2018, 2022; Banerjee & Yuill, 1999; Engelmann & Rapp, 2018; Silver & Shaw, 2018; Sperber & Baumard, 2012). Abundant evidence suggests that children readily attribute mental states (e.g., goals, knowledge, beliefs, desires) not only to humans but also to animals, fictional characters, and even inanimate objects (e.g., Hamlin, Wynn, & Bloom, 2007; Kahn et al., 2012; Wellman, Cross, & Watson, 2001). This raises an intriguing possibility: Insofar as the target of mental-state attribution extends beyond human entities, behaviors that stem from attribution of mental states may also extend beyond human-to-human interactions. Thus, children may demonstrate self-presentational behaviors even to non-human entities insofar as children consider those entities as capable of holding a representation about the self.

Despite recent interest in the early emergence of reputation management, prior studies have mainly focused on manipulating the presence of human observers or their visual access to participants' behaviors (e.g., Engelmann et al., 2012; Leimgruber et al., 2012) rather than manipulating the ontological status of the observer (e.g., whether they are human or not). Thus, there are open questions concerning the extent to which children might demonstrate self-presentational behaviors even to non-human entities, and what factors might influence children's tendency to do so. Here, we test whether young children would show self-presentational behaviors even to a non-human entity, especially in a context that facilitates mental-state attribution.

To this end, rather than manipulating the presence or absence of a puppet observer, we adapted a task used in Asaba and Gweon (2018, 2022) that requires children to track the contents of the observer's mental states about the self. They found that 3- and 4-year--olds consider others' prior observations of their failures and successes on a causal toy and strategically decide whether to "show off" their success. When a human observer (an adult experimenter) had seen children's initial failures as well as their final success on a toy, children selectively chose to show a novel toy over the familiar toy to the human observer. However, when the observer left before the final success (i.e., not seeing children's final success), children were more likely to show the familiar toy to the observer, compared to when the observer did see their success. Given that the observer already had seen how the familiar toy worked, children's decisions to show this toy reflect their attempt to "show off" that they can activate the toy. These findings suggest that young children understand how others' observations of their own failures or successes can generate or revise specific mental states about their competence (e.g., the observer's knowledge of their own failures or successes, or beliefs about their ability to activate a toy). While the original study featured an adult experimenter as the observer, by replacing the human observer with a puppet, we can explore whether such self-presentational behaviors would also appear in children's interactions with non-human entities. More specifically, we hypothesize the following: If attribution of mental states about the self (rather than a simple human-nonhuman distinction) is the key factor that influences self-presentational behaviors, then results from Asaba and Gweon (2018, 2022) should, in principle, replicate even when the human observer is replaced with a hand puppet. Critically, beyond asking *whether* children would engage in self-presentational behaviors even in front of a puppet, we explore *how* a puppet—a clearly non-human entity—might elicit such behaviors by systematically manipulating the ways in which the puppet is introduced and depicted in the experimental context: Do children demonstrate their success to a puppet regardless of how it is depicted by an experimenter, or do they do so only when the puppet is depicted as an agent capable of holding mental states?

This question is particularly relevant to the longstanding practice of using puppets or other toy agents as stand-ins for human confederates in developmental research. While recent debates have questioned and defended the validity of using puppets and other schematic stimuli for studying the development of social cognition in early childhood (see Kominsky, Lucca, Thomas, Frank, & Hamlin, 2020), key questions remain about how exactly children come to treat them as agents capable of perceiving, feeling, reasoning, and interacting with other agents (Revencu & Csibra, 2020). From one perspective, these stimuli only need to meet certain perceptual conditions (e.g., have eyes or other facial features, capable of self-propelled motion, or behave contingently; see Brink & Wellman, 2020; Johnson, Slaughter, & Carey, 1998; Scholl & Tremoulet, 2000; Spelke & Kinzler, 2007) in order for children to interpret them as agentic. If these perceptual cues are sufficient for rich mental-state attribution, the use of a puppet (with eyes and other human-like morphological features) may be enough to elicit self-presentational behaviors regardless of how it is introduced or depicted.

However, recent theoretical proposals and empirical work have suggested that the ways in which children interpret everyday objects and non-human entities (e.g., dolls, toy animals) critically depend on how they are being presented, or depicted (Clark, 2016; Kominsky et al., 2020). Examples of such depictions not only include how other people (usually adults) communicate about non-human entities (e.g., parent talk about the psychological properties of nonliving kinds; see Jipson, Labotka, Callanan, & Gelman, 2018) but also how adults might interact with these entities in their demonstrations; indeed, preschool-aged children readily engage in pretend play following an adult's demonstrated use of, or interactions with, an object (e.g., Leslie, 1994; Harris, Kavanaugh, Wellman, & Hickling, 1993; Rakoczy, Tomasello, & Striano, 2004). From this perspective, even the same physical entity such as a hand puppet may be represented differently—as an agent or an object—depending on how it is being depicted; more specifically, if an experimenter

presents and treats a puppet as "a friend", such communication might facilitate children's interpretation of the puppet as (a representation of) a sentient agent capable of holding mental states. If this is the case, the results from Asaba and Gweon (2018, 2022) should replicate when a hand puppet is used instead of the human observer, but critically, only when the puppet is treated as an agent.

Prior literature provides some indirect support for this second possibility. In cognitive development research, non-human entities such as hand puppets, cartoon characters, or geometric shapes have often been used as convenient and engaging stand-ins for social agents. Researchers may use these entities to replace human confederates in order to have better experimental control over specific constructs of interest, reduce potential confounds, or minimize processing demands (Kominsky et al., 2020; but see also Packer & Moreno-Dulcey, 2019). Consistent with such practices, a large meta-analysis (Wellman et al., 2001) has shown that children's responses in classic false-belief tasks do not systematically vary depending on the nature of the protagonist (i.e., a hand puppet vs. a cartoon character vs. a live human). Prior work on children's ability to teach, which often use puppets as learners instead of human confederates, also suggests that children readily attribute epistemic states or beliefs to non-human entities and communicate information to these entities to revise and update their mental states (e.g., Bartsch, Wade, & Estes, 2011; Gweon, Shafto, & Schulz, 2018; Rhodes, Bonawitz, Shafto, Chen, & Caglar, 2015; Ronfard & Corriveau, 2016). In particular, Bartsch et al. (2011) compared children's ability to consider others' beliefs when they had to persuade a human versus a puppet: Six- and 7-year-olds provided belief-relevant responses to both types of targets (albeit more so with a human target). Importantly, in these studies, puppets were never treated as just toys or objects; they were often given names and introduced as entities capable of seeing, thinking, feeling, and engaging in social interactions.

In sum, prior work provides theoretical and empirical grounds for our hypotheses. We predict that preschool-aged children would engage in self-presentational behaviors even in their interactions with a puppet as the observer, conceptually replicating Asaba and Gweon (2018, 2022); critically, we expect that such tendency would be modulated by whether the entity is depicted as a social agent with a mind (i.e., a friend) or as an object (i.e., a toy). Going beyond asking whether children would follow the entity's gaze (Johnson et al., 1998), trust information (Brink & Wellman, 2020), or communicate (e.g., Bartsch et al., 2011; Rhodes et al., 2015), the behavior we expect to find here is a tall order: We predict that children will go so far as to "show off" and demonstrate their own competence to non-human entities, to the extent that such entities are depicted as being capable of holding mental states.

In Experiment 1, we ran a replication of Asaba and Gweon (2018, 2022) using the same experimental design, but with one major change: Children's behaviors were "observed" by a puppet rather than a human.[2] As in prior work, the experimenter called the puppet her "friend", referred to the puppet's mental states (i.e., ignorance) about the toys, and asked children to "show" one of two toys to the puppet. In Experiments 2 and 3, we depicted the same puppet as an object with no mental capacities and asked children to choose a toy to play with in the presence of the puppet (Experiment 2) or choose a toy to show to the puppet (Experiment 3). While Asaba and Gweon (2018, 2022) found successful demonstration of strategic self-presentational behaviors in 3- and 4-year-olds without clear age-related differences, here we focused on 4-year-olds because we wanted to recruit children who can also readily ascribe mental states even to non-human entities such as puppets (Wellman et al., 2001).[3] All materials, data, and analyses are available here: https://osf.io/3zsb7.

1. Experiment 1: puppet as agent

1.1. Methods

1.1.1. Participants

Fifty 4-year-olds ($M_{age} = 4.49$ years, $SD = 0.29$, range = 4.01–4.99; 30 girls, 20 boys) were recruited from a local preschool and randomly assigned to the Present ($N = 25$) or Absent ($N = 25$) condition. Most children were from middle-class families with diverse socioeconomic, cultural, and ethnic backgrounds representative of the local population. Fourteen additional children were tested but not included due to failure on the memory check question ($N = 13$) or technical error ($N = 1$).

1.1.2. Materials

We designed two novel light-up toys with distinct causal mechanisms. The blue toy had two green buttons and a rubber frog on top, which lit up when both buttons were pressed simultaneously. The yellow toy had two gray knobs on the sides and a rubber owl on top, which lit up when both knobs were turned simultaneously. In reality, the toys were activated by the experimenter using a remote control hidden from the participants' view. A girl hand puppet and a 3″ x 4″ picture of the puppet were used. See Fig. 1.

1.1.3. Procedure

Children were tested individually in a quiet room at their preschool. The experiment consisted of four phases: Introduction, Observed Toy, Unobserved Toy, and Choice Phases. The Introduction, Unobserved Toy, and Choice Phases were identical between conditions; only the Observed Toy Phase differed (see Fig. 2). The procedure was almost identical to Asaba and Gweon (2018, 2022) with minor modifications to make the task amenable to using a puppet as the observer, as described below.

[2] In addition, the two toys used in the current work looked different from the toys used in Asaba and Gweon (2018, 2022) but had similar causal structures (simultaneous operation of two buttons or levers) and functions (the toy lights up).

[3] Here we are agnostic to the exact nature of children's mental state representations, i.e., epistemic states (knowledge) or belief representations (for further discussions, see Asaba & Gweon, 2022).

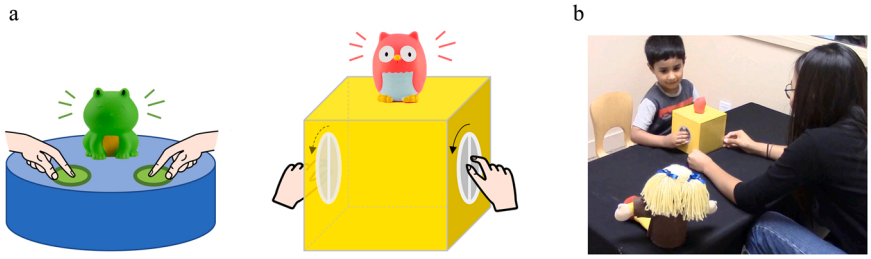

Fig. 1. (a) Schematic of the two novel toys and (b) example screenshot of participant attempting to activate the toy in front of the puppet in Experiment 1.

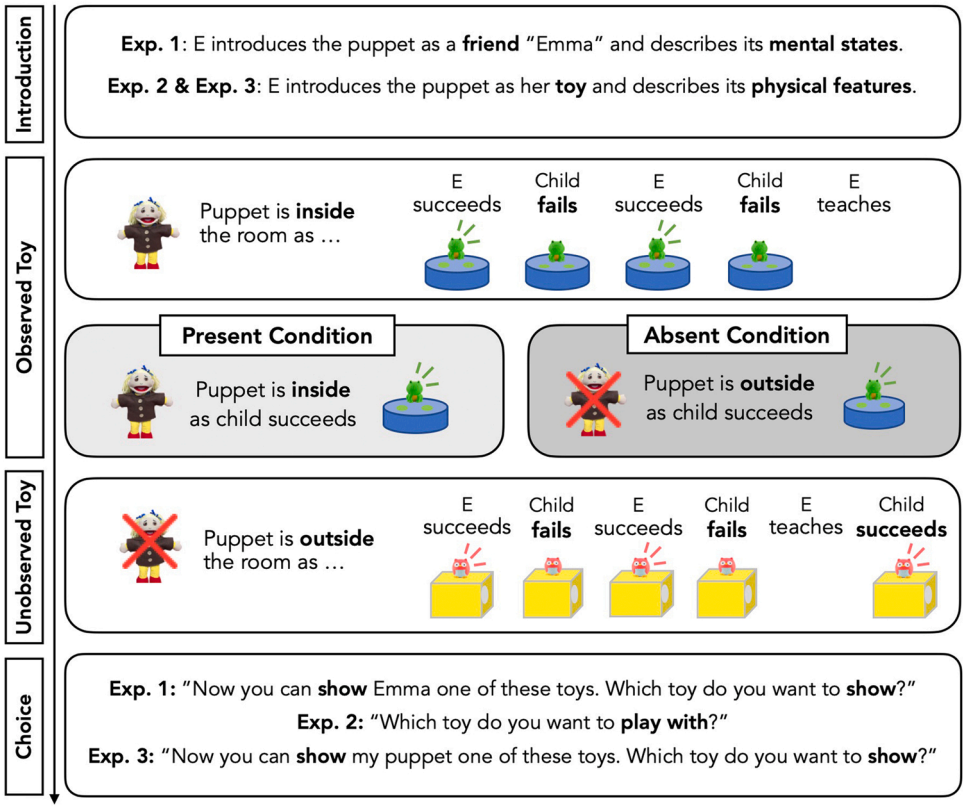

Fig. 2. Procedures for all experiments.

1.1.3.1. Introduction phase. The experimenter first presented the two toys to the child and said that her friend "Emma" (a hand puppet) would watch them play. The experimenter put the puppet on the table facing the child and asked the child to say hello to Emma. Critically, the experimenter described the puppet's mental states, saying, "Emma has never seen these toys before, and she doesn't know anything about them." Thus, the experimenter treated the puppet observer here just as the human observer was treated in Asaba and Gweon (2018, 2022), and these initial interactions were meant to suggest to participants that the puppet is an agent capable of holding mental states (e.g., ignorance or knowledge about the toy).

1.1.3.2. Observed toy phase. The puppet "watched" (i.e., present on the table, facing the child) as the child and the experimenter played with one of the two toys (Observed Toy; blue and yellow toy counterbalanced across participants). The experimenter successfully made the toy light up by pressing the two buttons simultaneously (blue toy) or turning the two knobs simultaneously (yellow toy). The child then attempted to operate the toy but failed, and the experimenter acknowledged the failure by saying, "Hmm." After repeating this sequence ("E succeeds, Child fails" in Fig. 2) again, and then the experimenter instructed the child how to activate the toy ("E teaches" in Fig. 2) by saying, "You have to push this button and this button at the exact same time" (blue toy) or "…turn this thing and this thing at the exact same time" (yellow toy). Then, the child was given another chance and succeeded in making the toy light up.

The critical manipulation between conditions was whether or not the puppet was in the room observing the child when the child succeeded. In the Present condition, the puppet was on the table facing the child and the toy for the entire sequence, then was brought outside the room after the child's success on the toy. In the Absent condition, the puppet was brought out of the room just before the child's success, thus having been present only for the child's first two failures and the experimenter's instruction about how the toy works. In both conditions, the experimenter said that "Emma has to go now," before bringing the puppet outside.

1.1.3.3. Unobserved toy phase. The child and the experimenter played with the other toy (i.e., Unobserved Toy) while the puppet was outside. Just as in the Observed Toy Phase, the child experienced two failures on the Unobserved Toy, received the experimenter's instruction, and then succeeded in activating the toy on the third try. So, participants' experiences of failures and successes were matched between the two toys: two initial failures and one final success.

1.1.3.4. Choice phase. Next, the child successfully activated both the Observed Toy and Unobserved Toy twice more in a counterbalanced order, ensuring that the child was confident in operating both toys. The experimenter then placed the toys equidistant from the child, placed a photo of the puppet in front of the child, and asked, "Do you remember Emma? Now you can show Emma one of these toys. Which toy do you want to show her?" Participants responded by touching or pointing to one of the toys. Children were asked to explain their choice, "Why do you want to show Emma this toy?" Then, they were asked a memory check question, "Did Emma watch when you were playing with this toy or this toy?" Only children who correctly responded to the memory check question (i.e., selecting the Observed Toy) were included in the final sample (similar to the results from Asaba & Gweon, 2022, including children who failed the memory check, Present: $N = 5$, Absent: $N = 8$, did not change the qualitative results; see Supplementary Materials). At the end, the puppet was brought back into the room, and children demonstrated the chosen toy.

In both conditions, the puppet had seen the Observed Toy's effect and mechanism but not the Unobserved Toy's effect or mechanism. Thus, children in both conditions had reasons to show the Unobserved Toy to provide information that the puppet had not observed. Critically however, in the Absent condition, the puppet only observed the child's failures (but not the child's final success on the Observed Toy), whereas in the Present condition, the puppet not only observed the child's failures but also the child's final success. Thus, if children are motivated to change the puppet's mental state regarding their own ability to activate the toy, they would be more likely to choose the Observed Toy in the Absent condition than in the Present condition.

1.2. Results and discussion

Our key question was which toy children would choose to "show" to the puppet, depending on the puppet's prior observations of the children's failures and successes. Following prior work (Asaba & Gweon, 2018, 2022), we used Fisher's Exact to test for differences in toy choice between conditions. The results mirrored the findings from Asaba and Gweon (2022): Participants chose the Observed Toy more often in the Absent condition ($M = 60\%$, 95% confidence interval (CI) [40%, 80%]) than in the Present condition ($M = 20\%$, 95% CI [8%, 36%]), $p = .009$ (Fisher's Exact; see Fig. 3). In the Present condition, children selectively chose the Unobserved Toy (80%, $p = .004$, Binomial Test), suggesting a preference to show the puppet a novel toy. In the Absent Condition, children did not selectively show a preference for either toy ($p = .42$).

As in Asaba and Gweon (2022), we coded children's explanations for their choices into four categories (see Table S1 in Supplementary Materials): (1) references to the puppet's prior observations of the toy (e.g., "She already saw this one"), (2) references to the puppet's prior observations of the child's attempts to activate the toy (e.g., "She didn't see me do it"), (3) references to other aspects of toy or the puppet (e.g., "because bright toys are cheerful", "because she will like it"), or (4) irrelevant responses (e.g., "because I love to jump in water") or no response, including "I don't know". Given that children in both conditions had reasons to refer to the puppet's observations (and accordingly, the prior study did not find meaningful differences across conditions), we did not have a priori

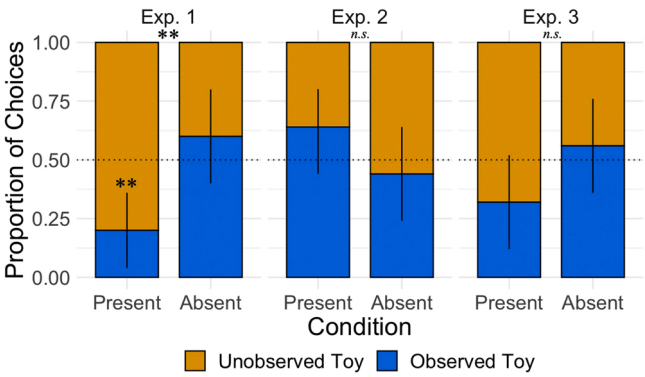

Fig. 3. Proportion of children's toy choices by condition (Present vs. Absent) in Experiment 1 (puppet as agent) and Experiments 2 and 3 (puppet as object). Error bars represent 95% confidence intervals. Asterisks between bars indicate significant differences in toy choice between conditions (Fisher's Exact); asterisks within a bar indicate selective choice for one toy (Binomial Test). $^{**}p < .01$

predictions for children's explanations of their choices in the current study. Nearly half of the children provided irrelevant responses or no response at all ($N = 23$; Present = 12, Absent = 11). Six children (Present = 5, Absent = 1) did refer to the puppet's prior observations of the toy, while the other 21 (Present = 8, Absent = 13) mentioned only other aspects of the toy or the puppet. No children referred to the puppet's prior observations of the child's attempts in either condition. The distribution of children providing explanations in these categories did not differ across Present and Absent conditions, $p = .17$ (Fisher's Exact).

As noted above, children in both conditions had reasons to choose the Unobserved Toy because the puppet had never "observed" this toy. Nonetheless, their choice of toys differed across conditions; children were more likely to choose the Observed Toy when the puppet had only seen their failures on that toy (Absent condition). This suggests that children not only attributed perceptual capacities to the puppet but also were motivated to revise the resulting mental state—the *puppet's* representation of the self—by demonstrating their success on the Observed Toy. While it might seem rather counterintuitive that children would "show off" their success to a non-human entity, children in our study were willing to do so even to a puppet.

2. Experiment 2: puppet as object

Given the results from Experiment 1, one might ask: Would children *always* attempt to demonstrate their competence to a puppet? While it is possible that children would show self-presentational behaviors indiscriminately to any object (especially when they resemble humans, as in the case of our toy puppet used in Experiment 1), prior work raises the possibility that this effect might depend critically on how the puppet is treated by the experimenter (Clark, 2016); more specifically, describing the puppet as an object (rather than as a social entity capable of holding mental states) might eliminate the effect. To test these possibilities, in Experiment 2, we changed how the puppet was depicted in two key ways. First, the experimenter referred to the puppet as a "toy" (i.e., an object, rather than an agent) throughout the task and described only its physical appearances. Second, we also changed the test question; rather than asking which toy to "show" to the puppet (which implies that the puppet has perceptual–in particular, visual–capabilities), the experimenter placed the puppet on the table and asked children to choose a toy to "play" with. We predicted that these changes would eliminate the effect we found in Experiment 1 (i.e., no difference in children's choice of toys across conditions).

2.1. Methods

2.1.1. Participants

Fifty 4-year-olds ($M_{age} = 4.50$ years, $SD = 0.30$, range = 4.01–4.98; 30 girls, 20 boys) were recruited from the same local preschool (none of these children participated in Experiment 1) and randomly assigned to the Present ($N = 25$) or Absent ($N = 25$) condition. An additional 29 children were tested but excluded from the analysis due to failure on the memory check.

2.1.2. Procedure

The procedure was nearly identical to Experiment 1, except for critical modifications described below that aimed to depict the puppet as an object, rather than as an agent with mentalizing capacities.

2.1.2.1. Introduction phase. After introducing the two causal toys, instead of introducing the puppet as a "friend", the experimenter told the child that she had another *toy* (the same hand puppet used in Experiment 1) that she would put on the table as they were playing. Further, rather than referring to the puppet's ignorance about the toys, the experimenter now only described the puppet's physical features, saying, "My puppet has blond hair and brown eyes. I also got blue ribbons to tie my puppet's hair."

2.1.2.2. Observed toy phase. The puppet's presence was emphasized at the beginning of this phase ("Now the puppet is on the table"). In the Absent Condition, before bringing the puppet out of the room, the experimenter stated that someone else needed the puppet (cf. in Experiment 1, the experimenter said that the puppet (Emma) needs to go). To ensure that children were paying attention to the puppet and remembered when the puppet was present or absent in the room, the experimenter asked the child to help bring the puppet outside the room.

2.1.2.3. Choice phase. The experimenter brought the puppet back inside before asking the test question and placed the puppet on the table facing the child. Importantly, instead of asking "Which toy do you want to show my friend?", the experimenter positioned the puppet on the table, facing the child, and then asked the child, "Now you can play with one of these toys. Which toy do you want to play with?" Children were then asked to explain their response, and asked the memory check question, "Was the puppet here on this table when you were playing with this toy or this toy?" As in Experiment 1, only children who correctly responded to the memory check were included in the final sample, but including children who failed the memory check (Present: $N = 18$, Absent: $N = 11$) did not qualitatively change the results (see Supplementary Materials).

2.2. Results and discussion

In Experiment 2, the puppet's presence during the child's failures and success varied across conditions just as in Experiment 1 (present only for the initial failures in the Absent condition, but for the initial failures and the final success in the Present condition). However, if children's attribution of mental states to the puppet critically relies on how the puppet is depicted, participants in

Experiment 2 (where it was depicted as an object) should have no reason to demonstrate their success on the Observed Toy to the puppet. Thus, unlike Experiment 1 and Asaba and Gweon (2018, 2022), we did not expect to find a difference in children's choices of toys across conditions.

As predicted, we did not find a significant difference in children's choice between conditions in Experiment 2: Children chose the Observed Toy at similar rates in the Absent condition ($M = 44\%$, 95% CI [24%, 64%]) and the Present condition ($M = 64\%$, 95% CI [44%, 80%]), $p = .26$ (Fisher's Exact). Children did not show a preference for either toy (Present: $p = .23$, Absent: $p = .69$; Binomial Tests) or provide different types of explanations across conditions, $p = .42$ (Fisher's Exact; see Table S1).

To compare across Experiments 1 and 2, we ran a generalized linear model (family = binomial) with Experiment (dummy coded; Experiment 1/Agent = 0, Experiment 2/Object = 1) and Condition (dummy coded; Present = 0, Absent = 1) as predictors, and an interaction term between Experiment and Condition: Toy Choice ~ Experiment * Condition. As expected, we found a significant Experiment x Condition interaction ($\beta = -2.61$, $z = -3.01$, $p = .003$), as well as significant main effects for Experiment ($\beta = 1.96$, $z = 3.01$, $p = .003$) and Condition ($\beta = 1.79$, $z = 2.78$, $p = .006$). This interaction suggests that the key effect—children's tendency to choose the Observed Toy more often in the Absent condition than in the Present Condition—was significantly larger in Experiment 1 compared to Experiment 2. Post-hoc comparisons between experiments should be interpreted with caution, as we did not design the experiments to be compared against each other. Nonetheless, this analysis provides additional support for the idea that children's self-presentational behaviors are specific to contexts in which they are interacting with other agents.

In sum, unlike children in Experiment 1, children in Experiment 2 did not choose different toys depending on the puppet's absence or presence during their success. These results suggest that a puppet treated as an object may not elicit self-presentational behaviors.

3. Experiment 3: puppet as object - effect of test question

In Experiment 2, we removed all social cues to the puppet's agency. First, the experimenter introduced the puppet as a toy (object) rather than a friend (agent) and treated it as such throughout the study. Second, the experimenter asked children to choose a toy to "*play with*" rather than asking them to choose a toy to "*show*" the puppet. Given that we varied both the experimenter's description of the puppet as well as the test question, one might wonder to what extent the test question alone contributed to the difference in children's responses. What would happen if we described the puppet as an object (as in Experiment 2) but asked children to choose a toy to show the puppet (as in Experiment 1)?

To address this question, in Experiment 3, we used the same procedure as in Experiment 2 but used the test question in Experiment 1 by asking children to "show" a toy to the puppet. One possible outcome is that we find no difference between conditions, just as we did not find a difference in Experiment 2. This might suggest that the experimenter's description of the puppet (e.g., as a "toy") was enough to convince children to consider the puppet as an object throughout the experiment; even though the specific test question ("show" the puppet) implies that the puppet has perceptual capacities, it may be insufficient to influence children's choices. Another possible outcome is that we do find a clear difference between conditions, as we did in Experiment 1; this might suggest that even the indirect, subtle reference to the puppet's agency at the time of the test question may be sufficient to elicit self-presentational behaviors. Finally, it is also possible that the "show" test question alone only weakly recovers the results from Experiment 1, likely because both the experimenter's depiction of the puppet during the study and the final test question contribute to how children themselves represent the puppet.

3.1. Methods

3.1.1. Participants

Fifty 4-year-olds ($M_{age} = 4.48$ years, $SD = 0.29$, range = 4.01–4.99; 29 girls, 21 boys) were recruited from the same local preschool (none of these children participated in Experiments 1 or 2) and were randomly assigned to the Present ($N = 25$) or Absent ($N = 25$) condition. An additional 12 children were recruited but excluded due to failure on the memory check question ($N = 11$) or not completing the task ($N = 1$).

3.1.2. Procedure

The procedure was nearly identical to Experiment 2, except for one key change. At test, just as in Experiment 1, we brought out a photo of the puppet and asked: "Now you can show the puppet one of these toys. Which toy do you want to show the puppet?" As in Experiments 1 and 2, only children who passed the memory check question were included in the final sample, but including children who failed the memory check (Present = 7, Absent = 4) did not change the qualitative results (see Supplementary Materials).

3.2. Results and discussion

Children did not choose the Observed Toy significantly more often in the Absent Condition (56%, 95% CI [36%, 76%]) than in the Present Condition (32%, 95% CI [16%, 52%]), $p = .15$ (Fisher's Exact); within each condition, participants did not preferentially choose either toy (Present: $p = .11$; Absent: $p = .69$).

We coded children's explanations and compared across conditions in Experiment 3 (see Table S1). As in Experiments 1 and 2, we did not find a significant difference in the distribution of children's different explanations across conditions, $p = .77$ (Fisher's Exact). Comparisons across Experiments 1, 2, and 3 showed that children did not provide different types of explanations across experiments, $\chi^2(4, N = 150) = 7.69$, $p = .10$. As an exploratory analysis, we also coded for whether participants referred to the puppet in their

explanations or not (children who provided no response or "don't know" were excluded for this analysis). We found that whether children referred to the puppet or not in their explanations significantly differed across experiments, $\chi^2(2, N = 125) = 8.92, p = .012$. Specifically, more children referred to the puppet in their explanations in Experiment 1 (29%, or 12/42) compared to Experiment 2 (10%, or 4/40) or Experiment 3 (7%, or 3/43) (see Table S2 in Supplementary Materials, for details). These results suggest that the agency manipulation, especially the experimenter's depiction of the puppet as a friend, may have called more of the children's attention to the puppet's presence in the specific context.

Although the main analysis did not show a significant difference across conditions, there was a trending pattern in the same direction as Experiment 1. To further explore the differences across experiments, we used the same generalized model that we used to compare Experiments 1 and 2. In a comparison between Experiments 1 and 3, we did not find a significant interaction between Experiment and Condition ($\beta = -0.80$, $z = -0.91$, $p = .36$). We found a significant main effect of Condition ($\beta = 1.79$, $z = 2.78$, $p = .006$), but no significant effect of Experiment ($\beta = 0.63$, $z = 0.96$, $p = .34$). Next, we compared Experiments 2 and 3, and found a significant interaction between Experiment and Condition ($\beta = 1.81$, $z = 2.19$, $p = .028$), as well as a main effect of Experiment ($\beta = -1.33$, $z = -2.22$, $p = .026$), but no effect of Condition ($\beta = -0.82$, $z = -1.41$, $p = .16$). This interaction suggests that children were more likely to choose the Observed Toy in the Absent Condition than in the Present Condition, specifically in Experiment 3 compared to Experiment 2. However, we caution against strong interpretations of these unplanned comparisons across experiments, as we did not design these experiments to be statistically compared against one another.

Taken together, these findings provide somewhat mixed evidence concerning the role of the test question (i.e., asking children which toy they would like to *show* the puppet versus which toy they would like to *play* with) on children's choice of toys. Unlike Experiment 1, children in this experiment did not show a clear difference in their toy choice between conditions, and few children referred to the puppet in their explanations; however, comparisons across experiments (Experiment 2 vs. 3) suggest that children were more likely to make choices in the direction of the key effect (choosing the Observed Toy more often in the Absent Condition than the Present Condition) in the current experiment than in Experiment 2. These results suggest that these indirect, nuanced mentions of the puppets' perceptual capacities—as indicated by the use of the verb "show" in the test question—may not be sufficient on their own for eliciting self-presentational concerns in front of a puppet. Nonetheless, the results are rather weak, and do not conclusively rule out the possibility that these indirect cues may influence children's behaviors.

4. General discussion

Across three experiments, we found that 4-year-old children demonstrated their success on a toy to a puppet, and that these self-presentational behaviors were modulated by whether or not the puppet was depicted as an entity with mentalizing capacities. Experiment 1 provided a rich context that supported the puppet's social agency (e.g., an adult experimenter calling it a "friend", referring to its mental states, asking children to "show" a toy); participants were more likely to show a familiar toy over a novel one when the puppet had only observed the participants' failures on the familiar toy compared to when the puppet had observed their success on this toy. This pattern did not emerge in Experiment 2, where all references to the puppet's social agency were removed (e.g., an adult experimenter calling it a "toy", referring only to its physical states, asking children to "play" with a toy). Finally, Experiment 3 findings offer a more nuanced picture of the factors that modulate children's self-presentational behaviors to a puppet; although treating the puppet as an object as in Experiment 2 and just asking children to "show" one of the toys to the puppet as in Experiment 1 did not elicit robust self-presentational behaviors, comparisons across experiments (specifically, Experiment 2 vs. 3) raise the possibility that children may be sensitive to such subtle cues from the specific wording of the test question. Taken together, these results demonstrate the importance of social contexts in eliciting self-presentational behaviors; children are motivated to engage in self-presentational behaviors to non-human entities, especially when the puppet is depicted to be an agent with mental states.

These results may seem rather baffling: Why would children ever show off to a puppet at all? Even though "losing face" in front of a puppet could not bear any foreseeable, real-world social consequences, children in Experiment 1 (and weakly, in Experiment 3) were nonetheless driven to present positive information about the self (i.e., their success on the Observed Toy) instead of sharing information about a novel toy (Unobserved Toy) when the puppet had only seen their failures. One possibility is that the experimenter's depiction of the puppet supported full-fledged anthropomorphism (e.g., Severson & Lemm, 2016), leading children to attribute human-like characteristics, particularly internal states and capabilities, to the puppet; under this account, children could have genuinely wanted the puppet to think well of them, or simply wanted to feel good about themselves by having another agent know about their abilities, at least within the brief interaction in our experiments. However, prior work suggests that 3- and 4-year-old children do understand that puppets are make-believe agents (e.g., children report that puppets are not "real" or a doll can see "for pretend"; see Gelman, Spelke, & Meck, 1983) and can flexibly transition in and out of pretend play (Connolly, Doyle, & Reznick, 1988; Doyle, Doehring, Tessier, de Lorimier, & Shapiro, 1992). Thus, a more plausible explanation of our findings is that children played along with the experimenter's depiction of the puppet as a friend and interpreted it as a representation of an agent (Revencu & Csibra, 2020). Under this account, children may have still wanted to demonstrate their competence to the puppet within the pretend-play context, without genuinely believing that the puppet has mental capacities and wanting the puppet to think well of them.

In addition, another non-mutually exclusive possibility is that children's choices in Experiment 1 were driven by their desire to indirectly "show off" to the experimenter. Rather than demonstrating their ability to activate the toy (the experimenter had already observed their success in both conditions), children may have wanted to show the experimenter that they can track what the puppet "saw", and that they "know what to do" in response to the experimenter's question, specifically when the experimenter depicted the puppet as an agent (i.e., show the experimenter that they know which toy would best demonstrate their competence to her friend; see also related discussion below about children's interpretations of the test question). Though the current study cannot rule out this

possibility, it still requires that children can track the puppet's observations of their failures and successes and understand which toy is better to show to the puppet, depending on the social context (e.g., how the experimenter describes the puppet). Investigating children's underlying motivations for showing off to non-human entities remains an interesting direction for future work.

These results also raise important questions about the mechanisms underlying children's perceptions of puppet's agency. Although the puppet already had morphological features (e.g., a human-like face, hands, body) that provide cues to agency, these physical features were present in all experiments and therefore cannot account for our results on their own. Nonetheless, it is possible that these physical features made the experimenter's depiction of the puppet as an agent more effective and convincing, leading children to treat the puppet as an agent themselves as well. Indeed, past work with infants suggests that different kinds of cues agency—both perceptual (e.g., morphological features, self-propelled motion) and social (e.g., contingency and predictability of social interaction)—may accumulate in an additive manner (Setoh, Wu, Baillargeon, & Gelman, 2013, see also Tauzin & Gergely, 2021). In light of these findings, even when the experimenter treats the puppet as an agent, removing the perceptual cues (e.g., replacing the puppet with a clearly inanimate object such as a cup) or adding more perceptual cues (e.g., the puppet moves in a self-propelled manner) could further modulate children's tendency to treat the puppet as an agent. Our results also suggest that different kinds of social information may have similarly additive effects. More specifically, we manipulated social information by (i) introducing and describing the puppet as a social agent or as a physical object, and (ii) asking a test question that nudges the children towards a communicative goal (i.e., show) or a non-communicative goal (i.e., play); children's tendency to engage in self-presentational behaviors was the strongest when both cues were present (Experiment 1). Taken together, our work suggests that all of these features—the puppet's physical appearance, others' description of the social status of the puppet, and the test question that encourages a communicative goal—may have collectively contributed to representations of the puppet in children's minds and together.

Relatedly, we found somewhat inconclusive evidence concerning the influence of the test question on children's choice of toys. Although we failed to find clear evidence for self-presentational behaviors in Experiment 3 (i.e., lack of a robust condition difference), the comparison across Experiments 2 and 3 suggested a weak effect of the test question on the difference between conditions. Though we caution against strong interpretations of this finding due to the relatively small effect size and the post-hoc nature of the cross-experiment comparisons, here we speculate about a few possibilities for how the test question might have informed children's choice of toys. First, it is possible that the test question genuinely helped elicit attribution of mental states to the puppet, giving rise to self-presentational concerns. Prior work has suggested that children at this age are able to retrospectively attribute mental states to others (Király, Oláh, Csibra, & Kovács, 2018). Thus, to the extent that children are using the verb "show" as evidence for the puppet's agency, children in Experiment 3 may have attributed self-relevant mental states to the puppet upon hearing the test question of which toy to "show" even if the puppet had previously been described as an object. Such interpretation raises the possibility that children are sensitive even to indirect, nuanced suggestions about the mentalizing capacities of these entities. Yet, given that we have repeatedly found robust differences between conditions both in prior work (using a human observer; Asaba & Gweon, 2018, 2022) and in Experiment 1 (using the same puppet) but did not in Experiment 3, this possibility remains a conjecture. Second, as noted earlier, it is also possible that participants interpreted the experimenter's question as *the experimenter's request to show* the puppet what they can do. In other words, some children may have simply been following the experimenter's instructions (i.e., the test question), rather than using the test question as a cue to reason about the puppet's representation of the self. In future work, paradigms that do not require such test questions could be useful for further exploring the influence of depiction in children's self-presentational behaviors. Indeed, prior work (e.g., Engelmann et al., 2012) has shown that early self-presentational actions, such as sharing more in the presence of others, can emerge even in the absence of explicit requests to communicate with the observer; similarly, in our study, a follow-up could entail having the experimenter describe the puppet as a social entity (as in Experiment 1) but asking children to choose a toy to play with in front of the puppet (as in Experiment 2), and leaving the room to see how the child interacts with the puppet next in the absence of the experimenter.

In cognitive development research, puppets or other inanimate entities (e.g., stuffed animals, cartoon characters, geometrical shapes with facial features) are often used as "stand-ins" for humans. Puppets, in particular, are popular props for studies on early social cognition (e.g., Theory of Mind, helping, social evaluation, social groups, social learning): Beyond using puppets to probe children's mental state reasoning (e.g., Wimmer & Perner, 1983; Wellman et al., 2001), children are asked to evaluate them (e.g., Hamlin et al., 2007; Jara-Ettinger, Tenenbaum, & Schulz, 2015), share with them (e.g., Chernyak & Sobel, 2016; Kanngiesser & Warneken, 2012), give them what they "like" (e.g., Kushnir, Xu, & Wellman, 2010), learn from and teach them (Birch, Vauthier, & Bloom, 2008; Gweon et al., 2018, Ronfard & Corriveau, 2016), persuade them (e.g., Bartsch et al., 2011), and even deceive them (Rhodes et al., 2015). The use of these non-human entities can be methodologically critical in studies that present properties of agents that are implausible to convey using human adults (e.g., someone who does not know labels of simple household objects) or tricky to convey with human actors (e.g., someone who attempts to climb a hill). Despite questions and debates about their ecological validity, the fact that these studies "work" suggests that these schematic agents can nonetheless elicit social goals and effectively recruit children's social-cognitive capacities (Kominsky et al., 2020).

Yet, these findings also raise questions about *how* these entities come to be perceived as agents (Revencu & Csibra, 2020). Our findings have two key implications for this debate. First, our work suggests that the experimenter's depiction of the puppet is critical for shaping the way children reason about and interact with the puppet, not just in our study, but in any experimental paradigm that uses puppets; consistent with prior proposals that emphasize the role of depiction (Clark, 2016), others' behaviors—communicative behaviors in particular—serve as powerful contextual information that can change whether children treat a puppet as someone's "friend" or as someone's "toy". Second, beyond showing that children can ascribe mental states to non-human entities, our findings also show that children can go so far as to attribute self-relevant mental states, and as a consequence, even try to "show off" their positive traits to these entities. Thus, researchers who use puppets in their studies should be aware of the possibility that these

concerns, in some cases, may interfere with the predicted results in unexpected ways, or even confound the researchers' interpretation of the results. For instance, while children may be generally motivated to "teach" a puppet, their communication may also be influenced by their desire to "show off" their knowledge or competence to the puppet.

Our findings also have broader implications for how children perceive and interact with nonhuman entities in their everyday lives, and in particular, "intelligent artifacts" including social robots and AI assistants (e.g., Amazon's Alexa or Apple's Siri). While much prior work has focused on the role of physical features of robots (i.e., whether a robot looks or behaves like a human; Breazeal *et al.* 2016; Brink, Gray, & Wellman, 2019; Manzi et al., 2020) in children's agency attributions, our work suggests that others' depiction of these entities as social agents could inform how children reason and interact with them (Clark, 2016; Clark & Fischer, 2022). Indeed, even adults' behaviors can be influenced by their beliefs about the identity of the interlocutor; in one study, adults showed a stronger tendency to align their choice of labels with "computer" than with "human" interlocutors, though in reality all dialogs were scripted (e.g., Branigan et al., 2011). Another perspective, however, is that these intelligent artifacts are perceived directly as social agents, rather than as depictions of social agents (Clark & Fischer, 2022). The "computers are social actors" hypothesis (see Nass, Steuer, & Tauber, 1994; Reeves & Nass, 1996) posits that people treat computers, TV, and other types of technology like people, applying the same social expectations, beliefs, and behaviors toward technology as they would in their interactions with other people. Consistent with this idea, Vollmer and colleagues (2018) found that 7- to 9-year-old children were affected by the social pressure from a group of humanoid robots and would follow the suggestions made by the robots (Vollmer, Read, Trippas, & Belpaeme, 2018). Social robots or AI assistants differ from puppets in important ways; for instance, social robots can move autonomously, whereas AI voice assistants do not even look like agents. Thus, future work in this domain should further explore how adults' interactions with these entities might influence children's own tendency to treat them as agents, and whether children could become concerned about what these agents might think about them in such contexts (e.g., interacting with a robot tutor).

What others think of us is deeply important for our everyday interactions with others, and the ability to reason about others' minds might allow us to reason about others' beliefs about us in savvy, sophisticated ways. Our findings suggest that children's strategic self-presentational behaviors are specific to the social context. Children do not promiscuously show off to anyone or anything; rather, they are sensitive to cues about an entity's agency and mental states and specifically communicate about the self to other agents depicted to have mental capacities.

Data availability

We have shared a link to our data and analyses in the manuscript. Here's the link: https://osf.io/3zsb7.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.cogdev.2022.101186.

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