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How do 3-month-old infants attribute preferences to a human agent?

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ABSTRACT

The current study showed that 3-month-old infants attributed a preference to a human agent, with her face and upper body visible, when she consistently reached for and grasped one of two objects with her bare hand. In contrast, infants did not appear to interpret the agent's same actions of grasping the object as indicative of her preference when it was the only object present or when it hid the other object from her but not from the infants. These results suggest that even from an early age, infants interpret human agents' actions in terms of mental states such as goals and preferences. In light of the current results, mechanisms for early psychological understanding are discussed.

Introduction

As adults, we use a coherent construct of mental states—including goals (e.g., to grasp a toy), dispositions (e.g., preferences; an individual likes Toy A more than Toy B), perceptions, beliefs, and false beliefs—to make sense of each other's behavior. A crucial aspect of such psychological understanding is perspective taking—that is, to realize that others view the world differently from us and to "put ourselves in others' shoes" to understand their behavior—which facilitates our interactions and relations with others. Developmental research reveals that the origins of such psychological understanding emerge during infancy (e.g., Bíró & Leslie, 2007; Gergely, Nádasdy, Csibra, & Bíró, 1995; Hamlin,

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Ullman, Tenenbaum, Goodman, & Baker, 2013; Hernik & Southgate, 2012; Kuhlmeier, Wynn, & Bloom, 2003; Luo & Beck, 2010; Onishi & Baillargeon, 2005; Sommerville & Woodward, 2005; Southgate & Vernetti, 2014; for reviews, see Baillargeon, Scott, & Bian, 2016; Baillargeon et al., 2015; Luo & Baillargeon, 2010).

For example, in Woodward's (1998) groundbreaking study, after watching a human agent's arm and hand repeatedly reach for and grasp Object A but not Object B, 5-month-old infants seemed to have interpreted her actions as directed by a goal of choosing Object A. Therefore, they responded with prolonged looking when the hand reached for Object B. Luo and Baillargeon (2005) extended these results to situations involving a self-propelled box agent (agents are entities that can detect their environment and control their actions, whether human or nonhuman; e.g., Luo & Choi, 2013). Importantly, they suggested that if the box agent consistently moved to contact A when both Objects A and B were present (two-object condition), infants seemed to have attributed to the agent a *preference* for A over B and, therefore, responded with heightened interest when the agent acted inconsistently with this preference and contacted B (a preference denotes a disposition for why an agent makes choices between two options; e.g., Luo, Hennefield, Mou, vanMarle, & Markson, 2017). In addition, if Object B was absent when the agent contacted A (one-object condition), infants failed to attribute a preference to the agent. They no longer responded with heightened interest when the box agent contacted B after it was introduced. These results have been extended to younger 3-month-old infants (Luo, 2011b).

Such evidence that young infants engage in intentional interpretation about nonhuman agents supports a *system-based view* of early psychological understanding. According to this view, an early emerging psychological reasoning system affords a skeletal causal framework that enables infants to make sense of the actions of any entity they identify as an agent, whether human or nonhuman (e.g., Baillargeon et al., 2015; Gergely & Csibra, 2003; Johnson, 2005; Leslie, 1995). In support of this view, infants are also found to consider the agent's *perceptions* or *representations* when interpreting the agent's actions in terms of goals and preferences. Various studies used situations in which Object B was hidden from the agent, but not from infants, while the agent approached Object A (e.g., Choi, Luo, & Baillargeon, 2018; Kampis, Somogyi, Itakura, & Király, 2013; Kim & Song, 2015; Luo, 2011a; Luo & Baillargeon, 2007; Luo & Johnson, 2009). For example, Object B was behind a large screen or behind a human agent's back and, thus, was invisible to the agent. Infants as young as 6 months seemed to view the situations from the agent's perspective and realized that although they themselves could see both Objects A and B, this experimental context was essentially a one-object condition to the agent because she could not see Object B when she grasped Object A. Therefore, the agent's actions toward A did not warrant the attribution of a preference.

Naturally, learning and experiences (e.g., learning to act on objects by grasping, pointing, or merely looking; experiences with self and others) are vastly important in infants' understanding about agents (for reviews, see Meltzoff, 2005; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Woodward, 2005). For instance, over development, infants become more and more adept at producing various goal-directed actions and come to understand intentions underlying others' similar actions, partly through innate capacities to align own actions and mental states with those of others (Meltzoff, 1995, 2005; Tomasello, 1999; Woodward, Sommerville, & Guajardo, 2001). A study with 3-month-olds illustrates this point (Sommerville, Woodward, & Needham, 2005). When tested with a procedure similar to that in Woodward (1998), these young infants, who generally cannot yet grasp objects (Needham, Barrett, & Peterman, 2002), failed to "read" the intention behind the human agent's arm and hand reaching for Object A, but not Object B, and hence did not respond to the change of goal object from A to B (the agent's arm and hand either had a mitten on or was bare). However, they responded positively, as did the 5-month-olds in Woodward (1998), if they first participated in an action task where they wore Velcro mittens to manipulate the two objects. The "sticky mittens" allowed young infants to contact and even pick up the objects, similar to grasping. They then encoded the intention underlying the agent's grasping one of two objects with her arm and hand, also wearing the mitten. These results point to the importance of firsthand action experiences—even those acquired in a laboratory setting—in infants' understanding about agents' goals and preferences.

Therefore, the psychological reasoning system provides a blueprint for infants' understanding about agents. Infants identify certain entities as agents and use mental states, such as goals,

preferences, and perceptions, to interpret and predict their actions. Learning and experiences help to enrich the psychological reasoning system, for example, to inform infants that pointing at an object, similar to grasping, is also goal directed, although there is no physical contact (Woodward & Guajardo, 2002), or to teach infants under what circumstances a preference for Object A over Object B is likely to be specific to one agent or shared by different agents (e.g., Buresh & Woodward, 2007; Egyed, Király, & Gergely, 2013; Gergely, Egyed, & Király, 2007; Henderson & Woodward, 2012; Kampis et al., 2013; Moore, 1999).

A puzzling case remained, however, in that although 3-month-olds readily interpreted the actions of a self-propelled box agent in terms of goals and preferences (Luo, 2011b), they required the artificial "grasping" experiences in order to interpret the human agent's mittened arm and hand grasping one of two objects as indicative of a preference (Sommerville et al., 2005). One possible reason for the discrepancy is that the experimental situation in Sommerville et al. (2005) was insufficient to support young infants' psychological understanding (Baillargeon et al., 2015; Luo & Choi, 2013); infants saw only the agent's arm and hand either with or without a mitten on. In the study with the box agent (Luo, 2011b), by contrast, the infants saw the box move around and then seemingly make a choice for Object A over Object B. Similarly, whereas 5-month-olds understood the goal directedness of a human agent's bare hand reaching for a toy (Woodward, 1998), 7- and 12-month-olds failed to do so when the hand had a glove on unless they interacted with the agent with gloved hands beforehand (or they could see the agent's face and upper body with gloved hands during the experiment, although this worked only with 9- and 12-month-olds) (Guajardo & Woodward, 2004). Therefore, providing a richer context even simply by showing the human agent instead of only her arm and hand might help young infants to interpret her grasping actions in terms of goals and preferences. The current study aimed to test this hypothesis and provide further support for the system-based view of early psychological understanding.

For this study, we designed three conditions. The two-object and one-object conditions were similar to those in Luo (2011b) except that a human agent was present. Different from Sommerville et al. (2005), the human agent's face and upper body were visible. If the presence of the agent triggered infants' psychological understanding, as suggested by the system-based view, results similar to previous ones (e.g., Hamlin et al., 2013; Luo, 2011b; Luo & Baillargeon, 2005) should be obtained. That is, in the two-object condition where the agent reached for and grasped Object A but not Object B with her *bare* hand during the familiarization phase, infants should attribute to the agent a preference for A over B and respond with heightened interest when she acted inconsistently with this preference and grasped Object B during the test phase. In the one-object condition, by contrast, Object B was absent when the agent grasped Object A during familiarization. Infants should have no information to predict the agent's choice between Objects A and B and, hence, should respond similarly when the agent chose A or B during test.

It might be suggested that negative results could be obtained in the one-object condition simply because infants were confused or interested by the introduction of Object B and, hence, failed to notice the change in the agent's choice from the familiarization phase to the test phase.[1] To address this possibility, in a third, hidden condition, both Objects A and B were present during familiarization, as in the two-object condition. Object A, however, was large enough to hide Object B from the agent but not from infants. Different from the two-object condition, we expected negative results from the hidden condition. One possible reason for our prediction is based on the previous reports of infants' primitive perspective-taking abilities in preference attributions (e.g., Luo & Baillargeon, 2007; Luo & Johnson, 2009). In the hidden condition, infants might be able to realize that the agent could not see Object B when she grasped Object A and that her actions did not indicate her preference. If so, they should respond like the infants in the one-object condition and show no difference in their looking behavior to either of the agent's choices during test. In the Discussion, we return to the issues of how infants would perceive the setup of the two objects and whether or not they would consider the agent's perspective during the familiarization phase of the hidden condition. At a minimum, because both Objects A and B were present throughout the experiment in the hidden condition, similar to the two-object condition, obtaining negative results in

[1] We thank an anonymous reviewer for this and other very helpful suggestions.

this condition would argue against the alternative explanations concerning the different numbers of objects during familiarization between the two-object and one-object conditions.

In the current experiment, 3-month-old infants were randomly assigned to one of the three conditions: two-object, one-object, or hidden condition (see Fig. 1). During the familiarization phase of the two-object condition, infants could see the human agent sitting behind an apparatus that resembled a stage. She was equidistant from a toy pumpkin on the right and a toy pyramid on the left and reached for and grasped the pumpkin with her bare hand (the target of her action was counterbalanced). During the test phase, the positions of the two objects were reversed and the agent grasped the pumpkin again in the old-goal event or the pyramid in the new-goal event. The one-object condition was identical except that during familiarization only the pumpkin was present on the apparatus. In the hidden condition, the pumpkin hid the pyramid from the agent during the familiarization phase (see Fig. 2). The two objects were separated by about 2 cm at the closest point. The agent always reached for and

Fig. 1. Photographs of the events shown during the familiarization and test trials of the two-object, one-object, and hidden conditions. In the first two conditions, the target of the agent's actions was counterbalanced.

Fig. 2. During the familiarization phase of the hidden condition, from the agent's perspective, the large pumpkin hid the pyramid from her.

grasped the pumpkin in the hidden condition. The test phase was identical in the three conditions. If infants attributed to the agent a preference for the pumpkin over the pyramid only when she clearly made a choice between the two because both objects were present or visible, we expected positive results in the two-object condition but negative ones in the one-object and hidden conditions.

Method

Participants

Participants were 48 healthy, full-term infants (23 male; M_{age} = 3 months 10 days; range = 2 months 15 days to 4 months 9 days). Among this sample, 16 infants were randomly assigned to either the two-object condition (8 male; M_{age} = 3 months 11 days), the one-object condition (8 male; M_{age} = 3 months 10 days), or the hidden condition (7 male; M_{age} = 3 months 8 days). Another 16 infants' data were excluded because of maximum looking time allowed (60 s) in all four test trials (n = 4) (e.g., Choi & Luo, 2015; Scott & Baillargeon, 2013), test looking time differences more than 2.5 standard deviations from the mean of the condition (n = 4; 2 in the two-object condition, 1 in the one-object condition, and 1 in the hidden condition), observer difficulties (n = 4), being fussy (n = 2), being distracted (n = 1), or procedural problem (n = 1).

Apparatus

The apparatus consisted of a wooden display box (106 cm high × 104 cm wide × 61 cm deep) mounted 76 cm above the room floor. The infant sat on a parent's lap and faced an opening (56 cm high × 102 cm wide) in front of the apparatus. Between trials, a curtain consisting of a muslin-covered frame (61 cm high × 104 cm wide) was lowered in front of the opening. The side walls of the apparatus were painted white. The floor was covered with a foam board. A rectangular notch was created at the back (56 cm wide × 17 cm deep) to seat the human agent, who wore a white shirt. A large white cloth curtain covered the area behind her. In the two-object and one-object conditions, the floor was covered with white floral-patterned contact paper and was 81.5 cm deep. The agent was approximately 40 cm from the center of each of the two objects during the familiarization and test trials. In the hidden condition, because of the different setup of the objects from the other two conditions during the familiarization trials, the floor was longer (119 cm deep); it was covered with blue granite-patterned contact paper. The agent was approximately 55 cm from the center of the pumpkin and approximately 80 cm from the center of the pyramid during the familiarization trials and was approximately 60 cm from the center of each of the two objects during the test trials.

Two objects were used. The orange stuffed cloth pumpkin was 18.5 cm high and 31 cm in diameter at its widest, with a 5-cm-high brown stem at its top. The cardboard pyramid was about 7.5 cm high, 10.5 cm wide, and 10.5 cm deep at the bottom, covered with green tape and decorated with stickers.

The apparatus was also equipped with two video cameras. One recorded the events being shown on the apparatus, and the other recorded the infants. The input from the two cameras could be monitored online and checked offline to ensure proper testing. A metronome that beat softly once per second was used to help the agent adhere to the scripts.

Procedure

The infant sat on a parent's lap facing the apparatus. Parents were instructed to close their eyes during the test trials and not interact with their infants. After the infant and parent were seated in front of the apparatus, the agent greeted the infant. Two naïve observers viewed infants through peepholes in large cloth-covered frames on either side of the apparatus. Each observer held a controller linked to a computer software program (Baillargeon & Barrett, 2005) and pressed the button when the infant looked at the event. Looking times recorded by the primary observer were used. For 7 of the 48 infants, only the primary observer was present. Inter-observer agreement for the remaining 41 infants averaged 90% per trial per infant.

Infants first received six familiarization trials. Each trial consisted of a 2-s pretrial and a main trial. In the two-object condition, after infants watched the scene with the agent and the two objects for a cumulative 2 s, the pretrial began with the agent reaching for and grasping the object on the right with her right hand (2 s). The agent then paused, with her eyes fixated on the object. In the main trial, the infant watched the paused scene until the trial ended when the infant (a) looked away for a consecutive 2 s after having looked for at least a cumulative 2 s or (b) looked for a cumulative 30 s. In the two-object condition, of the 16 infants, 8 (4 male) saw the agent grasp the pumpkin during the familiarization trials and the rest saw her grasp the pyramid. In the one-object condition, there was no object on the left. Of the 16 infants, 7 (2 male) saw the agent grasp the pumpkin during the familiarization trials. In the hidden condition, the large pumpkin hid the pyramid from the agent. Therefore, all 16 infants saw her grasp the pumpkin during familiarization.

During the test phase, infants in all three conditions received four test trials alternating between a new-goal event, in which the agent grasped the object on the right that she did not touch before during the 2-s pretrial, and an old-goal event, in which the agent grasped the same object as during familiarization except that it was on the left. In the main trial, infants watched the paused scene with the agent's hand resting on the object until the trial ended when they (a) looked away for a consecutive 2 s after having looked for at least a cumulative 5 s or (b) looked for a cumulative 60 s. Of the 48 infants, 24 (10 male) saw the new-goal event first and the other half saw the old-goal event first. Of the 48 infants, 5 contributed data from the first pair because of observer difficulties ($n = 2$), drowsiness ($n = 1$), fussiness ($n = 1$), or lack of interest ($n = 1$). For them, the second pair of test trials was treated as missing data.

Infants were attentive in the 2-s pretrials, during which the agent grasped an object, of the familiarization trials ($M = 1.9$ s) and test trials ($M = 1.8$ s) trials in all three conditions. Preliminary analyses revealed that in the two-object and one-object conditions, which object was the target of the agent's action during familiarization did not affect infants' looking at the two types of test events [two-object condition: $F(1, 14) = 1.77$, $p = .205$; one-object condition: $F(1, 14) = 1.40$, $p > .250$]. Thus, the data were collapsed across this factor.

Results

Infants' looking times during the six familiarization trials were first averaged and analyzed by a single-factor analysis of variance (ANOVA) with condition (two-object, one-object, or hidden) as a between-participants factor. The main effect of condition was not significant, $F(2, 45) = 1.95$, $p = .154$, $\eta_p^2 = .080$, suggesting that despite the differences in the number or positions of the objects during familiarization across the three conditions, infants' looking behavior did not differ significantly (two-object condition: $M = 20.6$, $SD = 8.6$; one-object condition: $M = 15.8$, $SD = 6.7$; hidden condition: $M = 19.4$, $SD = 6.3$). When averaged looking times were analyzed by a $3 \times 2 \times 2$ ANOVA with condition (two-object, one-object, or hidden), test order (new-goal or old-goal event first), and sex (male or female) as between-participants factors, no effect involving condition was significant, $Fs(2, 36) < 1.97$, $p > .155$. Finally, when trial (familiarization trials 1–6) was entered as a within-participant factor into the multivariate ANOVA, only this factor was significant, $F(5, 180) = 2.70$, $p = .022$, $\eta_p^2 = .070$, reflecting the decrease in looking times throughout the familiarization phase in all three conditions.

Infants' looking times in the four test trials (see Fig. 3) were averaged and analyzed using a $3 \times 2 \times 2 \times 2$ ANOVA with condition (two-object, one-object, or hidden), order (new-goal or old-goal event first), and sex (male or female) as between-participants factors and event (new goal or old goal) as a within-participant factor. The analysis yielded a significant Condition $\times$ Event interaction, $F(2, 36) = 3.59$, $p = .038$, $\eta_p^2 = .166$. The analyses also revealed a significant Condition $\times$ Event $\times$ Order $\times$ Sex interaction, $F(2, 36) = 5.71$, $p = .007$, $\eta_p^2 = .241$. Given the small number of infants in each cell, these results did not warrant further discussion. No other effect was significant. Because of this significant interaction, we used the omnibus ANOVA (e.g., Baillargeon, 1987; Choi, Song, & Luo, 2018; Gergely et al., 1995; vanMarle & Wynn, 2006) as opposed to an ANOVA concerning only the factors of condition and event.

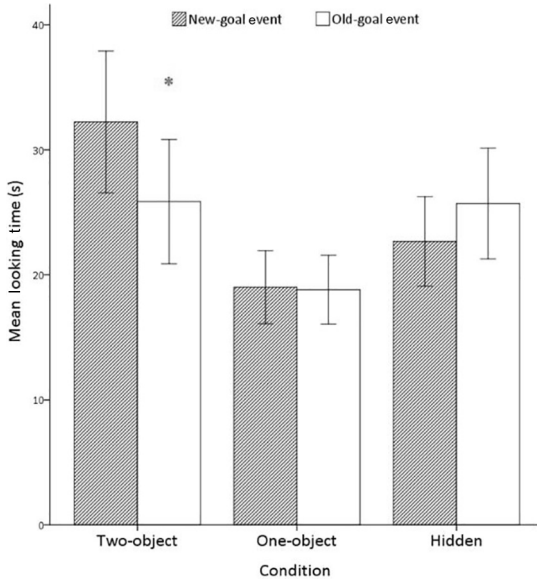

Fig. 3. Infants' mean looking times during the test trials in the two-object, one-object, and hidden conditions. Results are shown as a function of event type and condition. Error bars represent standard errors. An asterisk denotes a significant difference between events ($p < .05$).

Planned comparisons revealed that the infants in the two-object condition looked reliably longer at the new-goal event ($M = 32.2$ s, $SD = 22.7$) than at the old-goal event ($M = 25.9$ s, $SD = 19.9$), $F(1, 36) = 4.32$, $p = .045$,[2] Cohen's $d = 0.527$, whereas those in the one-object and hidden conditions did not look significantly differently at the two events [one-object condition—new-goal event: $M = 19.0$ s, $SD = 11.7$; old-goal event: $M = 18.8$ s, $SD = 11.0$, $F(1, 36) = 0.00$, $p > .250$, $d = 0.016$; hidden condition—new-goal event: $M = 22.7$ s, $SD = 14.3$; old-goal event: $M = 25.7$ s, $SD = 17.7$, $F(1, 36) = 0.98$, $p > .250$, $d = -0.237$]. Examination of individual infants' looking times confirmed these results. Of the 16 infants in the two-object condition, 10 looked longer at the new-goal test event than at the old-goal test event, Wilcoxon signed-ranks $z = 1.55$, $p = .061$ (one-tailed),[3] whereas only 6 infants in the one-object condition ($z = 0.52$, $p > .250$, one-tailed) and 9 in the hidden condition ($z = 0.45$, $p > .250$, one-tailed) did so.

Discussion

The current results suggest that when seeing a human agent's face and upper body, as opposed to only her arm and hand as in Sommerville et al. (2005), 3-month-old infants appeared to interpret her actions of choosing one object over another with her bare hand as evidence for her preference. Therefore, they responded with heightened interest when the agent acted inconsistently with this preference during test. By contrast, when only one object was present, infants seemed to recognize that the agent's same actions of grasping the object were not indicative of a preference. Therefore, they did not respond with heightened interest when the agent chose a newly introduced object during test. In addition, when both objects were present, with one hiding the other from the agent, infants again responded similarly when the agent chose either of the objects after both of them became visible or

[2] Planned comparisons and t tests both are common practices in the field. Admittedly, in a multivariate $3 \times 2 \times 2 \times 2$ ANOVA, a planned comparison within one condition is a statistically weaker test than a paired t test. In the current two-object condition, the paired t test yielded a marginally significant result, $t(15) = 2.04$, $p = .059$ (two-tailed).

[3] Because of this marginally significant one-tailed result, it will be of great value to replicate the positive two-object condition results in future research.

accessible to her. Together with previous reports on young infants' responses (Hamlin, Wynn, & Bloom, 2010; Luo, 2011b; Skerry, Carey, & Spelke, 2013; Sommerville et al., 2005), therefore, the current study demonstrates that even by 3 months of age, infants seem to engage in psychological reasoning about agents, whether human or nonhuman.

A caveat of the current study is that the direction of the agent's reach during familiarization was not counterbalanced. Instead, in all three conditions, she reached right to grasp an object. If the imbalanced design had somehow affected infants' responses, similar-looking patterns should have been expected from the three conditions. However, we found positive results in the two-object condition but negative ones in the one-object and hidden conditions. The only difference between the two-object and one-object conditions was the presence or absence of the nontarget object during familiarization. Infants' different responses suggest that they seemed to realize that this factor contributed to whether or not the agent's actions were evidence for a preference.

The only difference between the two-object and hidden conditions was the position of the nontarget object during familiarization. In the latter condition, it was hidden from the agent by the target object. Infants again responded differently in the two conditions. There are at least three possible reasons for the negative results from the hidden condition. First, infants might have realized that the pyramid was hidden from the agent during the familiarization phase. Therefore, similar to findings from previous perspective-taking studies (e.g., Luo & Baillargeon, 2007; Luo & Johnson, 2009), infants might have realized that this was essentially a one-object condition to her while they themselves could see both the pumpkin and the pyramid. A second possibility is that infants might have recognized that the pyramid was out of the agent's reach, or difficult to access, during the familiarization phase, again rendering the hidden condition a one-object situation. The third possibility has to do with infants' limited object segregation skills. In the current setup during the familiarization phase, there was no direct evidence that infants clearly segregated the pumpkin and the pyramid in their perception of the scene. For example, the two objects did not move apart and were close to each other (with a 2-cm gap at the closest). Although the two objects differed in shape, size, color, and texture, not all infants in the hidden condition could have used such configural information to perceive them as two separate objects given that this ability seems to develop between 3 and 4 months of age and is related to infants' own abilities to manipulate objects (e.g., Kestenbaum, Termine, & Spelke, 1987; Needham, 1998, 1999, 2000; Needham, Baillargeon, & Kaufman, 1997). Therefore, infants who had perceived the two objects as one single set during the familiarization phase might have responded to the fact that the two objects stood separately during the test phase. Although we had designed the hidden condition so that the infants saw more of the scene than the agent could have seen during the familiarization phase, infants' own perceptions of the scene limited by their object segregation skills might have taken precedence in how they construed the current condition. Nevertheless, positive results from further testing when the agent held both the pyramid and the pumpkin in her representation of the scene while infants still saw the two objects set up as in the current hidden condition would shed light on these young infants' perspective-taking abilities. For the current purposes, the negative results of the hidden condition make clear that in the one-object condition the absence of the nontarget object before the test trials was not likely the reason for the negative results obtained.

Furthermore, in the hidden condition, as mentioned above, the pyramid was also less accessible than the pumpkin to the agent, similar to experimental situations with older 6-month-olds in which a screen hid one of two objects from the agent, obstructing her reach (Luo & Johnson, 2009). Future research will examine whether or not varying physical access of the two objects can affect infants' preference attributions. For example, would young infants be able to consider effort information (Baillargeon et al., 2015)? Prior studies have shown that if an agent makes efforts to contact the only object available in a scene (e.g., by going through different routes to always contact it), infants appear to understand that the intention to contact the object is sufficiently strong to guide the agent's future actions, that is, to choose this object over a newly introduced one (Bíró, Verschoor, & Coenen, 2011; Hernik & Southgate, 2012; Luo, 2011b). It is worthwhile to examine whether effort information can influence infants' preference attributions when there are two objects to choose from but one is more difficult to obtain than the other. Answers to these questions will yield better understanding of how young infants learn about agents.

The comparisons between the current study and Sommerville et al. (2005) demonstrate that, at least with human agents, 3-month-olds need sufficient *featural* information to identify an agent, for example, the agent's face and upper body as opposed to only her arm and hand, whether wearing a mitten or not (for discussions on how *behavioral* information contributes to infants' intentional understanding about agents, see, e.g., Baillargeon et al., 2015; Luo & Choi, 2013). In addition, given 7-month-olds' failure to attribute a preference to a human agent's grasping one of two objects when she had gloves on her hands (Guajardo & Woodward, 2004), younger 3-month-olds should fail as well. In fact, Skerry et al. (2013) reported such a failure, albeit in a different goal attribution context from the current one. After watching a human agent, with her face and upper body visible, reaching over a barrier to bring back an object using her *mittened* hand, 3-month-olds did not expect her to reach directly toward the object after the barrier was removed. Interestingly, as in Sommerville et al. (2005), the "sticky mitten" experience led 3-month-olds to respond with heightened interest when the agent still reached in an arc toward her goal object with the barrier removed. Thus, the first-person action experience is quite helpful; it not only can facilitate young infants' understanding the goal and preferences underlying agents' similar actions when only an agent's arm and hand are visible (Sommerville et al., 2005), it also can help them to evaluate the efficiency of agents' goal-directed actions even in different contexts, possibly guided by general assumptions about agents (Skerry et al., 2013). Furthermore, in Skerry et al. (2013), when the action experience was ineffective (i.e., the mitten was no longer sticky and, hence, did not afford successful grasping for infants), 3-month-olds failed to respond to the agent's inefficient goal-directed reach, demonstrating how specific the firsthand action experience needs to be in helping infants' intentional reading of agents. It remains an open question whether or not 3-month-olds, without any first-person action experience, would still respond to the agent's inefficient reach with her *bare* hand, as was shown in the current study. Nevertheless, the discussions above again point to the importance of learning and experiences in early intentional understanding. Specifically, whereas 3-month-olds seem to attribute a preference to a human agent if she chose one object over another with both objects clearly visible or accessible to her as in the current two-object condition, they might have gathered from everyday experiences during the first few months to realize that a person with bare hands is an agent who acts toward objects to achieve her goals, usually in an efficient manner.

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