

## DEVELOPMENTAL SCIENCE REVIEW

# The foundations of psychological understanding

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### Abstract

*In this paper, I review some recent submissions to Developmental Science that advance our understanding of psychological development. More and more submissions to the journal explore the origins of knowledge and, for psychological knowledge, such origins are multiple. Here I consider the contribution of mechanisms such as contingency detection, gaze following and gaze monitoring, social referencing and joint attention to emergent psychological understanding. I also consider infant understanding of goal-directed action, and the intimate connection between language acquisition and psychological development. The centrality of intention-reading skills to both language and social cognition is highlighted.*

What is really exciting in current developmental science? I propose that we are in the decade of the baby. More and more submissions to *Developmental Science* explore the *origins* of physical, biological and psychological knowledge in the human mind. There are also vigorous theoretical debates. For example, what are the origins of conceptual thought? (Mandler, 2004; and commentaries by Nelson, 2004; Shutts & Spelke, 2004; Quinn, 2004; Murphy, 2004). Do infants *reason* about physical events such as occlusion and containment during the first year of life? (Baillargeon, 2004; and commentaries by Hood, 2004; Leslie, 2004; Bremner & Mareschal, 2004). Increasingly ingenious paradigms are being devised to investigate these questions in babies of younger and younger ages. In writing the current review, I have therefore had to be selective, and so I have decided to focus on the growth of *psychological* understanding. Relatively early on, humans become able to understand that other humans have unobservable things called minds, and that their actions and behaviours can be predicted by the knowledge and beliefs that they hold in these minds. Early developments such as viewing actions as goal directed, joint attention, gaze following and social referencing help the infant to attribute mental states to others. Language, too, plays an important role. Eventually, infants become able to distinguish different types of intentional action, and gain some understanding of true and false beliefs. Is the individual mind the main driver in the infant's attainment of an understanding of mental states? Or is the process a more social one, with psychological development dependent on cultural imitative learning and 'collective

intentionality'? (Rakoczy, Tomasello & Striano, 2005). Let us consider some evidence.

### Contingency detection

One reason that infants may develop psychological understanding relatively early in life is that their caretakers treat them as social partners. When caring for infants, we often make our behaviour contingent upon, rather than ignoring of, their attempts to communicate. In fact, mothers may treat their infants as acting communicatively even before infants are intentionally acting in this way (Meins, Fernyhough, Wainwright, Das Gupta, Fradley & Tuckey, 2002). The question of how early infants become sensitive to social contingencies was addressed by Striano, Henning and Stahl (2005).

In their study, 1- and 3-month-old babies interacted face to face with their mothers, in three types of maternal contingency situation. In their first visit to the laboratory, all mothers were instructed to interact with their infants 'as they normally did'. The infants and mothers faced each other with eyes 50 cm apart, and 3 minutes of interaction were recorded. In a second visit a week later, three different contingencies were experienced, for one minute each. *Normal* interaction was as on the previous visit. *Non-contingent* interaction required the mother to reprise 1 minute of her interaction from the previous visit. For this condition, the mothers wore headsets that played them 1 minute of their interaction from the prior week, which they reproduced. The third *Imitation*

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interaction required the mother to mirror their infants' facial expressions, arm/hand gestures and vocalizations. Gazing and smiling by the infant was recorded during each of the contingencies. The older infants received 3 minutes of each contingency.

Striano and her colleagues reported that the 1-month-olds did not distinguish between the different contingencies. Gazing and smiling by the infant did not differ across the three conditions. By 3 months of age, however, the infants were behaving differently in response to the different contingencies. They showed more gazing in the Imitation condition, and more smiling in the Normal interaction condition. Striano *et al.* argued that infants were sensitive to social contingencies by 3 months of age. As suggested originally by Watson and his colleagues (Watson, 1994; Gergely & Watson, 1996), the ability to detect contingencies may be an important mechanism in the development of a primary representation of the self. Given that the findings for the 1-month-olds in this study depended on a null result (no difference between the three conditions), it is possible that social contingencies are detected even before 3 months of age by some babies.

### Understanding actions as goal-directed

The understanding of goal-directed action is another fundamental social-cognitive skill. As pointed out by Carpenter, Call and Tomasello (2005), understanding of a person's goals transforms a series of meaningless bodily motions into intentional and purposive behaviour. Particularly strong evidence for infant understanding of goal-directed action comes from studies in which infants view agents making identical actions. Only a change in the context within which the action occurs suggests a change in goal. How early do infants use contexts to determine goals? Carpenter *et al.* (2005) devised an imitation paradigm to find out. They explored 12- and 18-month-old infants' understanding of hopping and sliding actions made by an actor with a toy mouse.

In the experiment, the infants watched a toy mouse making a distinctive hopping or sliding journey across a mat. In the hopping journey, the adult experimenter made the mouse cross the mat in a series of eight jumping actions, with suitable hop noises ('bee' 'bee' 'bee' . . .). In the sliding journey, the mouse was made to cross the mat in one long slide ('beeeeeeeee'). In one condition, the mouse ended its journey by being put into a little house on the other side of the mat. The journey followed a straight line into one of two possible goal houses. In the second condition, no houses were present. In this condition, the experimenter appeared to be making the mouse hop or jump just for the fun of the action. The

question was what the infants would imitate in each condition. Would they put the mouse straight into the goal house in the first condition, but jump or slide the mouse across the mat in the second?

In the test trials, the infants were simply handed the mouse and told 'Now you'. Carpenter *et al.* (2005) reported that the infants in the House condition were significantly less likely to imitate the action style of the adult at both ages compared to the infants in the No House condition. The majority of infants in the House condition simply put the mouse into the correct house. In contrast, the majority of the older infants in the No House condition made the mouse hop or slide across the mat. Carpenter *et al.* argued that the infants were interpreting the actions of the adult in terms of her assumed goals. They were analysing the ends and means of her actions, and choosing to imitate either 'putting the mouse in the house' or 'making the mouse hop up and down'.

### Goal-directed human action and the attribution of mental states

In fact, there is increasing evidence that infants view the actions of human agents as goal-directed from as early as 3 months of age (Woodward, 1998; Sommerville, Woodward & Needham, 2005). For example, they are most attentive to actions on toys when human agents have novel goals. A rich interpretation of this prioritizing of goal-directed actions would attribute an emergent understanding of the mental states of the agent to the infant. According to this viewpoint, the infant prefers to watch these actions because of a growing understanding that the agent has certain goals, and that figuring out these goals might provide useful clues to their current mental states and enable prediction of their behaviour. An alternative theoretical position is that infants adopt a 'teleological stance' to the representation of action (Gergely & Csibra, 2003). Explanations that are teleological depend on the relevant aspects of the actual situation rather than on causal explanatory analyses of the mental states of agents. Such accounts would predict that infants also attribute goals to the actions of non-human objects which appear to display intentional behaviour. The interesting question of how infants identify the psychological actors in their environments was addressed by Shimizu and Johnson (2004).

Shimizu and Johnson adapted Woodward's (1998) looking time paradigm to incorporate non-human objects that behaved as though they were agents. In the critical experimental condition, a novel faceless green oval object behaved in self-propelled ways that appeared intentional.

For example, it acted as though it could interact with its social environment, beeping contingently in response to small talk from the experimenter. It also acted as though it could choose between the relative merits of two toys, deliberately turning away from one and approaching the other. Infants aged 12 months participated in one of three conditions. In one condition, a human hand performed grasping actions on one of two toys. In the second, the Agent-Object beeped to the infant, and then repeatedly approached one of the toys. In the third condition, the same green object was first shown behaving in a random and non-intentional way, and then repeatedly approached one of the toys exactly as in the Agent-Object condition.

Following habituation, the human hand or the green object either performed the same action as before, but to a new toy (as the location of the two toys had been switched), or performed a novel action by reaching to the old toy in the new location. Woodward (1998) had reported increased looking by infants when the human hand performed a familiar action with a novel goal, but not when a cardboard tube did the same thing. Shimizu and Johnson replicated this effect for the human hand, but found the same effect for the Agent-Object. When the green oval object had been introduced as though it was capable of intentional behaviour, infants watched longer when it performed a familiar action with a novel goal than when it performed a novel action with a familiar goal. Infants who saw the same green oval object in the Non-Agent condition did not differentiate between the two events. Shimizu and Johnson argued that infants do attribute goals to non-human agents, thereby supporting a lean rather than a rich interpretation of infant sensitivity to goal-directed action. They suggested that infants might have an evolutionarily given system for detecting all sorts of agents. This would be a mechanism given to the individual mind. However, they also noted that current evidence for intentional attributions to people comes also from gaze following and other paradigms. These paradigms, too, have been the subject of recent papers in *Developmental Science*.

## Gaze following and gaze monitoring

A mentalistic interpretation of infant gaze following behaviour would go as follows. 'That person is looking at something in particular. Let me look too, so that I can see what she/he is seeing. Let me understand what this person is thinking and feeling about what she/he sees, so that I can predict their behaviour.' By this kind of interpretation, seeing is a mental act. Brooks and Meltzoff (2005) explored gaze following behaviour in infants aged

9, 10 and 11 months. They argued that if infants were truly *gaze* following, they would look at the person's target significantly more often when the person's eyes were open. If infants were simply following the direction of a person's head movement as a cue to an interesting event (see Corkum & Moore, 1998), then they should follow gaze even if the person 'gazing' had their eyes shut.

To test this idea, Brooks and Meltzoff (2005) used two conditions in a looking experiment with young infants, *open-eyes* and *closed-eyes*. In each case, an experimenter made eye contact with the infant, who was sitting opposite on their mother's lap. She then silently turned her head towards a target. In the closed-eyes condition, she first closed her eyes before performing this movement. The 10- and 11-month-old infants almost only looked at the target when the experimenter's eyes were open. They were also more 'talkative' in this condition, producing many spontaneous vocalizations. The 9-month-olds did not distinguish the two conditions. Correct interpretation of gaze + vocalization at 10–11 months predicted language comprehension at 14 and 18 months. Brooks and Meltzoff suggested that infants who were advanced in recognizing the connection between looker and object might have an advantage in using gaze to disambiguate the referent of linguistic utterances. Psychological development and language development are clearly linked.

Another way to measure infants' understanding of the looking behaviour of adults is to see whether they will move their viewing position if an adult is gazing at something behind a barrier, out of view of the infant. Moll and Tomasello (2004) investigated this question with 12- and 18-month-old infants. In their experiment, four different barrier situations were studied (a dividing wall, a cardboard box, an open filing cabinet, a wooden panel). All of the barriers blocked the child's line of sight, and had fixed positions in the testing room. In the experimental trials, an attractive toy was hidden behind one of the barriers. The experimenter looked behind the barrier, and said 'Oh!' in an excited fashion. She gazed behind the barrier for about 3 seconds, and then looked back at the child. In the control trials, the experimenter gazed at a toy that was in full view of the child on a wall. She again said 'Oh' in an excited fashion. The question of interest was whether the child would move to look behind the barrier.

Moll and Tomasello found that all the babies were significantly more likely to crawl around to look behind the barrier in the experimental trials than in the control trials. The 18-month-olds did this in more trials overall than the 12-month-olds. Although the objects that the adult was gazing at were initially out of the infants' view, even the 12-month-olds wanted to see what the adults

were seeing. Moll and Tomasello concluded that 12-month-olds understood seeing as a mental act. They argued that epistemologically, infants know that others see things like they themselves do.

## Joint attention

Joint attention has long been recognized as a fundamental mechanism for psychological development. Joint attention episodes have been called 'hotspots' for learning, linking also to advances in language development and in pretend play (see Tomasello, 1995). Joint attention is characterized by triadic exchanges involving a social partner and an object. Bigelow, MacLean and Proctor (2004) argued that sustained joint attention indicates infants' understanding of others as intentional beings, like themselves, whose attention to objects may be shared, followed or directed. Bigelow and her colleagues therefore examined the effects of joint attention on infants' play with objects. Infants were expected to show increases in more advanced play during episodes of joint attention.

The infants studied were aged 12 months, the age at which infants begin to be intentional in their play with objects: rather than simply sucking or banging objects, infants now begin to attend to the specific functional uses of their toys, and play gradually becomes symbolic. Bigelow *et al.* provided some enticing objects for the infants to play with, including a tea set, a doll with her bed, and a toy telephone. Following a period of free play by the infants alone, mothers and infants were encouraged to play as they normally would. Infants' activities with the toys were then scored in both conditions. Bigelow *et al.* found that the infants had significantly more advanced play within joint attention episodes, and significantly more stereotyped play outside joint attention episodes. They argued that mature play hence depended on more than simply the presence of the mother. Adult scaffolding of play within joint attention episodes had a particular effect on symbolic development. This supports Rakoczy *et al.*'s (2005) ideas about the potential importance of 'collective intentionality' in pretend play and psychological development.

## Social referencing

Social referencing is using the behaviour of others as a guide to how to respond yourself to novel objects or events in the world. The emotional expressions and behaviours of others in a given situation are used to regulate your own responses accordingly. Vaish and

Striano (2004) used an old apparatus called the 'visual cliff' to explore the potential importance of the context in which social referencing takes place. The visual cliff is an apparatus in which a plexiglass surface provides invisible support across an apparent drop. Vaish and Striano placed 12-month-old infants on a visual cliff with a 28-cm 'drop'. They were interested in the relative influence of visual versus vocal cues in potentially threatening situations. All infants placed onto the visual cliff looked up to their mothers after looking down at the drop. The mother was then instructed to act according to one of three possible conditions.

In the *Face + Voice* condition, the mother faced the infant across the cliff, smiled, and vocalized to her infant to encourage him/her to cross the drop. In the *Face Only* condition, the mother faced the cliff and smiled and nodded to her infant. In the *Voice Only* condition, the mother had her back to the cliff, but vocalized to encourage the infant to cross the drop. Vaish and Striano measured the time that it took the infant to cross the visual cliff. Infants in the *Face + Voice* condition crossed fastest, taking around a minute. Infants in the *Voice Only* condition crossed next fastest, taking just under 2 minutes (a non-significant difference). Infants in the *Face Only* condition were slowest to cross, taking almost 4 minutes, significantly slower than the other two conditions. Language therefore plays an important mediating role in social referencing. The evolutionary advantage is clear. Vocal cues can be experienced even when the mother's face cannot be seen (e.g. if she is carrying you on her back). Vaish and Striano pointed out that infant sensitivity to vocal cues deserved greater attention in studies of the ontogeny of human social cognition. Obviously, from the point of view of the mother, vocal interaction is often the most direct way of guiding the responses of an infant.

## Psychological understanding and language

Research studies on topics such as gaze following (Brooks & Meltzoff, 2005) and social referencing are hence directing us towards the links between psychological understanding and language. These links comprise another clear theme in recent submissions to *Developmental Science*. For example, Courtin and Melot (2005) studied psychological understanding in deaf children, using theory of mind tasks. Deaf children, who lack oral language exposure, typically show marked delays in theory of mind tasks such as false belief tasks. Courtin and Melot demonstrated that native deaf signers (deaf children born to deaf parents, who use sign language to communicate from early in life) showed no delays in

psychological development as measured by these tasks. They argued that early exposure to language, be it signed language or oral language, facilitates social-cognitive development. Language enables communication about non-observable psychological mechanisms. Kuhl and her colleagues reported that young children with autism spectrum disorder, whose social-cognitive development is atypical, show atypical neural and behavioural responses to human language (Kuhl, Coffey-Corina, Padden & Dawson, 2005). Kuhl *et al.* found that children with ASD preferred to listen to non-human sounds. This is very different to young infants, for whom speech is the privileged signal (Vouloumanos & Werker, 2004).

One direct way in which language may facilitate psychological development is that family conversations about mental states are likely to be important in the normative development of an understanding of mind. Another way in which language and social cognition might be linked is that young children might infer the meanings of new words by attending to the context of discourse. By trying to understand what is in people's minds, they might use communicative intent to figure out word meanings. 'Collective intentionality' determines word meanings as well as social meanings. A given word only has a certain meaning because all speakers in a community treat it as having that meaning. This 'social-pragmatic' account of word learning differs from more mechanistic accounts, according to which children interpret word meanings from memory and attentional cues (Samuelson & Smith, 1998).

Diesendruck, Markson, Akhtar and Reudor (2004) contrasted the social-pragmatic and mechanistic accounts of word learning in a study of 2-year-olds. They argued that if infants and young children interpret the behaviour of other people in primarily psychological terms, then changes in context that highlight target objects should only lead to word learning when these changes are perceived as relevant to the speaker's communicative intent. In their study, the experimenter told the child that she was going to show her some things. She produced a novel object from a box, saying 'Look what I have here'. She then placed it in a pan, covered the pan and shook it, so that it made a noise. The pan was given to the child, who was encouraged to shake it and play with the object for 1 minute. The object was then returned to the box. Two more novel objects were introduced in the same fashion. The experimenter then produced a fourth object, but instead of putting it in the pan said, 'Come play with me over here', and moved to a table. At the table, she put the new object into a basket, and spun it around, handing the basket to the child. After a play period, child and adult then

moved back to their original location, and a puppet appeared. The puppet chatted with the child, and then the experimenter turned her attention to the box, exclaiming 'Look, there is a *teega* in here'. This novel label was repeated five times, and then all objects were taken from the box and played with. Finally, the objects were put back in the box, and the child was asked to select the *teega*. Ten out of 24 children chose the fourth object.

This condition was contrasted with two other conditions. In one, it was the puppet who looked in the box and exclaimed 'Look, there is a *teega* in here'. In this condition, only one out of 24 children chose the fourth object. In the other condition, the experimenter dropped the fourth object as she was taking it from the box, and it fell near the table. Hence the move to the table to play with the fourth object was accidental. In this condition, only three out of 24 children chose the fourth object. Diesendruck *et al.* argued that children only interpreted the novel name as referring to the object presented in a new context when the contextual change was intentional. They also only linked the novel name with the new context when the original experimenter provided the name rather than a different speaker who was new to the scene. Diesendruck *et al.* concluded that even a rudimentary understanding of the intentions and knowledge states of others is enough to support children's mapping of new words to referents. Children are sensitive to what speakers *intend* to label.

This selective review of recent papers in *Developmental Science* provides a flavour of the richness of current research on early language development and the development of psychological understanding. We can conclude that the two domains are inextricably linked. Further, diverse studies suggest that intention-reading skills play a key developmental role in both. Both language development and psychological development are inherently social activities, heavily scaffolded by adults, yet underpinned by mechanisms given to individual minds. For psychological development, these mechanisms include a perceptual system that prioritizes information from the eyes and information from action, particularly goal-directed action, and that is sensitive to contingency. Mechanisms such as these provide a means of detecting agents, and language is also involved – agents usually produce language (the contingent beeping of the Agent-Object in Shimizu and Johnson's study was probably important for the infants' attribution of agency). Another mechanism given to individual minds is the capacity for imitation (Meltzoff, 2002). As imitation is both individual and intrinsically social, it enables cultural imitative learning and facilitates the developing understanding of intentionality.

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