Early Threads of Connection: Probing Infants' Early Understanding of Caregiving Relationships

Christina M. Steele[1] (csteele@g.harvard.edu), Megan K. Richardson[1] (mrichardson@g.harvard.edu), Azwayla F. Taylor[1] (azwaylataylor@college.harvard.edu), Denis Tatone[2] (denis.tatone@gmail.com)[1], and Ashley J. Thomas[1] (athomas@g.harvard.edu)

[1]Department of Psychology, Harvard University, Cambridge, MA 02138

[2]Department of Cognitive Science, Central European University, Vienna, Austria 1100

Abstract

Despite the centrality of caregiving relationships in the lives of infants, little is known about whether and how infants represent these relationships characterized by strong attachment and asymmetry in obligation and skills. The current studies (N=95) investigate whether 8-to-10-month-old infants attend to two cues—affiliative touch and physical size—to predict who will respond to distress. In Study 1 (n=49), infants expected larger characters to respond to the emotional needs of smaller characters, only when they saw affiliative touch (proportion looking time at large character: BF_{10}=6.72). In Study 2 (n=46), they did not expect smaller characters to respond to larger characters (proportion looking time: BF_{10}=0.17), suggesting they expect asymmetrical roles in caregiving relationships. Collectively, these findings suggest that humans have an early-emerging ability to recognize key relationships in their social world.

Keywords: caregiving relationships; infants; social cognition

Introduction

From birth, the most critical relationships that humans experience are caregiving ones. In caregiving relationships, one person responds to the physical and emotional needs of someone who is otherwise unable to support themselves (Gopnik, 2023). These relationships often occur in intimate relationships, characterized by strong attachments and obligations that often but not always, occur among genetic relatives. Caregiving relationships also tend to involve asymmetries in abilities, knowledge, or obligations. Compared to most other primates, human infants rely on their caregivers for a longer time and have relationships with more caregivers. Caregivers can include a wide range of social actors (e.g., parents, older siblings, grandparents, friends, teachers, and nannies, etc.; Helfrecht et al., 2020; Hrdy, 2009; Hrdy & Burkart, 2022). Given the importance of caregiving relationships for infant survival (Hrdy, 2009; Sullivan et al., 2011) and our early reliance on many caregivers (Burke et al., 2022; Cheney et al., 2016; Hrdy & Burkart, 2020; Hrdy & Burkart, 2022; Silk et al., 2016; Tibbetts et al., 2022), we hypothesize that humans should be able to recognize caregiving relationships from an early age. What cues might infants use to do so?

Caregiving relationships typically include prosocial interactions. Infants indeed recognize prosocial actions, even when they observe simple animated characters (refer to Spelke, 2022 for review). Before 10 months, infants expect individuals who coordinate their actions (Powell & Spelke, 2013), help (Hamlin et al., 2007), and those who imitate (Powell & Spelke, 2018) to affiliate with the target of these prosocial actions (e.g., by approaching them; refer to Powell (2022) for review on why imitation may be viewed as prosocial). However, while prosocial actions often occur in caregiving relationships, prosocial actions also occur between strangers or in other types of less intimate relationships (Bennett & Einolf, 2017; Fiske, 1992; Levine et al., 2001). Caregiving relationships are marked specifically by responses to the physical or emotional needs of others. Do infants have expectations about responses to needs?

Infants indeed form expectations about responses to distress. In one study, infants as young as 4 months of age were shown a video in which a woman either comforted or ignored a crying baby (Jin et al., 2018), and expected the former action to occur. Tellingly, they no longer expected the woman to respond when the infant laughed instead of cried. In another study, infants saw a large and a small, animated character approach each other, then separate (Johnson et al., 2007). Next, the smaller character started to cry. Twelve- to 16-month-olds who were securely attached to their own parents expected the large character to approach the small character instead of ignoring it. These two studies suggest that at least some infants expect responses to distress to occur. But who is more likely to respond to distress?

In one study, twelve- month-olds saw a woman engage in imitation with one with a puppet, and then saw the same woman respond to, but not imitate another puppet. They expected the puppet who had been in the imitative interaction to respond to her distress (Kudrnova et al., 2023). Once more, infants no longer expected responses if a woman laughed or if a novel person signaled distress. Together, these findings show that infants draw inferences about the relationships between the individuals they observe to predict who will respond to distress. In a related set of studies, infants used cues of intimate relationships to predict who would respond

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

to distress. Eight-to-10-month-old infants saw a puppet have different prosocial interactions with two women (Thomas, Woo, et al., 2022). However, only one of the interactions involved a cue of social intimacy–sharing saliva, as opposed to a cue of general social affiliation (Hung et al., 2022; Miller et al., 1998). Infants expected that the woman who had shared saliva with the puppet would respond to its distress as opposed to the other woman who had passed a ball back and forth with the puppet. Like the study about imitation, infants' expectations did not depend on general expectations about responsiveness: Infants did not expect responses to any social gesture (i.e., they did not expect the saliva-sharing partner to respond to a request for a ball or to a nonsense syllable). Moreover, their expectations seemed to rely on inferences about relationships rather than traits of the saliva-sharing partner. When a new puppet expressed distress, infants did not expect the saliva-sharing partner to respond. In fact, the expectation that caregivers will respond to one another's distress may be phylogenetically old. Even non-human primates expect mothers as opposed to other adults to respond to their babies' distress (Cheney & Seyfarth, 1990; Seyfarth & Cheney, 2000). In another set of studies, when toddlers, aged 15- to 18-months observe responses to distress, they make inferences about relationships (Spokes & Spelke, 2017). In this study, toddlers predicted that two characters who responded to the distress of a single target would coordinate their actions by touching and moving in synchrony. The studies above suggest that infants expect certain characters to respond to distress which could be evidence that they recognize caregiving relationships. However, they do not directly test whether infants recognize that caregiving relationships involve individuals with different roles, nor do they directly test the cues that infants may use to recognize caregiving relationships.

Given that caregiving relationships are often intimate relationships, the ability to recognize cues of intimate relationships may support concepts of caregiving relationships. However, intimate relationships also include romantic partnerships, siblings, or close friendships. Therefore, if infants indeed represent caregiving relationships it may also involve recognizing cues of asymmetry, such as size differences, and having expectations about asymmetrical behaviors (i.e., they should expect larger characters to respond to smaller characters, but they should not expect smaller characters to respond to larger ones).

Caregiving relationships involve asymmetries in abilities, effort, or cost (Powell, 2022; Silk, 2021; Thomas, Steele, Gopnik, Saxe, in press). For infants, these asymmetries also come in the form of age and size: older and larger individuals care for infants. Thus, infants may use size to predict who will respond to distress given other contextual information. In line with this, several of the studies discussed above portray caregiving via size difference. For example, in the study where the securely attached infants expected responses to distress, the event featured a larger character responding to the distress of a small one (Johnson et al., 2007). Similarly, in a study where infants inferred affiliation between two agents being comforted by the same larger character, a substantially weaker effect was found when the comforter and recipient of comfort were equal-sized (Spokes & Spelke, 2017). Likewise, in the saliva-sharing study, infants' expectations about responses to distress were attenuated when the test interaction was reversed, with the smaller character responding to the distress of the woman (Thomas, Woo, et al., 2022). Furthermore, infants also use size differences to infer dominance status in conflicts. In one study, infants expected smaller characters to yield to larger characters in right-of-way conflicts, in line with patterns of dominance across other species (Thomsen et al., 2011). These findings show that infants are sensitive to cues of asymmetry. Infants may flexibly leverage these asymmetry cues, depending on context, to form relationship-specific expectations (from prevailing to responding to distress).

Here we investigate the kinds of cues that infants use to identify caregiving relationships. While the prior studies are suggestive that infants represent caregiving relationships (Johnson et al., 2007; Spokes & Spelke, 2017), they have not directly assessed which cues induce infants to set up these representations (Billingsley et al., 2019; Sorokowska et al., 2021). Specifically, we hypothesize that infants represent caregiving relationships as asymmetric relationships that occur in intimate relationships. To cue intimate relationships, we use touch instead of saliva sharing. Like saliva sharing, individuals in intimate relationships are more likely to seek or tolerate physical closeness compared to those in thin relationships. Indeed, touch is a phylogenetically ancient means for individuals to establish closeness and promote relationship building (Fiske, 1992; Sorokowska et al., 2021; Suvilehto et al., 2015; Suvilehto et al., 2023). For instance, non-human primates and other gregarious mammals engage in touch behaviors such as grooming to reinforce social bonds (Dunbar, 2010; Silk et al., 2013). Moreover, across cultures individuals recognize affective touch (e.g., embracing, hugging, stroking) as a cue of intimate relationships (Sorokowska et al., 2021; Suvilehto et al., 2019). Given the cross-cultural and species-wide relevance of touch-related behaviors in indicating intimate relationships, infants may recognize touch as one cue of caregiving relationships. To cue age asymmetries, we use physical body size since, as mentioned above, human caregivers are typically larger than their young. While physical size need not always indicate age difference (e.g., grandparents, for instance, can be smaller than their adult children), in the case of infant-adult caregiving relationships, physical size difference and age difference generally co-occur. Finally, we predict that infants represent caregiving relationships as asymmetrical in roles and obligations. That is, infants will expect large characters to respond to small characters, but they will not expect small characters to respond to larger ones.

We also explore whether infants have different expectations for responses, depending on the type of need. Caregivers provide both comfort and food, which represent key physiological and psychological needs in humans and other mammals (Harlow & Zimmermann, 1958; Maslow,

1943). However, for infants, responses to distress may be a particularly relevant cue of caregiving relationships over and above provision of food (Harlow & Zimmermann, 1958). While caregivers provide infants with food, it typically comes through breastfeeding, where resource provision and intimate touch are tightly linked. We hypothesize that the discrete transfer of valuable goods may instead be perceived as cueing a form of exchange relationship, which regulates expectations about fair distribution and reciprocity (Geraci & Surian, 2011; Schmidt & Somerville, 2011; Tatone et al., 2015; Tatone & Csibra, 2020). Accordingly, since caregiving does not strictly characterize those relationships, we should observe weaker behavioral predictions when the target agent at test is requesting food instead of needing emotional support.

The present studies aim to test these hypotheses in 8- to 10-month-old infants by measuring anticipatory looking at animated displays involving abstract geometric shape-like characters. We used anticipatory looking under the assumption that infants look toward places where they expect action to occur (e.g., Spelke, 2022). We used 8-to-10-month-olds since this project builds on prior work suggesting this age group can recognize intimacy and can interpret agency and social causality in animated shapes (Rochat et al., 2004; Thomas, Woo, et al., 2022).

Infants saw two series of animations each with a small central character flanked by a large and similarly small character. In Study 1, we hypothesized that infants would anticipate that the larger character would respond to the distress of the central character, but only if they had previously touched. We also asked whether infants use these cues to predict who will respond to requests for food. In Study 2 we ask whether infants have asymmetric expectations of the behavior of the small and large character in the caregiving relationship. We hypothesized that infants would not expect smaller characters to respond to larger characters even when affiliative touch is present.

Study 1

We complied with all ethical regulations to conduct this research. This study received Institutional Review Board approval. This study was pre-registered on Open Science Framework (OSF; https://osf.io/h3u2c/?view_only=da2d777c1bca48919fb3f5b5258af305).

Methods

Participants We tested 57 infants (from parental report: Mean Age_{days} = 272.75; SD Age_{days} = 20.02). We aimed to include data from full term infants between 8 months 0 days and 10 months 0 days, however some infants recruited were outside of this age range, and we included them in the analysis (N=4; Mean Age_{days} = 298.25; SD Age_{days} = 41.81). We excluded data from eight infants who were too difficult to code because of video quality, leaving a total of 49 participants whose data are included in the analysis. Exclusion decisions were made before the data were analyzed (refer to the pre-registration for more exclusion decisions).

Design and Materials The present studies took place online using video-chat software. We used an online design to recruit a more diverse and representative sample in terms of race, ethnicity, parental education, income, and region, than is typical in developmental psychology experiments (Thomas, Woo, et al., 2022). In both studies, we used a two-by-two within-subjects design in which participants saw two sets of familiarization trials (i.e., "touch" and "no touch") each followed by two test trials (i.e., "distress" and "food"). The familiarization trials were repeated 4 times. The animations in the video sessions featured three different colored animated characters. In both sets of familiarization trials, a central character was flanked by one larger character and one same-sized character. The characters retained the same neutral-positive facial expressions throughout the study, except in the distress test trial, in which the central character frowned. The presentation of the characters (i.e., by color, size, position on screen) were counterbalanced. The order that infants saw the familiarization trials (i.e., touch and no touch) and the order of the test trials (i.e., distress and food) were counterbalanced.

In the no touch condition, the central character and a flanking character looked towards each other and then moved in synchrony without touching. The same interactions were repeated with the central character and the other third character. We used this as a cue of general affiliation based on prior work (Powell & Spelke, 2013).

In the touch condition, the familiarization trials showed the same actions except that the characters touched. We used touch as a cue of intimacy given cross-cultural evidence suggesting that touch guides inferences about intimate relationships (Fiske 1992; Sorokowska et al., 2021; Suvilehto et al., 2023).

In the distress test event (Figure 1), the central character made a sad face (i.e., closed eyes and frowning) and shook, while the sound of a human baby crying played. The side characters looked toward the central character, and then remained still, making it salient that the central character was the one crying (refer to OSF for an example video of the test event). Then, the flanking characters looked toward the central character. After 6.25 seconds of crying, there was an 8 second pause, during which we recorded which flanking character the infants looked toward first, and the time that infants spent looking at the two flanking characters.

In the food test event, one bowl of strawberries dropped in front of each of the flanking characters. Then, the central character looked toward the two bowls and looked down, as if to notice that it did not have its own bowl. The flanking characters looked at the central character. Then, the central character requested food (i.e., the animated character's mouth moved in synchrony with a child-like voice that said, "Strawberries, I want strawberries!"), then extended its hands in a request gesture. We used this behavioral signal of food requests based on evidence that infants recognized "give-me

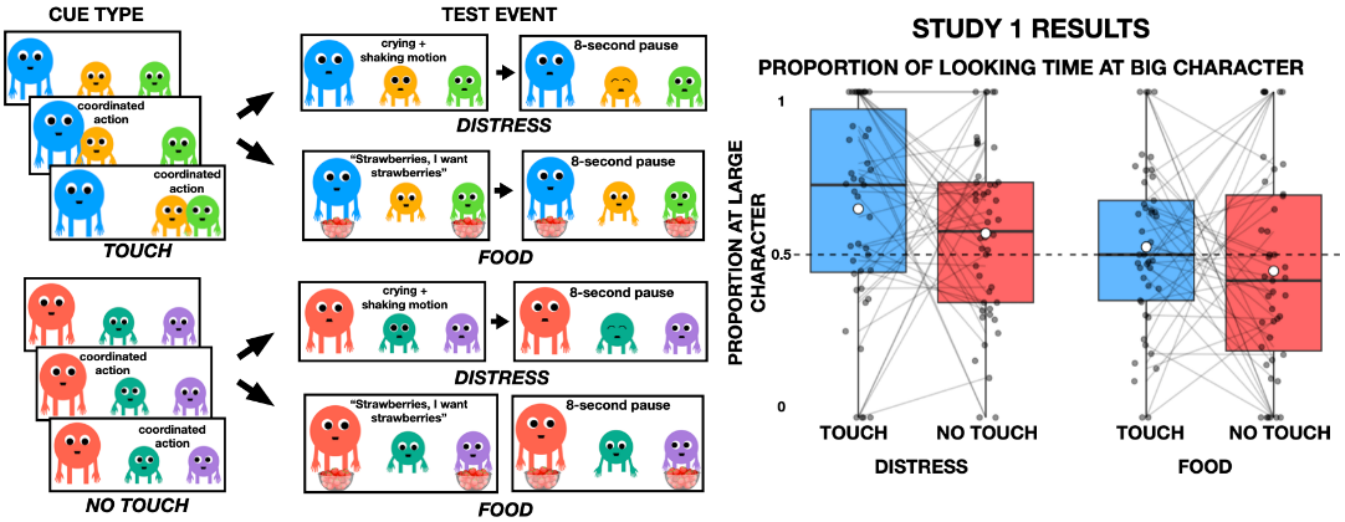

Figure 1: [LEFT] Stimuli shown to infants in Study 1. [RIGHT] Boxplots of the proportion of time that infants spent looking towards the larger character in Study 1. Solid black lines indicate medians, white dots indicate means, small gray dots indicate participants' individual data points, gray lines connect data points of the same participant.

gestures" (Elsner et al., 2014). Again, an 8-second pause began, during which both the infants' first looks, and duration of looks were recorded.

Coding and Data Analysis We used manual video-coding, done by people who are unaware of the conditions, to track infants' recorded eye-movements (Datavyu Team, 2014). We initially planned to double-code 25% of all videos. However, after achieving reliability under 85%, both coders met to double code the full dataset and discuss disagreements that arose. In the final coding, we achieved reliability of 98%. To analyze infants' expectations, we used Bayesian mixed models using the brms package (Bürkner, 2017) in R (R Core Team, 2023): One estimated the proportion of looking time towards the large character (a gaussian model, which fit our data well upon model diagnostic checks) and another to estimate first looks towards the large character (a Bernoulli model). Fixed effects included touch condition ("touch" and "no touch" cue types) and test event ("distress" and "food" test events) with participant ID as a random effect. Default priors were used for each model. To test whether infants spent more time looking at the large character or looked at the large character first within each condition, we respectively ran Bayesian t-tests and Bayesian binomial tests in JASP (JASP Team, 2024).

Results

Infants spent more time looking at the larger character than the smaller character only in the touch condition and only when the central small character expressed distress ($Mean_{TouchDistress}$:0.64, [0.56; 0.73][1], BF_{10} = 6.72; $Mean_{NoTouchDistress}$: 0.57, [0.48, 0.65], BF_{10} = 0.60; $Mean_{TouchFood}$: 0.52, [0.44, 0.61], BF_{10} = 0.19; $Mean_{NoTouchFood}$: 0.45, [0.36, 0.54], BF_{10} = 0.27). We did not find a main effect of touch condition (β = 0.07; [-0.04, 0.19]) but did find a small effect of test event (β = -0.12; [-0.23, -0.001]), and we do not find evidence of an interaction between the two (β = -0.0004; [-0.17, 0.17]). We also calculated a Bayes Factor (BF) to compare models that included and did not include the interaction and did not find evidence for the inclusion of the interaction (BF_{10} = 0.29).

Based on a reviewer's suggestion we analyzed the proportion of time infants spent looking at the large character for test events that were shown first within each condition. While we did not find evidence for an effect of order in an exploratory model analysis (β = -0.08; [-0.16, 0.01]), when looking within conditions we found the following: In the distress test, we found strong evidence that infants looked longer at the large character in the touch condition (M = 0.73; SD = 0.28; BF_{10} = 27.87, and positive but insubstantial evidence that they looked longer at the large character in the no touch condition (M = 0.63; SD = 0.25; BF_{10} = 2.28). In the food test event, we did not find evidence that for the first trials infants looked longer at the large character in the touch condition (M = 0.50; SD = 0.25; BF_{10} = 0.22) or no touch condition (M = 0.48; SD = 0.33; BF_{10} = 0.23).

Infants were not more likely to look first at the large character in any of the conditions (66% of infants (28/43) looked first in the touch distress condition, BF_{10} = 1.32; $Frequency_{NoTouchDistress}$: 62% (28/46), BF_{10} = 0.53; $Frequency_{TouchFood}$: 39% (18/45), BF_{10} = 0.45; $Frequency_{NoTouchFood}$: 46% (20/43), BF_{10} = 0.21). Based on the confidence intervals, we do not find a main effect of touch condition (β = 0.20 [-0.69, 1.08]), test event (β = -0.64, [-1.54, 0.24]), or an interaction between the two (β = -0.50, [-1.81, 0.74]). However, we calculated a BF and found positive evidence for a model that includes an interaction (BF_{10} = 54.34).

[1] From here on out brackets means 95% Credible Interval

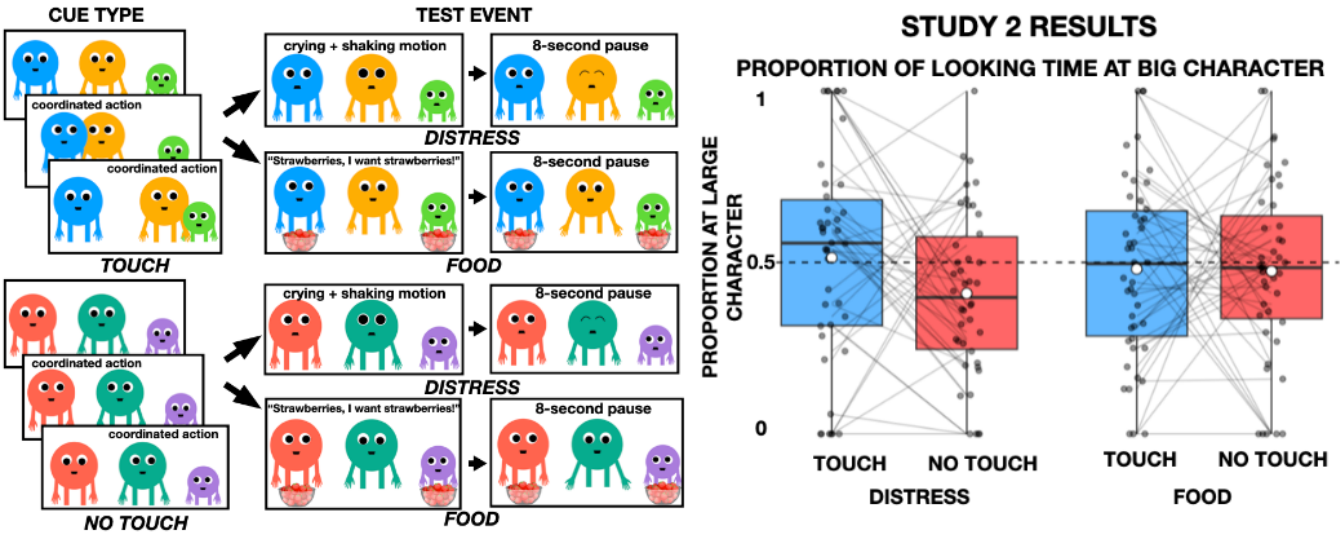

Figure 2: [LEFT] Stimuli shown to infants in Study 2. [RIGHT] Boxplots of the proportion of time that infants spent looking towards the larger character in Study 2. Solid black lines indicate medians, white dots indicate means, small gray dots indicate participants' individual data points, gray lines connect data points of the same participant.

Study 2

In Study 1, we found that infants used touch and size to predict responses to distress, in support of the hypothesis that infants represent caregiving relationships. In Study 2, we test the hypothesis that infants have expectations of asymmetrical behavior. To do so, we followed the same design as above, but the central character was the same size as the larger character. We reasoned that if infants have symmetrical expectations in these relationships, they should expect the smaller character to respond, if they make trait inferences (i.e., larger characters are more likely to respond to distress no matter the target) then they should expect the large character to respond, but if they have asymmetrical expectations they should be at chance.

Method

The methods and animations were the same as in Study 1, except in Study 2, the central character was large and flanked by one smaller character and one similarly large character (Figure 2).

Participants We tested 62 infants (from parental report: Mean Age_{days}=257.21; SD Age_{days}=22.22). Exclusion criteria were the same as in Study 1. We excluded data from sixteen infants who were too difficult to code, leaving a total of 46 participants whose data are included in the analysis. We double-coded 25% of all videos and achieved a reliability of 98%.

Results

Infants were equally likely to look at the larger and smaller characters (i.e., at chance) when the central large character expressed distress in the touch condition ($Mean_{TouchDistress}$: 0.51, [0.43, 0.60], BF_{10} = 0.17). We found very weak evidence that they looked more at the small character in the no touch condition ($Mean_{NoTouchDistress}$: 0.41, [0.33, 0.50], BF_{10} = 2.13 in favor of them looking more at the small character). We did not find evidence they looked more at the large character in the food test trials $Mean_{TouchFood}$: 0.48, [0.40, 0.56], BF_{10} = 0.18; $Mean_{NoTouchFood}$: 0.48, [0.39, 0.56], BF_{10} = 0.20). Consistent with our predictions, we did not find a main effect of touch (β = 0.10; [-0.01, 0.22]), test event (β = 0.07; [-0.05, 0.18]), or an interaction effect (β = -0.10; [-0.26, 0.06]). We also calculated a BF to compare models that included and did not include the interaction and did not find evidence for the inclusion of the interaction (BF_{10} = 0.01).

We also found that infants were no more likely to look first toward the large character in the touch condition than in the no touch condition when the central small character expressed distress or requested food (51% of infants (21/42) looked at the larger character first in the touch distress condition, BF_{10} = 0.19; $Frequency_{NoTouchDistress}$: 41% (16/41), BF_{10} = 0.51; $Frequency_{TouchFood}$: 48% (24/46), BF_{10} = 0.19; $Frequency_{NoTouchFood}$: 48% (16/43), BF_{10} = 0.75). Consistent with our predictions, we did not find a main effect of touch (β = 0.48; [-0.42, 1.38]), test event (β = -0.08; [-0.96, 0.86]), or an interaction effect (β = 0.17; [-1.11, 1.39]). We also calculated a BF to compare models that included and did not include the interaction and did not find strong evidence for the inclusion of the interaction (BF_{10} = 4.45).

General Discussion

The present studies sought to investigate infants' early representations of caregiving relationships. The findings support the hypothesis that infants see caregiving as an asymmetrical, intimate relationship. In Study 1, infants expected larger characters to respond only after observing affiliative touch, a cue of intimacy, but not after seeing a perceptually similar and similarly affiliative interaction that

did not involve this cue of intimacy. There was anecdotal evidence that infants looked more at the large character in the no touch condition when we considered only infants who saw the distress test event first. Therefore, planned studies will attempt to replicate the effect of touch in Study 1, as well as testing whether infants use touch compared to synchronization to make predictions about who will respond to distress. Likewise, there was anecdotal evidence that infants expected the small character to respond to the large character in the no touch condition in Study 2. Planned studies will investigate whether this result replicates. The results align with prior research indicating that infants can make inferences about relationships and predict responses to distress in social interactions (Spokes & Spelke, 2017; Thomas, Saxe, et al., 2022; Thomas, Woo, et al., 2022). To our knowledge, these results are the first to systematically show that infants distinguish between affiliative touch and synchronized action. Finally, these results suggest that infants recognize roles in caregiving relationships, in which the caregiver responds to the distress of the target of care, but the target of care does not respond to the distress of the caregiver.

These findings align with the real-world dynamics of caregiving relationships. First, caregiving relationships often involve social intimacy. Second, caregivers are larger than infants, and take on the responsibility of responding to the needs of infants. Infants did not expect responses to food requests, which suggests an intriguing aspect of their understanding of care. Infants may recognize responses to distress as especially indicative of caregiving relationships but not provisioning of food. This may match up with real-world expectations in which food-sharing occurs across many types of positive relationships, including tit-for-tat relationships, which are markedly different from caregiving ones. Relatedly, most infants' caloric intake comes from breastfeeding or bottle feeding, which involves physical touch, and thus they may not recognize resource distribution as an aspect of caregiving. Comforting, by contrast, may be seen as an intimate act. It is possible, however, that infants did not recognize the request for food as such. Further studies could investigate whether infants indeed recognize this request as meaningful and have expectations in other contexts about responses to the request.

One interesting question about these studies is to consider the cue of size with respect to previous findings. Across species, size is not only a cue of age but also of dominance. Larger individuals are often dominant because they can inflict harm on smaller individuals, and it is in the best interest of smaller individuals to yield. Even in legitimate authority relationships, higher ranked individuals are often made to appear larger, by sitting in thrones, wearing headdresses etc., even if they are not physically larger than others (refer to Fiske, 1992 for a review). One interesting question is whether infants use size flexibly to recognize both caregiving relationships and ranked relationships, or if they see the relationships across these studies as similar. That is, larger characters are not only more likely to provide comfort to their intimate partners, but also are more likely to prevail in conflicts, but that the underlying relationship inference is the same. While infants only made the prediction after observing affiliative touch, touch is interestingly also part of the conflict scenes in prior work. However, the touch there is antagonistic. If infants distinguish between these ways of touching, then it would suggest that infants use the cue of size flexibly to recognize either dominance or caregiving.

There are limitations to these studies. The use of animated displays, while a common and controlled method, may have limitations in ecological validity. Additionally, our participants were from one geographical region, differences in experienced childcare may affect expectations.

Ultimately, the present studies shed light on infants' early abilities to recognize and form expectations about caregiving relationships. Specifically, they used affiliative touch and physical size to recognize these relationships. These findings contribute to the broader understanding of early social cognition and set the stage for further exploration into the intricate mechanisms underlying infants' perception of caregiving dynamics.

Acknowledgments

We thank the families who participated, Denisse Flores-Lopez for assistance with data collection and creating presentations, the Cambridge Writing Group and Harvard Laboratory for Developmental Studies for feedback, and ChildrenHelpingScience.com for support with recruitment. The first author was supported by the Harvard University Stimson Fund.

References

Bennett, M. R., & Einolf, C. J. (2017). Religion, altruism, and helping strangers: A multilevel analysis of 126 countries. *Journal for the Scientific Study of Religion, 56*(2), 323-341. https://doi.org/10.1111/jssr.12328

Billingsley, J., Boos, B., & Lieberman, D. (2019). What evidence is required to determine whether infants infer the kinship of third parties? A commentary on Spokes and Spelke (2017). *Cognition, 191*, 103976-103976. https://doi.org/10.1016/j.cognition.2019.05.013

Burke, N., Brezack, N., & Woodward, A. (2022). Children's social networks in developmental psychology: A network approach to capture and describe early social environments. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.1009422

Bürkner, P.C. (2017). Brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software, 80*(1). https://doi.org/10.18637/jss.v080.i01

Cheney, D. L., & Seyfarth, R. M. (1990). *How monkeys see the world: Inside the mind of another species*. University of Chicago Press.

Cheney, D. L., Silk, J. B., & Seyfarth, R. M. (2016). Network connections, dyadic bonds and fitness in wild female baboons. *Royal Society Open Science, 3*(7), 160255-160255. https://doi.org/10.1098/rsos.160255

Datavyu Team (2014). *Datavyu: A Video Coding Tool*. Databrary Project, New York University. URL http://datavyu.org

Dunbar, R. I. M. (2010). The social role of touch in humans and primates: Behavioural function and neurobiological mechanisms. *Neuroscience and Biobehavioral Reviews, 34*(2), 260- 268. https://doi.org/10.1016/j.neubiorev.2008.07.001

Elsner, C., Bakker, M., Rohlfing, K., & Gredebäck, G. (2014). Infants' online perception of give- and-take interactions. *Journal of Experimental Child Psychology, 126*(100), 280-294. https://doi.org/10.1016/j.jecp.2014.05.007

Fiske, A. P. (1992). The four elementary forms of sociality: Framework for a unified theory of social relations. *Psychological Review, 99*(4), 689–723. https://doi.org/10.1037/0033- 295X.99.4.689

Geraci, A., & Surian, L. (2011). The developmental roots of fairness: Infants' reactions to equal and unequal distributions of resources. *Developmental Science, 14*(5), 1012-1020. https://doi.org/10.1111/j.1467-7687.2011.01048.x

Gopnik, A. (2023). Caregiving in philosophy, biology & political economy. *Daedalus (Cambridge, Mass.), 152*(1), 58-69. https://doi.org/10.1162/daed_a_01961

Hamlin, J. K., Wynn, K., & Bloom, P. (2007). Social evaluation by preverbal infants. *Nature, 450*(7169), 557-559. https://doi.org/10.1038/nature06288

Harlow, H. F., & Zimmermann, R. R. (1958). The development of affectional responses in infant monkeys. *Proceedings of the American Philosophical Society, 102*(5), 501-509.

Helfrecht, C., Roulette, J. W., Lane, A., Sintayehu, B., & Meehan, C. L. (2020). Life history and socioecology of infancy. *American Journal of Physical Anthropology, 173*(4), 619-629. https://doi.org/10.1002/ajpa.24145

Hrdy, S. B. (2009). *Mothers and Others: The Evolutionary Origins of Mutual Understanding*. Harvard University Press.

Hrdy, S. B., & Burkart, J. M. (2020). The emergence of emotionally modern humans: Implications for language and learning. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences, 375*(1803), 20190499-20190499. https://doi.org/10.1098/rstb.2019.0499

Hrdy, S. B., & Burkart, J. M. (2022). How Reliance on Allomaternal Care Shapes Primate Development with Special Reference to the Genus Homo. In *Evolutionary Perspectives on Infancy*. Springer International Publishing. https://doi.org/10.1007/978- 3-030-76000-7_8

Hung, M. S., Thomas, A. J., Radkani, S., Tenenbaum, J., & Saxe, R. (2022). Modeling risky food sharing as rational communication about relationships. In *Proceedings of the annual meeting of the cognitive science society*.

JASP Team (2024). JASP (Version 0.18.3) [Computer software]

Jin, K., Houston, J. L., Baillargeon, R., Groh, A. M., & Roisman, G. I. (2018). Young infants expect an unfamiliar adult to comfort a crying baby: Evidence from a standard violation- of-expectation task and a novel infant-triggered-video task. *Cognitive Psychology, 102*, 1-20. https://doi.org/10.1016/j.cogpsych.2017.12.004

Johnson, S. C., Dweck, C. S., & Chen, F. S. (2007). Evidence for infants' internal working models of attachment. *Psychological Science, 18*(6), 501-502. https://doi.org/10.1111/j.1467-9280.2007.01929.x

Kudrnova, V., Spelke, E., & Thomas, A. J. (2023, January 31). Infants Infer Social Relationships between Individuals who Engage in Imitative Social Interactions. https://doi.org/10.31234/osf.io/zuwpc

Levine, R. V., Norenzayan, A., & Philbrick, K. (2001). Cross-cultural differences in helping strangers. *Journal of Cross-Cultural Psychology, 32*(5), 543-560. https://doi.org/10.1177/0022022101032005002

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50*(4), 370–396. https://doi.org/10.1037/h0054346

Miller, L., Rozin, P., & Fiske, A. P. (1998). Food sharing and feeding another person suggest intimacy; two studies of american college students. *European Journal of Social Psychology, 28*(3), 423-436. https://doi.org/10.1002/(SICI)1099-0992(199805/06)28:3<423::AID-EJSP874>3.0.CO;2-V

Powell, L. J., & Spelke, E. S. (2013). Preverbal infants expect members of social groups to act alike. *Proceedings of the National Academy of Sciences - PNAS, 110*(41), E3965-E3972. https://doi.org/10.1073/pnas.1304326110

Powell, L. J., & Spelke, E. S. (2018). Human infants' understanding of social imitation: Inferences of affiliation from third party observations. *Cognition, 170*, 31-48. https://doi.org/10.1016/j.cognition.2017.09.007

Powell, L. J. (2022). Adopted utility calculus: Origins of a concept of social affiliation. *Perspectives on Psychological Science, 17*(5), 1215-1233. https://doi.org/10.1177/17456916211048487

R Core Team (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Schmidt, M. F. H., & Sommerville, J. A. (2011). Fairness expectations and altruistic sharing in 15-month-old human infants. *PloS One, 6*(10), e23223-e23223. https://doi.org/10.1371/journal.pone.0023223

Seyfarth, R. M., & Cheney, D. L. (2000). Social awareness in monkeys. *American Zoologist, 40*(6), 902-909. https://doi.org/10.1093/icb/40.6.902

Silk, J., Cheney, D., & Seyfarth, R. (2013). A practical guide to the study of social relationships. *Evolutionary Anthropology, 22*(5), 213-225. https://doi.org/10.1002/evan.21367

Silk, J. B., Seyfarth, R. M., & Cheney, D. L. (2016). Strategic use of affiliative vocalizations by wild female baboons. *PloS One, 11*(10), e0163978-e0163978. https://doi.org/10.1371/journal.pone.0163978

Silk, J. B. (2021). The phylogenetic roots of human kinship systems. *Biological Theory, 16*(3), 127-134. https://doi.org/10.1007/s13752-020-00349-4

Sorokowska, A., Saluja, S., Sorokowski, P., Frąckowiak, T., Karwowski, M., Aavik, T., Akello, G., Alm, C., Amjad, N., Anjum, A., Asao, K., Atama, C. S., Atamtürk Duyar, D., Ayebare, R., Batres, C., Bendixen, M., Bensafia, A., Bizumic, B., Boussena, M., . . . Croy, I. (2021). Affective interpersonal touch in close relationships: A cross-cultural perspective. *Personality & Social Psychology Bulletin, 47*(12), 1705-1721. https://doi.org/10.1177/0146167220988373

Spelke, E. (2022). *What babies know*. First Edition New York, New York: Oxford University Press.

Spokes, A. C., & Spelke, E. S. (2017). The cradle of social knowledge: Infants' reasoning about caregiving and affiliation. *Cognition, 159*, 102-116. https://doi.org/10.1016/j.cognition.2016.11.008

Sullivan, R., Perry, R., Sloan, A., Kleinhaus, K., & Burtchen, N. (2011). Infant bonding and attachment to the caregiver: insights from basic and clinical science. *Clinics in perinatology, 38*(4), 643–655. https://doi.org/10.1016/j.clp.2011.08.011

Suvilehto, J. T., Glerean, E., Dunbar, R. I. M., Hari, R., & Nummenmaa, L. (2015). Topography of social touching depends on emotional bonds between humans. *Proceedings of the National Academy of Sciences - PNAS, 112*(45), 13811-13816. https://doi.org/10.1073/pnas.1519231112

Suvilehto, J. T., Nummenmaa, L., Harada, T., Dunbar, R. I. M., Hari, R., Turner, R., Sadato, N., & Kitada, R. (2019). Cross-cultural similarity in relationship-specific social touching. *Proceedings of the Royal Society. B, Biological Sciences, 286*(1901), 20190467- 20190467. https://doi.org/10.1098/rspb.2019.0467

Suvilehto, J.T., Cekaite, A. & Morrison, I. The why, who and how of social touch. *Nat Rev Psychol 2*, 606–621 (2023). https://doi.org/10.1038/s44159-023-00217-5

Tatone, D., Geraci, A., & Csibra, G. (2015). Giving and taking: Representational building blocks of active resource-transfer events in human infants. *Cognition, 137*, 47-62. https://doi.org/10.1016/j.cognition.2014.12.007

Tatone, D., & Csibra, G. (2020). Infants infer different types of social relations from giving and taking actions. In *CogSci*.

Thomsen, L., Frankenhuis, W. E., Ingold-Smith, M., & Carey, S. (2011). Big and mighty: Preverbal infants mentally represent social dominance. *Science (American Association for the Advancement of Science), 331*(6016), 477-480. https://doi.org/10.1126/science.1199198

Thomas, A. J., Saxe, R., & Spelke, E. S. (2022). Infants infer potential social partners by observing the interactions of their parent with unknown others. *Proceedings of the National Academy of Sciences - PNAS, 119*(32), e2121390119–e2121390119. https://doi.org/10.1073/pnas.2121390119

Thomas, A. J., Steele, C., Saxe, R., & Gopnik, A. (in press). *How do infants experience caregiving?* Daedalus 2025: The Social Science of Caregiving.

Thomas, A. J., Woo, B., Nettle, D., Spelke, E., & Saxe, R. (2022). Early concepts of intimacy: Young humans use saliva sharing to infer close relationships. *Science (American Association for the Advancement of Science), 375*(6578), 311-315. https://doi.org/10.1126/science.abh1054

Tibbetts, E. A., Pardo-Sanchez, J., & Weise, C. (2022). The establishment and maintenance of dominance hierarchies. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences, 377*(1845), 20200450-20200450. https://doi.org/10.1098/rstb.2020.0450