
The Body and the Self

edited by José Luis Bermúdez, Anthony Marcel, and
Naomi Eilan

A Bradford Book
The MIT Press
Cambridge, Massachusetts
London, England

1995

Infants' Understanding of People and Things: From Body Imitation to Folk Psychology

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Our interest is in the relation between the development of infants' understanding of physical objects and that of persons. We will suggest that the two are closely interwoven, so that infants' developing grasp of the nature of objects profoundly influences their idea of persons. We further suggest that newborns begin life with some grasp of people and of how people are like themselves.

Our approach to these issues is to study psychological development. Philosophers often consider abnormal patients and cultural universals as reference points in their analyses of mind. Infants have less often been considered. Nonetheless, infancy is a good place to look if one is interested in the origins of human knowledge. All adult minds were once infant minds. The nature of the infant's construal of the world and how it is revised to become the adult's conception should contribute to a fuller understanding of mind.

We suggest that accounting for infants' performance involving physical objects and persons requires that we recognize a progression through increasingly sophisticated concepts. This view stands in opposition to the idea that infants are born with adult concepts in full play (nativism) and to the idea that they start with only reflexes and have to bootstrap themselves up into anything remotely like our concepts (Piaget).

Although the idea of progression through increasingly sophisticated concepts has some intuitive appeal, the problem has always been to find the parameters to describe this development in ways that are both theoretically plausible and empirically valid. In what follows, we will first illustrate the parameters for explaining infants' progressive grip on the notion of a physical object. Then, through a consideration of imitation, we will show how there is, from the start, a special treatment of the movement of human bodies, and we will suggest parameters for describing infants' progressive grip on the concept of a person.

This essay has three major parts. First we analyze what infants understand a physical object to be. We examine the criteria infants use to maintain

object identity over successive perceptual contacts. We also examine infants' understanding of human bodies as a special case of physical objects and their grasp of the idea that their own bodies are like other human bodies. In the second part we analyze infants' developing conception of persons. We examine how infants distinguish human individuals and determine their particular identity. We also examine the development of infants' understanding of humans as bearers of psychological properties. In the third part we conclude by analyzing how the developments previously described might lead to a concept of the self as an entity in a world full of others and a concept of the other possessing a subjectivity as rich as the self.

1 Early Understanding of Physical Objects

Identity

How do infants interpret an object's entering into or exiting from their field of view as it moves, as their heads turn, or as they are carried from one place to another? The adult conception of "object" does that work for us. What is the infant's conception? There is reason to suggest that the infant's conception is quite different from the adult's. Our view is that (a) infants have concepts about objects, not simply lists of actions they perform on them, (b) these concepts undergo radical change, and (c) it is not a one-step, dichotomous change but rather successive cognitive restructurings that yield a causally related series of infant conceptions. This developmental view requires a careful use of language. Because the infants' earliest conceptions of objects are not the same as adults' but only early steps toward the mature attainment, we need a new word for object when it refers to the infant's conception. In this essay we call these "proto-objects."

These proto-objects do some of the work that the concept of an object does for adults, but they do not have all the properties of the adult's objects. Our use of the notion of proto-objects relates to certain philosophical considerations as to what it means to be a physical object or thing. In particular, Campbell (1993) has recently analyzed some distinctions between feature and object and between the internal causal connectedness inherent in objects and their spatiotemporal continuity. These distinctions seem to have some empirical reality in the world of infants. For example, we will show that infants can reidentify a proto-object as the same one across two encounters without their requiring that it followed a continuous space-time path between the encounters.

Our notion of proto-objects and how they relate to the mature adult notion differs from other psychological views of the "object concept" (as it is called in the psychological literature). It differs from that of Piaget (1954), who thought that there was no concept of object that remotely resembled

the adult notion during infancy (his theory focused on actions and the inseparability of objects from action), from that of Bower (1982), who thinks that young infants develop a concept of object but that only one important conceptual shift occurs (around 5 months of age), from that of Spelke (Spelke, Breinlinger, Macomber, and Jacobson 1992; Spelke and Van de Walle 1993), who thinks that infants innately hold the core adult conception of object with no significant change or overturning of this understanding, and from that of Baillargeon (1991, 1993), who attributes sophisticated knowledge about objects to young infants (like Spelke) but allows for cognitive development in certain aspects of physical reasoning to account for changes in performance.

For an adult, the flux of object appearances is organized by noting which of the many appearances are encounters with the same object. Thus an object seen at time t in place p may be identified as the same object when seen at t' in place p' by a rule for object identity. The identity referred to in this case is the object's unique or essential identity with itself and not featural sameness. No two objects, however exactly they may share the same features, are identical in this sense. Strawson (1959) calls this numerical or particular identity when it is the mature adult concept, and we call it "unique identity" when referring to the infant's less mature notion. We will argue that at different ages infants use different criteria for numerical identity, which suggests they are operating with distinct concepts of objects in development (hence the notion of proto-objects).

Three classes of events involving spatial transformations of objects seem to be significant for infants (Moore and Meltzoff 1978). Table 1 sum-

Table 1

Developmental levels in infants' understanding of unique (numerical) identity over spatial transformations of objects

| Level | Age (months) | Description of level | Examples of events for which an object's unique identity is maintained |
|-------|--------------|--|--|
| 1 | 0-4 | Identity is maintained for a steady state of the visual world. | Objects moving on a trajectory Objects staying at rest in a place |
| 2 | 5-8 | Identity is maintained for transformations of visible objects. | Objects in motion stopping Objects at rest starting to move |
| 3 | 9-18 | Identity is maintained for transformations producing occluded objects. | Objects disappearing in motion Objects disappearing at rest |

marizes this typology and the corresponding developmental changes in infants' understanding from birth to 18 months of age.

In our terms, the three levels display a developmental progression from proto-object to object. The first two levels are developmental changes within the realm of proto-objects; it is only by level 3, at about 9 months of age, that a notion of an object as such is achieved.

In the first 4 months of life, infants are concerned with the identity problems associated with the steady-state structure of the visual world: objects in motion continue in motion; objects at rest stay at rest. At this level, an infant's notion of object identity is that for each perceptual encounter, an object in motion is the same one at any point on its trajectory and an object in the same place is the same object.¹ At about 5 months of age there is a shift such that infants can solve identity problems associated with changes from the steady-state structure of the visual world. At this level, they have extended their notion of objects to encompass the idea that unique identity is maintained across visible transformations of visible objects, such as an object in motion stopping, a stationary object moving, etc. At about 9 months of age there is a third developmental change, one that allows them to make sense of identity problems associated with changes from the visible to the nonvisible world, the transformations producing occluded objects such as a stationary object being covered by a moving screen or a moving object going behind a stationary screen.²

Moore, Borton, and Darby (1978) investigated some predictions from this developmental sequence for the transition from level 2 to level 3. They designed an experiment that distinguished three rules for object identity that infants might employ when visually tracking a moving object as it disappeared and reappeared from behind an opaque screen: featural, spatio-temporal, and permanence. Adults use the permanence rule: we believe that the object remains permanent behind the screen when it is invisible and therefore that the pre- and posthidden object are the same one (provided there is no trickery). However, more primitive construals of object disappearances and reappearances can be imagined. The experiment was designed to diagnose whether infants conceived of objects according to the permanence rule or whether they operated with only proto-objects and hence lacked this belief. Figure 1 provides a schematic diagram of the object tracking problems posed to the infants.

Young infants might possess a featural rule for object identity and treat the pre- and postocclusion objects as the same if they are featurally identical. The featural task tests this by changing the object's features while it is obscured by the screen so that it emerges with a different appearance. A spatio-temporal rule for identity treats the pre- and postocclusion objects as the same if they share the same trajectory of motion on either side of the screen.

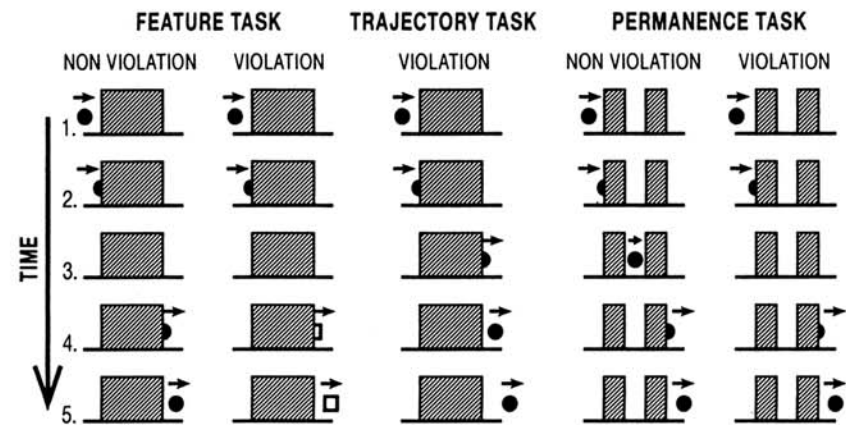


Figure 1

Schematic diagram of the object tracking tasks used to assess infants' rules for maintaining numerical identity. The diagram shows the feature, trajectory, and permanence tasks at five sequential points in time. The nonviolation condition in the trajectory task was the same as the nonviolation condition in the feature task. (Adapted from Moore, Borton, and Darby 1978.)

The trajectory of the preocclusion object specifies a unique speed, direction, and time of appearance for the postocclusion object. The trajectory task tests this rule by having the postocclusion object emerge much too soon to be on the trajectory of the preocclusion object even though their observed speeds and directions are identical. A permanence rule for identity treats the pre- and postocclusion objects as the same if an unbroken path of motion links them. The permanence task tests this rule by having the object disappear behind the first screen and emerge from the second screen still on the original trajectory but without appearing between the screens. Thus on some portion of its trajectory the object apparently did not exist.

As depicted in figure 1, the method used in the experiment was to create three object-tracking tasks (the featural, trajectory, and permanence tasks). For one condition of each task, an object disappeared and then reappeared in accord with all three identity rules; the other condition violated one of the rules. If infants showed a violation response (more disrupted tracking in the violation condition than in the nonviolation condition), this was taken as evidence that they used the identity rule in question. These tasks were presented to 5- and 9-month-old infants.

The results showed that 5-month-old infants displayed violation responses for both the feature and trajectory tasks but *not* for the permanence task. Evidently, the 5-month-olds saw no contradiction to their notions of object in the permanence-violation task. In contrast, the 9-month-olds showed violation responses in all three tasks. Moreover, the 9-month-olds

showed a novel behavior pattern not exhibited by the younger infants. For example, in the permanence task they looked successively at the reappearance and disappearance edges of the first screen when it did not appear between the screens, as though expecting its reappearance from behind that screen. Their notion of object was rich enough for them to seek a resolution of the mismatch between how the world should work and how it apparently did. They seemed to believe that the object emerging from the second screen was not the original object and that the original still existed and remained at a particular invisible place in space. No such thought occurred to the 5-month-old infants.³

It seems that for 5-month-old infants, a moving object traces a specific trajectory, and all visible appearances of a featurally identical object on that trajectory are encounters with the "same" object. The 5-month-olds' identity rules, therefore, enable it to parse the visible transformations of moving "objects" without reference to or implications for those same "objects" when hidden. The 5-month-old employs identity rules to match present objects with internal representations of them formed in an earlier encounter, to unify successive contacts with objects over time and space under the rubric of 'same' or 'different,' and to anticipate where the next contact with them should occur. These are powerful tools to tame the flux of appearances, but they are useless when confronted with occlusion transformations that produce invisible objects. For the 5-month-old, object identity does not reduce to or imply permanence of the object. In contrast, the 9-month-olds act as though a moving object must trace an unbroken path and therefore should be sequentially visible at all exposed points along its trajectory. By this age the maintenance of an object's identity across two perceptual contacts implies continuous existence between encounters.⁴

Human Bodies as Objects

The problem of identity is one that cuts across both people and things, because whatever else people are, they are also material bodies that trace a path in space and time. From this viewpoint, people and things are fundamentally similar. In our commonsense adult psychology, however, we obviously draw a distinction between them. Do infants? If so, what characteristics distinguish people from things for infants?

It is not just that people look a certain way, for example, they have eyes. People have human bodies and perform human movement patterns. Infants too have human bodies, and they move correspondingly. This correspondence between other people and the infant eventually raises questions of the sort, "Am I one of those?" The earliest behavioral tool infants use to explore self-other correspondence is body imitation. Imitation is a

two-way street: infants can copy and be copied. For infants, the possibility of having such a relation between themselves and other people makes people special and distinct from things.

In the sections that follow, we analyze infant imitation in detail. Based on recent research, we have drawn four inferences: (a) the ability to imitate is innate, (b) it is not automatic but is under intentional control, (c) it is not purely rote but reveals infants' interpretations of social encounters, and (d) it is mediated by an internal representational system. In particular, the representational system is one that does not operate on sensory specifics, but uses a modality-independent or "supramodal" code that links acts that are seen and those that are done.

The Problem of Imitation As commonplace as imitation is, it presents a puzzle not only for developmental psychology but for philosophical analysis of the preverbal mind as well (Brewer 1993; Campbell 1994, this volume; Eilan 1993; Goldman 1992). To imitate, the infant must perceive another's acts and use this as a basis for an action plan with its own body. This translation must be accomplished without verbal instruction and despite the large differences between the other's body and its own (different size, spatial orientation, visual perspective, etc.).

All imitative acts are not of the same kind. There are key differences between manual imitation and facial imitation. In manual imitation, the child sees the adult hand movement and must generate a matching movement. One possible aid is for the child to look at its own hand and use visual guidance as a way of achieving a match between self and other. Visual guidance is, however, completely impossible in the case of facial imitation. Infants can see the adult's face but cannot see their own faces. They can feel their own faces move but have no access to the feelings of movement in the other. By what mechanism can they connect the felt but unseen movements of the self with the seen but unfelt movements of the other?

Classical psychological theories answered this question by postulating learning experiences from mirrors and manual exploration of one's own and other's faces. Mirrors made the unseen visible, rendering one's own body and that of the other into visual terms. Manual exploration rendered both self and other tangible. Facial imitation was thought to emerge at about 1 year of age (Piaget 1962).

Innate Imitation: Strong Nativism Our research forced a revision of the conventional view of imitation and the infant's initial state. We conducted two experiments using newborn babies in a hospital setting. The oldest baby in these studies was 72 hours old. The youngest was 42 minutes

old. The results demonstrated successful facial imitation (Meltzoff and Moore 1983, 1989). The capacity for body imitation is part of the innate endowment of human beings. If ever there was an empirical case for nativism, body imitation provides it.

What does this finding imply about the human mind? A first question is how to characterize this behavior. The spectrum ranges from reflexlike, automatic, stimulus-driven behavior on the one end to a more cognitive understanding of people on the other end. This question was addressed in several studies. Meltzoff and Moore (1977) showed that 12- to 21-day-old infants could imitate four different adult gestures: tongue protrusion, mouth opening, lip protrusion, and finger movement (figure 2). These results revealed that infants imitated with several parts of the body. Moreover, infants confused neither actions nor organs. They differentially responded to tongue protrusion with tongue protrusion and not lip protrusion; they also differentially responded to two different actions produced by the same organ (lips protruding versus lips opening). The range of gestures imitated and the specificity of the imitative acts suggested that a more generative matching mechanism than a reflexlike one is needed to account for the behavior.



Figure 2
Young infants imitating adult facial gestures. (From Meltzoff and Moore 1977.)

A second study tested whether infants could imitate even if there was a temporal gap imposed between perception and production so that infants were disrupted from initiating the response while the adult gesture was being demonstrated. Reflexes do not jump such gaps. How do you ask an infant to watch what you are doing but delay its response until after the demonstration has ended? The technique was to put a pacifier in the infant's mouth before we showed it the gesture. The infant was thus engaged in a competing motor activity (sucking on the pacifier) during the presentation. The adult then stopped gesturing, assumed a neutral facial pose, and only then removed the pacifier. The results showed that infants were able to imitate (Meltzoff and Moore 1977), in contrast to what might be expected by the reflexive account.

The Intentional Nature of Imitation We believe that early imitation is a goal-directed, intentional activity. In one study, 6-week-old infants were shown the unusual gesture of a large tongue protrusion to the side (Meltzoff and Moore 1994). The prediction from a reflexive model is either no response, if the unusual adult gesture was not innately specified as a "triggering stimulus," or persistence in a preset motor pattern of normal tongue protrusion without revision. In fact, infants imitated and gradually corrected their imitative attempts to achieve a more faithful matching of the novel target. The initial response of most babies was not an exact copy of the adult. Instead, they made mistakes. The early attempts were to focus on the lateral components: the tongue either went into the cheek or was thrust slightly forward and then moved laterally during retraction. Strictly speaking, neither of these was shown. That infants made mistakes and then corrected them suggests that their responses are actively constructed and goal-directed.

We were also fortunate to come across an "experiment of nature," an anatomical malformation that prevented infants from fully protruding their tongues because of an attached freniculum.⁵ When shown no gestures or shown the mouth-opening gesture, the imitation of such infants was indistinguishable from other babies. The interesting case is where they were shown a tongue protrusion, which, of course, they could not produce. The infants attempted to poke out the tongue and then became frustrated and cried. This suggests that even for infants there is a primitive sense in which intentions are different from consequences; in particular the intended act is distinguishable from the actual motor movements produced.

Both the correction of imitative mistakes in normal infants and the frustration of the motor-handicapped infants implies a common story. In both cases infants made repeated attempts, and their intentions were not satisfied by the initial motor performance stemming from these

attempts. This suggests that infants differentiate between the representation of the target act derived from the external world and the representation of their own bodily acts. The intention is apparently to bring these two into congruence.

The Interpretive Nature of Imitation Three sets of findings illustrated the interpretive aspect of early imitative responses.

Selectivity In one study of 6-week-olds (Meltzoff and Moore 1994), infants were shown repetitive large mouth-opening gestures, each of a specific duration. Some infants initially responded with extremely large mouth openings, as if selecting the spatial dimension; others responded with normal-sized mouth openings of extremely long durations, as if selecting the temporal dimension. For both sets of infants, some switched entirely to the opposite dimension before finally achieving well-formed mouth openings whose duration approximated the duration of the adult's exemplars. This suggests that individual infants select different aspects of the stimulus to start with before settling on a more faithful multidimensional match.

Creativity In the tongue-to-the-side study (Meltzoff and Moore 1994), the predominant pattern was convergence on a match to the target via successive attempts and corrections, as already described. However, some infants displayed a different interpretation of the target. They poked out their tongues and simultaneously turned their heads to the side, thus creating a new version of "tongue to the side." This head movement was not part of the stimulus, but was the infants' construction of how to get their bodies to do a novel act involving both tongue protrusion and an off-midline direction. Tongue protrusion plus head turn was not the work of a mindless reflex. It was a creative error.

Volition The imitative response does not seem to be automatically released by the stimulus because it can jump temporal gaps, it does not burst forth fully formed, and some babies simply watch attentively and do not imitate. More compellingly, infants may choose to perform a different gesture than the one they are being shown. In particular, they may imitate a gesture they remember rather than the one they see. They demonstrate this in two ways (as will be analyzed in the next section): they imitate the gesture shown the day before when the same person returns and shows only a neutral face; when presented with two adults, they may imitate the first person's gesture when viewing the second person. Taken as a whole this

pattern suggests that imitation is noncompulsory. It appears to be under voluntary control.

Supramodal Representation of Human Acts We hypothesize that infants can represent human movement patterns they see and ones they perform using the same mental code. The perception of the adult's act is registered so that it can be directly used for executing a motor plan. There is thus something like an act space or primitive body scheme that allows the infant to unify the visual and motor/proprioceptive information into one common "supramodal" framework.

The notion of supramodality we are proposing deserves further analysis. One possibility is that the supramodal system is simply a translation device for turning visual perceptions into motor output, a perception-production transducer. There are three reasons to think that we need a more differentiated notion than this. First, the voluntary nature of the response indicates that the infant need not produce what is given to perception. The response does not pop out on the infant's seeing the act. The information gained from vision can be stored and accessed at a later time. One way of achieving this is to represent the adult's act. Thus at minimum there is an intermediary representation and not simply an automatic transduction. Second, as we have seen, the imitative acts can be corrected to achieve a more faithful match. Thus information about one's acts has to be available for comparison with the representation of the adult's act, but the representation of the visually specified act is not confused with or modified by one's own multiple motor attempts. Third, infants show special interest in being imitated themselves; they have the capacity to recognize when their facial behavior is being copied. Such recognition implies that there is a representation of their own bodies.

These three pieces of evidence go beyond the simple transducer story. They suggest a differentiation in the supramodal system such that the representation of the other's body is separate from the representation of one's own body. Although both representations use the supramodal language, they are not confused. The cognitive act is to compare these two representations, in one case to match one's own acts with the other's (imitative correction) and in the other case to detect being matched oneself (recognizing being imitated). Thus the mental code may use a supramodal "language," but the mind is not one undifferentiated supramodal whole.

One interesting consequence of this notion of supramodality is that there is a primordial connection between self and other. The actions of other humans are seen as like the acts that can be done at birth. This innate

capacity has implications for understanding people, because it suggests an intrinsic relatedness between the seen bodily acts of others and the internal states of oneself (the sensing and representation of one's own movements). A second implication of young infants' possessing a representation of their own bodies is that it provides a starting point for developing objectivity about themselves. This primitive self-representation of the body may be the earliest progenitor of being able to take perspective on oneself, to treat oneself as an object of thought.

Primacy of Human Acts for Connecting Self and Other We want to develop the notion that infants see other people in terms of *human acts* and, in imitating them, intend to match these acts. Here human acts are being thought of as an organ plus its transformation, and the goal of the act is the endstate of the transformation. A human act is neither simply a vector of movement nor an isolated body part but rather a goal-directed organ transformation.

Recall that some infants respond to the tongue protrusion to the side with a straight tongue protrusion plus a simultaneous head turn to the side. Note too that the tongue-tied infants (attached freniculum) became upset when they could not produce the full extent of the tongue protrusion shown. Both examples suggest that the adult's behavior is coded not at the level of specific movements per se but rather at the more abstract level of having an aim or goal. It is only at the level of goals that the head turn is relevant to tongue protrusion to the side. These are different as specific motor movements, but the infant's tongue protrusion ends up off the midline of the body in both cases. Although the literal movements were very different, the goals are similar.

The human act may be the earliest, most aboriginal parsing of the world into things that bear on the self and those that do not. Human acts are especially relevant to infants because they look like the way the infants feel themselves to act and because human acts are things that the infant can intend. Neither the swinging clock pendulum nor the swaying of trees bear that relation. When a human act is shown to a newborn baby, the act may provide its first "aha" experience. "Lo! Something interpretable. That (seen) event is like this (felt) event." The fact that infants can recreate the act allows them to give it special meaning. (Partly for this reason, the expressive faces of people are infants' favorite playthings and recruit more attention than other items in their world.) We thus suggest that the basic cut infants impose on the world of objects is neither self-initiated movement versus moved by a seen force (trees in the wind are not viewed as special), nor animate versus inanimate (armadillos will not be of much interest),

nor even people (as adults know them) versus things. The aboriginal distinction may be something closer to *human acts versus other events*.

Infants' tendency to see behavior in terms of human acts that can be imitated has interesting implications. First, the world of physical bodies is divisible into those that perform human acts (people) and those that do not (things). Second, after one has made this division in the external world, new meanings become possible. Because human acts are seen in others and performed by the self, the infant can grasp that the other is at some level "like me": the other acts like me, and I can act like the other. The cross-modal knowledge of what it feels like to do the act seen provides a privileged access to people not afforded by things.⁶

2 Infants' Conception of Persons

Identity for Human Individuals

We have argued that there is a rich innate grounding for infants' understanding of people. This innate construal is based on human acts. Surely, however, the newborn's notion is not yet the mature, adult concept of a person with all its entailments. For example, the differentiation of people from things, the specialness of people, and even a grasp of their similarity to oneself, need not mean that there is yet any differentiation within the class of people. The adult notion obviously makes distinctions within the class. This again raises issues of identity: how does one tell one individual from another? We propose that imitation serves an identity function as regards people. Infants reenact the behavior of the adult in part to test the identity of the adult and differentiate them from other particular ones.

Consider the problem of identity as it applies to people. It is a common experience for infants to see the features of people change, sometimes quite radically, during one continuous viewing of them. For example, a mother leans down over a bassinet so that her hair falls over her brow and covers her eyes. Is the mother a series of different people as she is featurally altered? A featural analysis cannot be the sole criterion infants use for determining identity, as discussed earlier. Spatiotemporal rules concerning place and trajectory of motion must be critically important.

What action might infants take to clarify an ambiguity such as "This person does not look like Mother, but Mother was not seen to leave. Is this Mother?" We believe that infants use body-movement patterns and non-verbal gestures to clarify ambiguities about the identity of people. If infants are unsure about the identity of a person who is perceptually present, infants will be motivated to probe whether this person has the same behavioral properties as the old one seen earlier, because body actions and

expressive behavioral properties are identifiers of who a person is. Body actions and distinctive interactive games are akin to nonverbal shared memories, or at least shared experiences, that can be used to probe a person's identity.

Differentiating Individuals In a study of 6-week-old infants, we presented two different people who were featurally very different: the mother and a male stranger (Meltzoff and Moore 1992). Previous research showed that infants this young can visually discriminate their own mothers from strangers, so the fact that they were featurally different could be visually registered (Bushnell, Sai, and Mullin 1989; Field, Cohen, Garcia, and Greenberg 1984; Walton, Bower, and Bower 1992). However, we found that when these people were not clearly differentiated by spatial criteria, infants seemed confused about numerical identity.

We arranged the test so that infants saw one person perform one facial gesture and the other person perform a different gesture. For example, the mother showed the tongue-protrusion gesture and then exited. The male stranger then entered and demonstrated the mouth-opening gesture. Using this multiperson, appearance/disappearance situation, we found something quite surprising. Many infants stopped acting; stared at the new person, and then slowly and deliberately produced the previous person's gesture. Instead of the perceptual stimulus automatically triggering a matching response, the new person's gesture prompted a reenactment of the absent person's gesture. Why should the infant produce the old person's gesture and not be driven by the gesture in current view?

Further analysis revealed that the subset of infants who were reenacting the previous person's gesture were those who had not completely visually tracked the people as the switch occurred. The reactions of infants in this subset is understandable in terms of the typology outlined in table 1. These 6-week-olds faced a dilemma, because they are confined to using steady-state rules (level 1). The two adults were featurally different but interacted with the infants from the same location in space. At level 1, objects in the same place are the same object by spatiotemporal rules, hence the mere featural differences between the adults would be insufficient to establish their separate identity. The other subset of infants, who had tracked the entrances and exits of the adults, could use the different paths of motion as a spatiotemporal criterion of identity, and this, perhaps taken in conjunction with the featural difference, would have allowed them to differentiate the two adults.

This suggested a new experiment. Everything remained the same but for one factor: the degree to which spatiotemporal criteria could be ap-

plied. Once again, two people viewed at different times performed different facial gestures. The crucial change was that we ensured that the infants smoothly tracked each adult as he or she moved about in space. The adults should now be different by infants' spatiotemporal as well as featural rules. The results showed that this small change in procedure produced a large change in the results: now a significant number of infants imitated the first person's gesture and then the second person's gesture in turn, without conflict between the two (Meltzoff and Moore 1992).

The deployment of imitation to help sort out ambiguities about identity assists us in understanding this pattern of results. For those infants who did not smoothly track the adults, the identity of the person in front of them was indeterminate. They were using the first person's gestures to help resolve this ambiguity. Once the conditions were modified so that spatiotemporal and featural criteria both suggested that this was a different person, then infants imitated each person in turn with no confusion.

Reidentifying Individuals Discussed so far was how imitation is used to distinguish individuals. We also think it is used for reidentifying an individual as being the same one over different encounters. To investigate this, we conducted a new experiment in which infants were shown a gesture by an adult on one day, and the same adult returned on successive days. Is this the same person?

In Meltzoff and Moore 1994, 6-week-old infants were assigned to one of four groups. On day 1, they saw a single adult demonstrate either mouth opening, tongue protrusion at midline, the novel gesture of tongue protrusion to the side, or a control display of no oral movement. On day 2 the same adult first sat and presented a neutral face; this assessed whether infants would remember and reenact what the adult did the day before. Then the assigned gesture was demonstrated again. Day 3 repeated the procedure from day 2.

The results showed both immediate imitation (when the gestures were shown) and imitation from memory (when the adult sat with a neutral face). The imitation from memory is noteworthy because infants were simply presented with a neutral face during this phase. The information about what to do was not in the stimulus. What differed across the groups was the infant's representation of this adult, not what the adult was actually doing. Nonetheless, the results showed that infants who had seen the adult demonstrate mouth opening 24 hours earlier were significantly more likely to look at the adult and produce mouth openings, and those who saw the adult demonstrate tongue protrusion were more likely to do that gesture. Infants were acting on their remembrance of things past.

The notion that imitation provides a functional criterion of identity helps us to understand infants' imitation of yesterday's acts. On day 1 the infant saw a person showing a tongue-protrusion gesture. Twenty-four hours later a person who looks featurally the same is encountered in the same context, but this time with a neutral face. For the 6-week-old, the most salient problem raised by this social encounter is one of the identity of the person. Is this the self-same person acting differently (no facial gesture) or a fundamentally different person who looks the same? Infants deploy imitation to help resolve this question.

A Functional Criterion for Identity: Gestural Signatures We thus have two cases in which infants' behavior is not governed by what is presently delivered to their senses: (a) Why should infants in a multiperson situation sometimes imitate a previously seen person instead of the perceptually present person? (b) Why should infants be prompted to imitate yesterday's behavior if the current adult is displaying a neutral face? It is as if infants use imitation to ask, "Are you the one who does the ____ gesture?"

Infants are confronted with people as they come and go, appear and disappear in front of them. If infants are to make sense of such events, then some rules are needed to determine whether the person seen at time t is the same as or different from the one seen at time t' . The infant must use whatever rules for identity they have at their disposal. Interestingly, young infants can be confronted with contradictions between two identity rules. Thus in the multiperson case, the new adult was featurally different but sitting in the same spatial location. Is this person the same one, who now looks different, or is this a new person in the old location? The infant employs the person's gestural signature to tip the balance one way or the other. In the case of the person coming back after a day's break in contact, the infant sees someone who is featurally the same but who is acting differently (presenting a neutral face instead of gesturing) and for whom a spatiotemporal rule cannot be applied (because of break in contact). Our idea is that infants try to resolve uncertainties concerning a person's identity by using imitation as a gestural probe. By 6 weeks of age, distinctive human behaviors serve as *gestural signatures*, aiding the infant to differentiate individuals within the general class of people: to distinguish one individual from another and to reidentify particular individuals on subsequent encounters.

Three Criteria for Object Identity: Spatiotemporal, Featural, and Functional At this point we need to integrate our findings from section 1 concerning identity and the new work on early imitation. We are proposing

that infants use three criteria for understanding the identity of objects: spatiotemporal, featural, and functional. 'Spatiotemporal' refers to location in space and time, 'featural' refers to perceptual properties; and 'functional' refers to how an object acts or how one can act with it.⁷ We are suggesting that for young infants, human behavior—in particular the type of distinctive acts we call *gestural signatures*—are used to identify individuals. These are the precursors of our everyday adult recognition that individual people have distinctive mannerisms, styles, and modes of behavior that can be expected from them. Even the same category of act can be so individualized that it can be used for identifying the person—my walk is not your walk. People can be recognized by their gait at a distance, although all other features are indiscernible.

From a philosophical point of view, the spatiotemporal criterion is the essence of numerical identity (Strawson 1959). From the viewpoint of psychology, the other criteria come into play and often must be used precisely because complete spatiotemporal histories are unavailable. This is especially so for the infant, who cannot move around at will, cannot ask questions, and, if young enough, may even be unable to track visually with much accuracy. Thus the featural and functional criteria are of considerable interest to developmental cognitive psychologists. Moreover, the special nature of human acts is that they allow the infant to initiate as well as to observe, which enables them to probe and test who a particular individual is. This bidirectionality makes imitation useful to the infant as a tool for addressing identity problems posed by people.

Developing Objectivity about Persons

We now wish to consider the relation between infants' notions of objects and their notions of persons. Infants have rules for determining the identity and permanence of objects they perceive. We have argued that these rules change and develop with age. People are physical bodies that exist in space and time. It follows that infants' understanding of other people change and develop as their underlying identity rules change. Looked at from this perspective, physical bodies and human bodies are understood equivalently.

This was demonstrated in a study of ours in which people were hidden behind barriers. The results showed that infants used the same rules in finding their mother hidden behind large screens as in finding a small inanimate object hidden on a table top. They made the same search errors and were essentially at the same level of understanding (level 1, 2, or 3) for both. This supports the idea that the identity and permanence rules are mental structures that apply generally to physical bodies, both people and

things, regardless of the particular motor movements used in recovering the objects, etc.

We have discussed the developing identity structures as if they were used by the infant only to interpret a particular person or thing as the same or different, permanent or not. Infants also interpret the failures of these rules in different ways at different ages. For example, for 5-month-olds (level 2), when the mother leaves the room, she can be remembered, but the infant does not conceive of her as existing anywhere else. A few months later (early level 3), the mother is now conceived of as continuing to exist in a particular place or on a particular trajectory of motion, which allows for search. If the mother is not found where she is conceived of as being, the infant can for the first time confront the possibility that although she did exist, she no longer does.⁸ No such thought is possible at earlier ages: there is no notion of ceasing to exist until objects can be conceived of as permanent. Before objects are permanent, infants conceive of the external world as what is present now. Nothing is hidden because there is nowhere else to be. However, this does not mean that they are solely influenced by the present. Representations constructed from previous encounters are maintained in memory, and current perceptions may be interpreted in terms of them (Meltzoff and Moore 1994). These memories create an internal realm, but before things are permanent, these memories do not refer to an enduring external world.

Toward the end of level 3, having successfully both recovered objects that disappear and reidentified objects not found where expected, the infants restructure their conception of objects. They now understand that physical bodies cannot be destroyed by simple disappearance transformations (occlusions). People and things can be lost: infants now understand that they continue to exist in a place, somewhere out of perceptual contact, but their location may be indeterminate. By about 18 months, infants have developed a notion of objects that resembles the naive adult view.

In summary, infants progressively conceive of a more objective world. The direction of development is toward construing people and things as unique entities tracing a single continuous path in space and time. This aspect of mind, which is a developmental achievement, does the work of interpreting what is not given directly by perception and of providing an enduring reality that exists in the absence of sensory input altogether.

Developing Subjectivity for Persons: Early Folk Psychology

Persons are more than enduring physical bodies that are like one's own body and move like one does. In the mature adult notion, persons also have beliefs, desires, and intentions that lie below surface behavior and can

be used to predict and explain behavior. One cannot see intentions, but it is an essential part of our commonsense or folk psychology that other people have them (Dennett 1987, Fodor 1987, Goldman 1993, Searle 1983, Stich 1983). At what age do infants begin to understand people in this way?

A recent study (Meltzoff 1995) suggests that by 18 months of age children go beyond imitating the visible surface behavior of the adult. In the critical test situation, infants saw an adult who demonstrated an intention to act in a certain way. Importantly, the adult never fulfilled this intention; he tried but failed to perform the act, so the end state was never reached. The goal toward which the adult was striving therefore remained unobserved by the infant. To an adult, it was easy to read the actor's intention. The experimental question was whether infants registered this behavior in purely physical terms or whether they too read through the surface behavior to the underlying goal, which remained unseen. The subjects, who were too young to give verbal reports, revealed how they represented the event by what they chose to reenact. The infants' tendency to perform the target act was compared in several situations: after they saw the full target act demonstrated, after they saw the unsuccessful attempt to perform the act, and when it was neither shown nor attempted.

The results showed that 18-month-old infants can interpret the unsuccessful attempts of adults even when the adult does not reach the intended goal. Infants who saw either the unsuccessful attempt or the full target act produced target acts at a significantly higher rate than the controls. It was striking not only that infants could interpret the unsuccessful attempts but also that they were as likely to perform the target after seeing the adult trying as they were after seeing the actual demonstration of the target behavior itself. We interpret this pattern of data as showing, at a minimum, that 18-month-olds can infer the goal toward which a sequence of actions is aimed, even though the end state is never attained. The findings strongly suggest that infants situate people within a psychological, not purely physical, framework. In this sense, they understand people to be bearers of psychological properties.

How did the infants know that the unsuccessful act was only an attempt? They could not have decided to go beyond the literal actions of the adult on the basis of language or emotional displays, because both were strictly controlled: the actor said nothing and showed no disappointment, sadness, or frustration. The chief basis for extracting the goal was probably the fact that the adult's attempts consisted of three different but related acts. The hypothesis is that the infants used the relation between the three attempts to infer the goal of the act (which was never shown).

To underscore why the current experiment is relevant to the ontogenesis of folk psychology, it is helpful to distinguish between seeing the behaviors of another in purely physical terms versus psychological terms. The minimum case of an interpretation being psychological is interpreting human behavior in terms that go beyond a simple description of the observable movements only. A physical interpretation refers to *movements or motions*, and a psychological interpretation refers to goal-directed actions or what we call *acts*. The behavior of another person can, of course, be coded using either (or both) the psychological or physical level of description. We can say 'Sally's hand touched the cup, and the cup fell over' or 'Sally reached for the cup'. Strict behaviorists insist on the former because what is in the respondent's mind is unobservable. Our research suggests that by 18 months of age, infants are not strict behaviorists. They ascribe goals to human acts. Indeed, they infer the goal of a sequence of behaviors even when the goal was not attained. They do this in preference to literally reenacting the motions seen. Thus it appears that they code the behaviors of people in psychological terms, not purely as physical motions (Meltzoff and Gopnik 1993).

Infants' Understanding of Psychological States The results would be nicely accounted for by postulating an innate understanding of intentions. On this account, the new findings with 18-month-olds are simply partial reflections of this innate knowledge. Taking an even stronger line, Fodor (1987) suggests that there is an innate belief-desire psychology that goes beyond the attribution of intention alone.

We favor a more developmental account. This view retains some aspects of nativism, but it differs from a full-blown innate folk psychology in two ways. First, it suggests that certain philosophical distinctions among mental states may have developmental reality. An understanding of the goals of human actions (or even simple intentions) does not demand a grasp of mental states like belief (Searle, 1983); the adult's folk psychology (a belief-desire psychology) may develop from simpler beginnings. Indeed, new empirical discoveries about children's conception of mind suggest that a belief-desire psychology gradually emerges between 2.5 to 4 years of age (Astington and Gopnik 1991; Flavell 1988; Gopnik 1993; Harris 1989; Perner 1991; Wellman 1990, 1993). The results discussed here demonstrate that there is some primitive grasp of intended actions at an even earlier age.

An early understanding of people in psychological terms emphasizes the competence of infants, but leads to a second difference from the strong nativist view. For us, finding a surprising competence at 18 months of age

does not warrant the conclusion that there is an innate grasp of intentions with a fixed nondevelopmental core. There may be significant revision in the infant's understanding of the meaning of "intention" in some or all of the following areas during early development: the locus of intentions (are they in the other's mind as mental states?), the contents of what can be understood as intentional, the equivalence between the intentions I know myself to hold and those I attribute to others, and awareness of one's own or others' intentions.

In fact, we have strong reason to suggest there are developmental shifts in the content of intentional acts that infants can understand: a progression from simple body acts, to actions on objects, to using one object as a tool to act on a second object. At the first level, infants may understand only intentions involving simple body movements, such as trying to raise one's hand or making particular facial movements. It is as yet unknown whether young infants can imitate the mere demonstration of an attempted act, rather than the whole act itself. However, even if this were the case, newborns probably would not respond to tasks involving actions on objects, the second level described above. Young infants attend to people or to things but not to the person-thing relation until the second half year of life (Campos and Stenberg 1981; Meltzoff 1988a, 1988b; Trevarthen and Hubley 1978). Thus they probably cannot give meaning to the adult's attempts to perform an action on an object, because this involves a person-thing relation. Even if intention were an ontological category available to the newborn, there could still be a developmental progression in the content of this category.

Moreover, we believe that there is development in conceptions about the locus of intention (and therefore in the meaning of intention itself). The earliest progenitor may be understanding the goals of action, which is logically separable from imputing intention to the minds of others. Even the attribution of goals requires that infants read below surface behavior. However, it does not require that they ascribe an invisible state to another's mind as the underlying cause of the behavior. Furthermore, there is room for development between having a primitive grasp of intention as an internal state and a mature folk psychology holding that if a person desires x and believes that doing y will bring about x , he will intend to do y , and that this is wholly independent of (and may be contrary to) one's own beliefs, desires, and intentions about the matter.

In summary, by 18 months of age there is a differentiation between what was actually done and the goal. Infants seem to know that every act is not a goal achieved. This indicates that they have begun to distinguish the surface behavior of people from another deeper level. They have already adopted the rudiments of a folk-psychological framework.

3 Concepts of the Self and the Other

We have explored three aspects of infant cognition—their understandings of physical objects, of human bodies, and of psychological states—in relative independence of one another. Such independence is a fiction. These three aspects are intertwined with each other in normal human development. They exhibit two poles of infant knowing: the objective and the subjective. Developing an equilibrium between these poles undergirds the earliest conceptions of self, other, and persons in relation with one another.

The objective pole of knowing is most clearly manifest in infants' changing levels of understanding the identity and permanence of physical objects. These changes also influence how infants objectify people and their relations with them. A major developmental change in the first 5 months is attaining a stable "here and now" world such that individual entities are differentiated and retain their identity as they move and change within the visual frame. Before this level of objectification, there are incomplete rules for maintaining identity over visual transformations. Consequently, most of the infant's energy, attention, and even acts of imitation are used in the service of resolving basic problems of identity.

Once the world is objectified in the sense of being stable in the here and now, and especially later after entities that are out of sight are conceived of as permanent, gestural interactions and imitation can be used in new ways that lead to new notions of people and relations with them. Because a particular gesture is no longer needed to differentiate or identify the individual, the issue shifts from "Who is this?" to the nature and quality of the exchange itself. Instead of being confined by a specific imitative exchange involving one gesture, infants can now play the game of imitation at a more general level. What matters is not the particular gesture but the matching game, in which specific gestures are infinitely substitutable. Moreover, the game can be played bidirectionally, so that mother can propose a gesture and baby can copy, or baby can propose and mother can follow. This entails a shared understanding of a new mental (invisible, inferred) entity: the imitative game. It allows a new conception of a relationship between self and other that transcends particular acts. As these types of relations develop with an enduring (permanent) other, the infant's understanding of social possibilities expands. Infants can seek out and initiate interpersonal exchanges, thus bringing certain social experiences under their own control.

The subjective pole of knowing is most clearly manifest in early imitation and its implications for developing self-other equivalences. From birth on infants can act as they see others act, and this enables them to rec-

ognize that the other is "like me." This grasp of the other as like oneself works in two directions. On the one hand, it allows the infant to use the self as a framework for enriching its understanding of the other. Having done an action itself, the infant has subjective, experiential knowledge of that act. When the infant sees another perform an act that he knows is like his own, the infant can interpret the seen act in terms of this subjective experience. On the other hand, infants may learn about themselves through seeing the acts of others. For example, by virtue of seeing the failed attempts of others and inferring unseen goals, infants gain experience in isolating and extracting goals. This could change infants' perspectives on their own acts, so that their own goals can become objects of attention in and of themselves.

Ultimately, of course, children must bring both the subjective and objective poles into balance. The outcome of such a process is an integration of knowledge of self and other that spans both, one more like our folk-psychological conception of a person. Within such a framework the self is construed as an objective entity enduring in a world of others, and the other is ascribed a subjectivity as rich as one's own. Although the infant is innately provided with tools for interacting with and understanding people—particularly imitation and supramodal representations—the mature folk-psychological construal of a person is a developmental achievement, not an innate given.

In summary, the infant's conception of a person does not develop in isolation from the rest of their cognitive structures. On the contrary, an infant's changing concepts of physical objects interact with the development of their understanding of people. For the young infant, ambiguities about the identity of people arise because of problems in tracing their *bodies* through space and time. These ambiguities are addressed with body imitation, which permits interacting with people at a distance rather than through direct physical contact. Later in infancy their general cognitive abilities again interact with their understanding of people. The infant's developing to a level at which invisible entities are postulated may be a logical prerequisite for its understanding that people have invisible mental states that lie behind behavior. The development of an infant's notion of a person is thus not restricted to their understanding minds but involves their understanding bodies as well. For infants, these two aspects of persons are interwoven.

Acknowledgments

The order of authorship is alphabetical; the work was thoroughly collaborative. We thank Pat Kuhl and Alison Gopnik for insightful suggestions on an earlier draft. We owe an enormous debt to Naomi Eilan, Tony Marcel, José Bermúdez, Bill Brewer, and

Alison Gopnik for encouraging us to think about various philosophical issues. Naomi was a particularly generous editor; she sharpened our thinking in numerous ways. This work was funded by the National Institutes of Health (HD-22514).

Notes

1. For 3-month-olds limited to a steady-state understanding of the world, changes from steady states present a problem. They will visually follow an object as it moves, and if they temporarily lose sight of it, they will shift their eyes to anticipate where it should be on the trajectory. However, when they observe the object stop, they will simply pause to note the object at rest (the stopped object is perceptually registered), and then continue tracking out the trajectory (Bower, Broughton, and Moore 1971; Piaget 1954). This and related research leads to the inference that the moving and stopped "objects" are not interpreted as the *same one* by level 1 infants.

2. Even the 9-month-old understanding is not the final conception of object achieved (Moore, 1975, Moore and Meltzoff 1978, Piaget 1954), but for the purposes of this discussion we no longer call it a proto-object because the 9-month-old conception entails spatiotemporal continuity.

3. The same pattern of behavior (and difference between ages) occurred in the feature task. For the 9-month-olds, the featurally different object on the same trajectory was not accepted as the original, and their looking patterns suggested that they inferred that the original must still be behind the screen. Again, the 5-month-olds do not seem to draw this inference.

4. This illustrates development within the domain of spatiotemporal rules. For the 9-month-old it is *necessary* that the object exist at all points on the trajectory for it to be the same; for the 5-month-old it is sufficient that the object be on the trajectory whenever it is seen for it to be construed as the same one. Thus both the 5- and the 9-month-olds use spatiotemporal rules, but through development, the trajectory rule is reorganized to become the permanence rule.

5. The freniculum is the thin piece of skin connecting the base of the tongue blade to the soft palate on the bottom of the mouth. In some children this skin extends to the front tip of the tongue, which prevents protrusion of the tongue.

6. The use of 'I' and 'me' in the text is not meant to imply the mature, adult notion of these terms but rather refers only to the earliest progenitors of these concepts.

7. Campbell (1993) develops a distinction between "indexical causality" and "nonindexical causality," which may be relevant here. One could think of our functional criteria for identity as being related to Campbell's indexical features.

8. Interestingly, it is at about 9 to 12 months of age, but not before, that infants burst into tears when their mothers go out of sight (e.g., Ainsworth, Blehar, Waters, and Wall 1978).

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