Infants help a non-human agent

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Abstract

Young children can be motivated to help unfamiliar adults by sympathetic concern based upon empathy, but the underlying mechanisms are unknown. One account of empathy-based sympathetic helping in adults states that it arises due to direct-matching mirror-system mechanisms involving resonance in motor brain-regions which allow the observer to vicariously experience the situation of the individual in need of help. This mechanism could not account for helping of a geometric-shape agent lacking human-isomorphic body-parts. Here 17-month-olds observed a ball-shaped non-human agent trying to reach a goal but failing because it was blocked by a barrier. Infants helped the agent by lifting it over the barrier. They performed this action less frequently in a control condition in which the barrier could not be construed as blocking the agent. Direct matching is therefore not required for motivating helping in infants, indicating that our most basic helpful tendencies are not dependent on human-specific mechanisms. One plausible basis for the observed helping is a sympathy-based mechanism which does not require mirror-system mediated direct-matching. A second possibility is that rather than being sympathetic, the observed helping occurred as a result of a goal-contagion process in which the infants were primed with the unfulfilled goal.

Keywords: Infants; helping; empathy; mirror system; direct matching
Introduction

From at least 14 months of age young children help unfamiliar adults unable to reach their goals [1-3]. Motivations for prosocial behaviour in young children are diverse [4-6], but one important motivation for helping in young children is an intrinsic sympathy-based feeling of altruism towards the individual in need of help [7-9]. This is demonstrated firstly by studies showing that 36-month-olds are more likely to help victims of anti-social acts [10,11] and that helping is inhibited rather than promoted by rewards in 20-month-olds [12]. Furthermore, 24-months-old’s physiological arousal produced in response to an individual in need is reduced not only when the children provide the necessary help, but also when help is provided by a third party, indicating that help is motivated by a basic sympathetic concern for the individual’s welfare [13].

Although motivations for young children’s helping are therefore beginning to be understood, the underlying neural mechanisms remain unclear. To explain empathy in adults, and thus sympathy and helping⁷, one prominent type of mechanistic account invokes the mirror system. The mirror system is highly complex and includes numerous different pathways which might support empathy [15-19], but one frequently highlighted mechanism involves what is known as direct matching or motor resonance. In direct matching, the observation of others’ actions leads to motor activation in the premotor cortex and parietal cortex corresponding to the same actions [20,21]. This mechanism is known to play a causal role in social understanding [22]. One way in which direct-matching might enable empathy is by enabling observers’ perceptions of others’ facial expressions to be directly linked to the experience of displaying the same expression [23-25]. A more general mechanism not requiring emotional expression is that direct matching might allow the observer to vicariously

⁷ Empathy refers to the sharing of an emotion with another, whereas sympathy refers to the feeling of concern for another’s wellbeing which can be evoked by empathy [14].
experience the observed challenging situation, generating an empathic desire to help [8,26,27].

The purpose of the current study is to test the hypothesis that the direct-matching mechanism is a prerequisite for helping in infants. This strong hypothesis makes the strong prediction that infants would not help a geometric-shape agent lacking human-isomorphic body-parts because such an agent cannot elicit direct matching which by definition requires at least some degree of isomorphism of movable body parts [20]. This prediction has not to our knowledge been tested, but it is not implausible that infants might help such an agent. The extraction of social meaning from the movements of geometric-shape agents begins in early infancy [28-30]. Infants evaluate such agents’ helpful acts as positive and hindering acts as negative [31-33, but see 34], with even three-month-olds possessing the rudiments of this ability [35]. These results indicate that mechanisms independent of direct-matching are important for infants’ social cognition. However, as the mirror system is also active in infants [36], and as active helping may not be based on the same systems as evaluation of others’ helping, it remains unclear what underlying neural mechanisms motivate infants’ own acts of helping. Furthermore, although sympathy is clearly an important motivator for helping in young children, it is also possible that mechanisms not based on sympathy may play a role. It may be that a goal-contagion priming account [37] might explain some aspects of infant helping.

Here, in the experimental condition, a geometric-shape agent’s apparent goal is on the other side of a barrier. On reaching the barrier the agent first travels up and down the length of it and then repeatedly knocks into it as if attempting to force a way through. Infants can help the agent by lifting it over the barrier. Only accounts of helping not requiring direct matching predict that infants will do so. The numerous explanations for why infants might lift the agent over without intending to help it, such as exploratory behaviour, are controlled for
in a condition in which everything is identical except that the barrier is incomplete. In this condition the agent’s travelling up and down instead indicates that there is a clear passage to the other side which the agent chooses not to take. The agent’s goal in this condition therefore appears to be what it is doing – knocking into the barrier. Hypotheses of helping therefore do not predict that infants will lift the agent beyond the barrier.

Materials and methods

Ethics statement. The work conducted in this study was given written approval by the Uppsala Regional Ethics Committee (Regionala etikprövningsnämnden i Uppsala, application reference number 2009/103). Infants’ parents gave informed written consent.

Participants. Sixty 17-month-olds (27 girls; mean age 17.5, SD = .7) were randomly divided between the experimental or control conditions. An additional 7 infants were excluded from analysis because of parental interference (1), technical problems (2), or because of fussiness before a minimum criteria of three trials were reached (5).

Procedure. Each infant participated until it became fussy or until six trials were completed. Each trial was identical and began with the infant sitting in the parent’s lap just out of reach of the table. The table was divided into two by a barrier composed of three wooden blocks in the experimental condition, but in the control condition only the central wooden block was present (Figure 1). This was the only difference between conditions. A screen attached to the back of the table hid the experimenter as she sat behind moving the agent using a magnet under the table. The agent, a slightly elongated yellow ball with fabric eyes and small enough for infants to lift, was initially positioned to the left of the barrier. On the right side was a larger pink ball with fabric eyes, positioned on a pink shape, besides which was an unoccupied yellow shape intended to enhance the impression of an intended goal for the yellow agent. The gap between the blocks was one third of the diameter of the
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agent – from three months infants do not expect objects to pass through gaps smaller than themselves [38].

Fig 1. View at the start of the trial for the experimental condition (a) and the control condition (b).

Trials began with the agent travelling towards the central block, and on reaching its left side, travelling up and down the table. With identical movements, therefore, in the experimental condition the agent travelled up and down the length of the barrier, whereas in the control condition the agent moved past the empty spaces to the sides of the central block. After this the agent began to knock, hard and at speed, into the central block, with each knock followed by a slower backwards retreat (Videos S1 and S2 show the experimental and control conditions respectively). Each knock came from a slightly different angle, serving to reinforce the impression of agency rather than mechanical movement [39]. Parents were instructed to move forward after five knocks so that their infant could reach the agent. After this point, knocking continued until the infant began moving the agent or until 15 seconds had passed, at which latter point the trial was terminated. Once the infant had begun moving the agent, the trial was terminated either when the infant ceased contacting the agent or after an additional 15 seconds. After the trial, the experimenter retrieved the agent, the parent
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rotated the chair so the infant could not see the table, and the experimenter replaced the agent in the starting position.

**Stimulus validity.** To confirm that adults at least readily interpreted the agent in the experimental condition as an agent attempting to cross the barrier and in need of help, but made this interpretation less readily in the control condition, a convenience sample of 15 hypothesis-blind non-psychologist adults (mean age 44 years, $SD = 11$, 7 women) was recruited and tested via the internet. Participants were displayed movies of both conditions in counterbalanced order (Videos S1 and S2), and after each movie were asked "what is your immediate intuitive interpretation of what you just saw?" and "if you could intervene in this situation, what would you do?" One subject was excluded for stating only that the movies were "silly". All 14 adults described the agent as an agent in both conditions. The agent was marginally more likely to be described as attempting to travel past the barrier in the experimental condition (100%) than in the control condition (64%), $p = .074$, McNemar’s test. Adults were more likely to state they would help the agent past the barrier in the experimental condition (100%) than in the control condition (57%), $p = .041$, McNemar’s test.

Infants can in some circumstances infer the presence of a hidden agent when observing otherwise inexplicable object motions [40,41]. To our knowledge this has only been reported when there is a hidden location from which a hand might have contacted the agent, and does not occur if the moving object was previously shown to be capable of self-generated motion. As there is no such hidden location, as infants never saw the experimenter handle the agent until after they had observed it move by itself, and as the agent fulfils sufficient requirements for infants to classify it as a self-propelled agent [39], it is highly unlikely that infants infer that the experimenter controls the agent.
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Coding. Two coders, one of whom was blind to the study hypothesis, coded each trial from video. Whether or not the infant moved the agent beyond the barrier was coded (defined as leaving the agent on the table to the right of the right-hand edge of the central block). Also coded was whether the infant moved the agent at all. Inter-observer agreement was 96% for moving beyond the barrier, 100% for moving at all, and the blind coding was used for analysis.

Results

Moving the agent beyond the barrier occurred on a higher percentage of trials in the experimental condition, $t(42) = 2.14, p = .039, d = .55$ (Figure 2). Video S3 shows an infant in the experimental condition lifting the agent over the barrier (The parent of the participant in this video has given written informed consent, as outlined in the PLOS consent form, to publish this video). Because the behaviour was infrequent in both conditions this data was highly left-skewed. The comparison was therefore repeated using a non-parametric two-sample permutation test with one million random samples [42], producing the same result, $p = .039$. The agent was placed on the yellow square on 44% of trials it was lifted over the barrier in the experimental condition, and 21% of trials it was lifted over in the control condition, $t(14) = 1.16, p = .264$ ($t$-test), $p = .288$ (permutation test). The agent was moved beyond the barrier at least once by 40% of participants in the experimental condition and 23% of participants in the control condition.

There was no evidence that the conditions differed in how they engaged the participants’ attention and activity. The mean number of trials completed (of a possible six) before fussiness was the same for both conditions, 5.8, $SD = .5$. Infants moved the agent on a mean of 72% of experimental trials, $SD = 33\%$, and 59% of control trials, $SD = 37\%$, $t(57) = 1.47, p = .148$ ($t$-test), $p = .149$ (permutation test).
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Discussion

Although moving the agent beyond the barrier was infrequent compared to moving the agent in other ways, it did occur, and importantly, it occurred much more frequently in the experimental condition than in the control condition. Although there are many other reasons apart from helping (such as exploration) for why infants might move the agent beyond the barrier, these reasons apply equally (at least) to the control condition. Note that non-helpful exploratory movement of the agent would lead to moving it beyond the barrier more frequently in the control condition, because the incomplete barrier does not prevent the agent from being slid past it. We therefore conclude that at least some of the observed transportations over the barrier were motivated by a tendency to help, by which we mean a tendency to act in a way facilitating the achievement of another individual’s goal.
These findings further reinforce the point that direct matching is not a prerequisite for understanding others' actions in infants and adults [43-46]. Note that the presence of static eyes on the agent, although probably facilitating its classification as an agent [39], cannot have caused direct matching, which occurs in response to action [20].

Based on the observation that infants helped a non-human agent, the following key conclusions about the underlying mechanisms of helping can be made. The results cannot be explained by the direct-matching mirror account of empathy-based helping, and direct-matching mirror mechanisms are therefore not the only and perhaps not even the primary mechanisms for motivating help in infants. This does not, however, imply that direct-matching mirror mechanisms do not play a role when infants help human agents. It is not currently necessary to assume that they do, but the possibility that direct-matching mirror mechanisms play a role in infants’ helping of human agents could account for the observation that in comparison to rates of helping of adult strangers by 18-month-olds [47], the rates of helping observed here were very low. A related possibility which can also explain this observation is that infants may detect the unfulfilled goals of humans more easily than those of non-human agents.

What mechanisms did therefore account for the observed helping? Some prior observations allow informed speculation. Many neural mechanisms involved in empathy in adults and older children do not involve direct matching [16,17,48], and it is likely that these may play a role in infancy. More specifically, aspects of empathy depend on connections between emotion centres (particularly the amygdala, the insula, and the anterior cingulate cortex) and the prefrontal cortex [both in older children, 49, and in adults, 50,51,52]. We note that the amygdala also plays a key causal role in allowing the actions of animated geometric-shapes to be evaluated in terms of social meaning [known as anthropomorphizing, 53]. We suggest therefore that a plausible account of empathy for and thus helping of geometric-shape
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agents is based upon a network with the amygdala at its centre, because the amygdala plays a key role both in perceiving such agents’ movements as actions with social meaning, and in assigning emotional valence to these actions.

A second possible explanation for the observed helping is a non-sympathy-based priming mechanism. The representation of the observed goal may have primed behaviour resulting in that goal, in a similar process to the goal contagion which has been observed in adults [37]. Note that in this case, helping can be seen as a similar process to automatic imitation [54]. Priming can increase helping frequency in 18-month-olds [55]. Related to this, it has been argued that when young children observe unmet needs, they can sometimes be motivated to help not because of sympathy but because of a broader motivation to cause goals to be reached which is not predicated on an understanding of the self-other distinction [56].

In conclusion, the finding that non-matching-based mechanisms can result in helping in infants gives further support to the idea that they play a prominent role more generally in human helping behaviour [16,17,48]. What this study most clearly demonstrates is that humans’ most basic helpful tendencies are built not only upon mirror mechanisms in which others are perceived as “like me” [57], but on more general mechanisms which can also process non-human agents and their unachieved goals.

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References


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