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Perceptual-cue-based mechanisms for recognizing social agents and their roles in social interactions

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Abstract:	Thomas proposes the existence of core knowledge that supports an innate, or early developing, intuitive theory, where social relationships are understood in reference to three models: communal sharing, authority ranking, and equality matching. We consider possible precursor-representations that could support infants' discovery of relationships in the social world, and how these representations relate to the basic models discussed by Thomas.

Commentary to "Cognitive representations of Social Relationships and their developmental origins"

01. AUTHOR OF THE TARGET ARTICLE: Ashely Thomas

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10. **Abstract (60 words)**

Thomas proposes the existence of core knowledge that supports an innate, or early developing, intuitive theory, where social relationships are understood in reference to three models: communal sharing, authority ranking, and equality matching. We consider possible precursor-representations that could support infants' discovery of relationships in the social world, and how these representations relate to the basic models discussed by Thomas.

11. **Main text (991 words)**

The first requirement for understanding relationships is to recognize that individuals are connected. We propose that this process relies on a set of perceptual-cue-based mechanisms underlying a distinctive representation of *social agents* (i.e., agents engaged in a social relationship) *vs.* agents in general, and the assignment of social agents to roles in a relationship. Recent findings demonstrate that these mechanisms are already functional in the first months of life.

In one line of experiments (Goupil et al., 2022; 2024), we manipulated the interpersonal orientation of two individuals in a visual scene, so that it appeared that they could interact, either through *mutual accessibility* (face-to-face) or *transitive accessibility* (face-to-back: one faces another who faces away), or they could not interact (back-to-back: neither could access the other) (Fig. 1A). Taking differential looking times as an index of categorization of visual stimuli (Spriet et al., 2022), we found that 6-month-olds looked for a similar amount of time at face-to-face and face-to-back dyads, and significantly longer at back-to-back dyads. These effects, ruled out for scenes involving inanimate objects, showed that, much earlier than previously reported (Beier & Spelke, 2012), infants are sensitive to visual cues (e.g., interpersonal orientation) that distinguish social *vs.* non-social agents, or imply presence *vs.* absence of social relationship.

Further research showed that 7-month-olds use visual information not only to identify a social relationship but also to distinguish different roles in the relationship. In another study (Papeo et al., 2024), we manipulated body postures, so that, in a sequence of different scenes featuring two people face-to-face, person A always *looked like the agent* (the one who acts) and person B always *looked like the patient* (the one to whom the action is directed). In a minority of 'oddball' trials, roles, cued by the postures, were reversed: B appeared in agent-like postures, A appeared in patient-like postures (Fig. 1B). Increased pupil dilation in oddball trials, measured by eye-tracking, suggested that infants were surprised by the role switch (see Papeo et al., 2024, for a replication with the habituation paradigm).

First, these results show that infants encoded the agent and the patient in each particular scene. In doing so, they assigned A and B to the *abstract* categories of *agent* and *patient*, which could generalize across the different situations depicted in different trials. Moreover, since the surprise response in role-switch trials disappeared when individuals were represented as unrelated (back-to-back), these results suggest that what infants were representing was not just each individual's trait but one's role *in relation* to another. In other words, although, based on postures, infants could represent an individual as agent-like or patient-like (or more or less dynamic), the effect specific to the relational (face-to-face) context indicates representation of relationship rather than the individuals' traits.

The results discussed so far are likely to characterize the mechanisms in the first of the three central components of Thomas' intuitive theory of relationships, that is, the mechanisms to detect a social relationship (Thomas, 2025). However, infants' representation of agent-patient relationship also intrudes into the second component that specifies the relationship: communal sharing, authority ranking, or equality matching. *Where does the agent-patient relationship fit into the other three models proposed by Thomas?*

Roles such as agent and patient are regarded as universal components of core cognition (Carey, 2009; Rissman & Majid, 2019) and the agent-patient relationship, as a general structure to organize language (sentences) and thoughts (Strickland et al., 2012). Moreover, agent-patient exchanges (e.g., in physical or communicative interactions) can provide information about individuals' dispositions and their social relationships (e.g., whether two are friends, rivals, etc.), which can allow predicting future interactions between the same individuals or with others (Stavans & Csibra, 2023). The agent-patient relationship is an asymmetric social relationship, similar to authority ranking. In effect, it cannot be excluded that in Papeo et al. (2024), infants' representation of agent and patient overlapped with the representation of a dominant and a non-dominant individual. If so, this implies that certain postures (more dynamic and leaning forward) or certain orientations (those that allow perceptual access to another) can work as cues of formidability, analogous to physical size. Another possibility is that the agent-patient relationship provides a general framework, and the models of relationship discussed in Thomas fall out of this relational structure that emerges early in infancy. Hypothetically, different agent-patient dynamics might prompt the distinction between authority ranking on the one hand, and communal sharing and equality matching on the other hand. In authority ranking, individuals tend to be assigned to fixed roles, either agent or patient. The other two models of relationships, where individuals regularly swap and alternate roles (e.g., in giving-taking exchanges), might be distinguished by the 'level' of reciprocity (higher in equality matching), and additional intimacy cues (for community sharing).

At the implementation level, in adults, the processing of visual events characterized by interpersonal cues (postures and orientation) has been associated with neural activity in visual areas along the lateral occipitotemporal cortex (LOTC) to the posterior superior temporal sulcus (pSTS) (Abassi & Papeo, 2024; Gandolfo et al., 2024; McMahon et al., 2023; Walbrin &

Koldewyn, 2019). Recently, using functional near-infrared spectroscopy, we have observed a selective response to visual social interactions in LOTC/pSTS, in infants as young as 6 and 10 months, (Mello et al., 2025; Fig. 1C). This is interesting as it suggests a model where social relationships –at least those that are visually available and display the canonical cues of social engagement– are initially extracted via bottom-up visual processing (see also Malik & Isik, 2023).

If the effects of postures and orientation are captured by LOTC/pSTS activity, and if this neural processing is available early in development, it is plausible that the literature reviewed here characterizes the initial components of Thomas' intuitive theory of relationships, where social relationships are detected –and initially understood in terms of agent-patient dynamics.

12. COMPETING INTERESTS: The authors declare none

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14. REFERENCE LIST

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Figure caption

Fig. 1. A) Examples of face-to-face, face-to-back and back-to-back dyads (stimuli adapted from Goupil et al., 2022). B). Examples of agent-patient dyads used in Papeo et al. (2024). Displayed is a sequence of scenes where the boy always looked like the agent and girl always looked like the patient (grey squares), with oddball trials (red square) in which the postures implied a role switch (the girl looked like the agent and the boy looked like the patient). C) Brain response to viewing third-party social interactions in adults (n=20), 10- (n=21) and 6-month-old infants (n=20). Displayed are the group-averaged oxygenated hemoglobin (oxy-Hb) responses measured with event-related functional near-infrared spectroscopy during the presentation of animations of face-to-face (interacting) vs. back-to-back (non-interacting) body dyads. Red areas indicate significantly stronger response to face-to-face dyads; blue areas indicate significantly stronger response to back-to-back dyads. Face-to-face (*vs.* back-to-back) dyads recruited the bilateral middle occipital cortex, the middle/superior temporal cortex and the temporoparietal junction, in both adults (16 out of 37 channels) and 10-month-old infants (8 out of 39 channels), and the middle occipital cortex and temporoparietal junction in 6-month-olds (1 out of 39 channels). Channels have been projected onto the cortical surface using MNI brain space for reference.

Figure 1