UNDERSTANDING OTHER MINDS

Perspectives from Autism

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The role of imitation in understanding persons and developing a theory of mind

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So soul into the soul may flow, though it to body first repair—John Donne

Normal adults share a network of ideas about human psychology that are often described as 'common-sense' psychology. Although we directly observe other people's behaviour, we think of them as having internal mental states that are analogous to our own. We think that human beings want, think, and feel, and that these states lead to their actions. Our ideas about these mental states play a crucial role in our interactions with others and in the regulation of our own behaviour. Deepening our understanding of mind is a lifelong enterprise (Bruner, 1990); but recent research has shown that by the age of five years children operate with many of the key elements of a common-sense psychology. By five years old children seem to know that people have internal mental states such as beliefs, desires, intentions, and emotions. Moreover, they understand that a person's beliefs about the world are not just recordings of objects and events stamped upon the mind, but are active interpretations or construals of them from a given perspective. This allows five-year-olds to realize that people can have mental states that are different from their own, and more broadly that people act according to their mental representations of the world, rather than according to the way the world actually is. Such a model explains a lot of otherwise baffling human behaviour; it allows children to predict and comprehend many events within the interpersonal sphere. This model of the way people work has been referred to as a 'representational model of mind' (Forguson and Gopnik 1988). Although there is some debate about details of timing, there is a consensus that such a model develops somewhere between three and six, and supplants an earlier 'non-representational' understanding of mind (see Gopnik 1990; Flavell 1988; Perner 1991; Wellman 1990; Whiten 1991).

Understanding the way other people's minds work, and knowing how those minds are similar to or different from your own mind, is crucial if you want to interact with people. A particularly dramatic example of this is the suggestion that the pervasive social–communicative impairments of people with autism are rooted in an inability to develop this kind of psychological

understanding (Baron-Cohen *et al.* 1985). Autism has been likened to a kind of 'mindblindness' (Baron-Cohen 1990), in that autistic children seem unable to conceptualize another person as an entity with interpretative mental states.

The principal goal of this chapter is to inquire about the earliest developmental history of the normal child's understanding of the mind. How does common-sense psychology ever get off the ground? One way of putting this might be to say that we are interested in the earliest precursors of the child's 'theory of mind'. What sorts of things in infancy set the normal child on a developmental trajectory for eventually thinking of people as having interpretative minds—the level of psychologizing that seems so natural for five-year-olds, and so out of reach for most children with autism?

If we want to find the origins of common-sense psychology a good place to look might be in infant interactions with and understanding of persons. We will argue that the bedrock on which a common-sense psychology is constructed is the apprehension that others are similar to the self. Infants are launched on their career of interpersonal relations with the primary perceptual judgement: 'Here is something like me.' One of the aims of the chapter is to inquire about the basis and cascading developmental effects of this sort of judgement.

It is sometimes held that normal infants are innately endowed with a special attentiveness to the human facial pattern. This may be so, but we will argue that this is not the only, or even the most critical basis for the 'like me' judgement. Such pattern detectors might direct visual attention, but in themselves they do not provide a link between the self and the other. The infant might see the adult as a particularly interesting entity; but because infants cannot see their own facial features, why should they think of the adult as relating to themselves? Similarly, others have seen the roots of intersubjectivity in the early temporal co-ordination of infant and adult behaviour, the 'conversational dances' that infants and care-takers perform. But again there seems no clear reason why these behaviours, by themselves, should lead the infants to think of other people as similar to themselves in deep ways. Infants, for example, also engage in temporally contingent interplay with objects.

We propose that infants' primordial 'like me' experiences are based on their understanding of bodily movement patterns and postures. Infants monitor their own body movements by the internal sense of proprioception, and can detect cross-modal equivalents between those movements-as-felt and the movements they see performed by others. Indeed, we will suggest that one reason normal infants preferentially attend to other people is the perceptual judgement that those entities are 'like me'. Without such a judgement, other humans might have interesting visual or temporal characteristics, but they would not have the unique place they do in our world.* It is this fundamental relatedness between self and other that we wish to explore in this chapter.

Until comparatively recently, there was no reason to suppose that young infants could apprehend cross-modal equivalences between body-movements-as-felt in the self and body-movements-as-seen in others. Indeed, classical theories of infant development explicitly denied this capacity to young infants, portraying the infant as 'solipsistic', 'radically egocentric', and so on. Among the recent experiments that served to change this view are those showing that normal infants are more proficient imitators than was previously thought. As we shall see, these findings suggest that infants can, at some basic level, process the correspondence between self and other (Meltzoff 1985).

The news is not just that infants imitate, for that has been known for some time (Baldwin 1906; Piaget 1962), but that they can imitate facial movements at an early age. Why is early facial imitation so important for developmental theory, and particularly for accounts of the ontogenesis of common-sense psychology? One reason is that it informs us about the 'starting state' of social cognition in normal infants. A second reason derives from the unique nature of facial imitation itself. Facial movements are special because infants cannot make a direct visual comparison between their own faces and those of adults. We will argue that early imitation is relevant to developing theories of mind because it provides the first, primordial instance of infants' making a connection between the visible world of others and the infants' own internal states, the way they 'feel' themselves to be.

Early imitation also provides a mechanism for infants' learning about other people and distinguishing them from things. In order for a common-sense psychology to get off the ground infants must make a basic cut between people and things, and respond to them differently. What is a person for a young infant, for a newborn? How would a newborn recognize one when he or she sees one? For the youngest infants, persons may not be defined solely in terms of salient facial features like the presence/absence of eyes. We suggest that infants at first rely on more functional rules. We suggest that for the youngest infants, persons are: 'entities that can be imitated and also who imitate me', entities that pass the 'like me' test. Such a rule would be effective in sorting the world into people versus things, and could be operative in the opening weeks of life—because the data show that infants imitate at birth.

* This reverses the standard developmental relation; but it is as easy, perhaps easier, to see how a primordial 'like me' apprehension might determine the direction of perceptual preferences than how raw looking preferences in and of themselves would ever lead to a means of making the 'like me' connection of interpersonal relatedness. We return to this issue in the conclusions of this chapter.

Moreover, as increasingly complex imitative interactions take place, this basic knowledge may be extended. In particular, at least by nine months of age or so, infants will not only imitate pure body movements but will also duplicate specific object-manipulations, and will do so after extended delays. Such deferred imitations provide an important source of information about objects in the world and the shared relation to those objects that people can hold. As we will show, imitation is not only an indicator of early common-sense psychology, but may itself be a mechanism for developing and elaborating this framework.

Imitation in infancy also runs in the reverse direction: parents mimic their infants as well as infants imitating parents. Why should this be so enjoyable to both parties? Trevarthen (1979), Bruner (1975, 1983), Stern (1985), and others have shown that infants seem to take pleasure in the temporal aspects of early interactions; the interactions can be likened to gestural dialogues, because of their turn-taking nature and overall rhythm. Without denying these temporal characteristics, we want to highlight a different aspect of the gestural dialogues. In particular, we will focus on a subset of interactive games that are imitative in nature. Mutual-imitation games may be an especially meaningful avenue of early communication because both partners can recognize the common acts—the self–other equivalences that exist when the body movements of one person match the other. We will suggest that over and above turn-taking and temporal factors, infants take special pleasure in mutual-imitation episodes because the adult's acts become more 'like me' in their form. Mutual-imitation games ratify the identity between adult and child.

BODY AND SOUL

The kind of 'like me' equivalences that we have discussed so far all involve equivalences between the child's body and the body of others. In contrast, the aspect of common-sense psychology that has attracted so much recent attention is the development of the understanding that people have mental states of a certain character. Is it helpful to think of infants' understanding of bodily movements as the bedrock for 'like me' judgements, and this in turn as being connected up to the ascription of 'like me' human minds? Quite apart from the infant data, there are philosophical reasons for thinking that some understanding of a 'like me' equivalence, indeed one centred on body equivalences, is wrapped up in our ascription of mind. Although 'philosophy of the body' has always been a neglected area of inquiry, several philosophers have suggested that such abstract mentalistic notions as reference may have their origins in the perception and understanding of bodies (for example Evans 1982). From this viewpoint it makes sense that infants are engaged

in mapping out 'like me' equivalences in the bodily realm as the first step toward understanding persons.

Two aspects of the psychology of early imitation are particularly relevant here. First, the child maps externally perceived behaviour on to a set of *internal* bodily impressions. Second, the mapping is not only to internal states alone, but also to motor intentions and plans. We suggest that both internal proprioceptive sensations and motor intentions may be interesting half-way stations between behaviour on the one hand, and mental states on the other.

In common-sense psychology, one classical characteristic of mental states that distinguishes them from physical states is their spatial location. Mental states are located inside the skin (or the head or the body), while physical objects, including the bodies of others, are located outside it. In Wellman and Estes' (1986) work, this 'inside/outside' distinction is one of the first children use in differentiating the mental and the physical. Similarly, the paradigmatic example of behaviour is the body movements of others. The work on early imitation shows that even newborn infants recognize some equivalences between externally perceived behaviour—that is, perceived body movements—and literally internal proprioceptive states. Moreover, such proprioceptive sensations, in addition to being spatially located 'inside', would seem to have much of the character of mental states. In particular, they are not publicly observable, and are private experiences. Indeed, on many philosophical accounts, pains and other internal sensations, which are closely related states phenomenologically, are *the* quintessential mental states *par excellence*.

Moreover, in order to imitate infants must not only recognize the similarities between externally perceived bodily movements on the one hand and internal proprioceptive sensations on the other, they also must map those externally perceived movements on to intentions of a sort. The child must not only know that this visually perceived movement maps on to that motor plan, but also know how to go about producing the motor plan in question and in the case of deferred imitation the child must produce this motor plan in the absence of any visual guidance from the model. These motor plans, like the internal proprioceptive sensations themselves, are an interesting midpoint between the physical and the mental. It seems difficult to draw a hard and fast line between such simple motor plans and, say, 'simple desires', which themselves are viewed in the theory-of-mind literature as providing legitimate instances of very early and primitive mentalism (Wellman 1990; Astington and Gopnik 1991). The new findings on imitation strongly imply that motor plans and intentions are mapped on to the behaviour of others from the start. It is as if children, in the case of simple desires, immediately recognized that the other person's behaviour implies desires similar to their own. This would be grounds for attributing a simple common-sense

psychology capacity to the child. In the same way, in seeking the most primitive building-blocks of common-sense psychology, we see it as relevant that the young infant apprehends a similarity between a particular pattern of externally perceived behaviour, a particular internal proprioceptive sensation, and the motor plan that is necessary to produce both the sensation and the behaviour.*

Infants are, apparently, never strict behaviourists: one fundamental assumption of mentalism—that external, visible behaviours are mapped on to phenomenologically mental states—is apparently given innately. Clearly infants have much to learn about the nature of mind, but apparently they need not learn that it, or something like it, exists, and perhaps not even that it is shared by themselves and others. Ironically, given the great Platonic philosophical tradition of devaluing bodies in favour of minds, it may, quite literally, be our knowledge of the body that leads us to knowledge of the mind. From a developmental viewpoint, knowing that we inhabit similar bodies to others, and assuming that they share our internal bodily states, might be an important precursor to assuming that they share more abstract mental states as well. A person is, after all, both a body and a mind, and for very young infants these two aspects of personhood may not be divorced.

THE ORIGINS OF INFANT IMITATION AND THE NOTION OF A SUPRAMODAL BODY SCHEME: RECENT DATA AND THEORY

The last ten to fifteen years have seen the establishment of a new area of infant research, that of early infant imitation. Classical developmental theories had considered the imitation of facial actions to be a milestone in social–cognitive development that was first passed at about one year of age (Piaget 1962). Although other types of imitation, notably hand movements and vocal imitation, were said to occur earlier, facial imitation was classically viewed as a late achievement because infants cannot see their own faces. If they are young enough they will never have seen their own face in a mirror. How can infants possibly match a gesture they see with an action of their own that they cannot see? How can infants come to bridge the gap between visible and invisible experiences? Because this question is so baffling for developmental theory, researchers for many years were content with the analysis that facial imitation first became possible at about one year.

Meltzoff and Moore (1977) challenged the consensus that facial imitation was late to emerge by reporting that twelve-to twenty-one-day-old infants imitated tongue-protrusion, mouth-opening, and lip-protrusion. Beyond the

*This capacity to map ones own internal sensations onto the behavior of others might form the aboriginal basis for a simulation device of the sort that has been proposed by Harris (1989, 1991), Johnson (1988), Gordon (1986), and Goldman (1987).

raw fact that young infants imitate, there are several subtle points raised in this study and the ones that followed that are relevant to theories about the origins and early development of common-sense psychology.

First, the facial gestures used were picked to help assess the specificity of the imitative effects and distinguish it from a general arousal response. If infants were simply being aroused by the sight of a human face (but could not imitate) they might make more oral movements when they saw a human face than when they saw no face at all. This would not support the inference of imitation; but the increased oral movements might be confused with imitation if the correct control conditions were not employed. In Meltzoff and Moore's work true imitation was demonstrated, because infants responded differentially to two types of lip-movements (mouth-opening vs lip-protrusion) and two types of protrusion actions (lip-protrusion vs tongue-protrusion). In other words, the results showed that when the body part was controlled, when lips were used to perform two subtly different movements, infants responded differentially. Likewise, when the same general movement pattern was demonstrated, a 'protrusion in space', but with two different body parts (lip-vs tongue-protrusion), they also responded differentially. The response was not global or a general reaction to the mere presence of a human being or a human face, because the same face was present in all these conditions, yet the infants responded differentially.

Another issue concerns the psychological basis of the imitation. It is critical to determine if young infants are restricted to some sort of reflexive mimicry, a kind of Gibsonian 'resonance' in which perception of human acts somehow 'directly' led to their motor production with no intervening mediation. To test this notion experimentally a pacifier was put in infants' mouths as they watched the display, so that they could only observe the adult demonstration, but not duplicate the gestures. After the infant observed the display, the experimenter assumed a passive-face pose, and only then removed the pacifier. Infants were then given 2.5 minutes to respond, during which the adult maintained this passive face regardless of the infant's response. The pacifier was effective in disrupting imitation while the adult was demonstrating. Infants' sucking reflexes took precedence over any tendency to imitate. In Gibsonian terms, it was as if the second tuning-fork was bound and forbidden to resonate while the first tuning-fork was sounding. In such a situation there would, of course, be no transfer of the tone from one fork to the other. However, the infants imitated the displays. The finding suggests that imitation, even this very early imitation, could be mediated by memory of the absent display (Meltzoff 1990*a*; Meltzoff and Moore 1977, Study 2; Meltzoff and Moore 1989).

There are also other data showing that the early imitation is not well characterized as a simple reflex. In particular, the imitative response was not simply triggered, or fired off by the sight of the adult display. The data

showed that the infants did not produce exact matches early in the response period. The first responses of the infants were often with the correct body part, but were only an approximation of the adult's act. Infants would move their tongues, but not produce full tongue-protrusions. Infants then appeared to home in on the detailed match, gradually correcting their responses over successive efforts to correspond more exactly ~~correspond~~ to the details of the display. The adult was sitting with a passive face all this time; thus the infant was comparing his or her motor performance against some sort of internal model or representation of what had been seen. For these reasons and others it seems more accurate to think of early imitation as intentional matching to the target provided by the other, rather than as a rigidly-organized purely reflexive response (Meltzoff *et al.* 1991).

Learning theorists could argue that all this is unnecessary. The subjects were twelve to twenty-one days old. Perhaps they had been trained to imitate during the first weeks of life. Infants could be conditioned to poke out their tongues to a ringing sound, or to an adult tongue-protrusion. Perhaps the conditioning of a few oral gestures is part of the natural interaction between mother and baby. To resolve the point, Meltzoff and Moore (1983) tested 40 newborns in a hospital setting. The average age of the sample was 32 hours. The youngest infant was only 42 *minutes* old. The results showed that the newborns imitated both the gestures shown to them, mouth-opening and tongue-protrusion. We can infer that a primitive capacity to imitate is part of the normal child's innate endowment.

These findings of early infant imitation were originally considered surprising, and sparked lively debate in the literature. Surprising though they may be, they have ~~have~~ now been replicated and extended in well over 20 different studies. Early imitation is a cross-cultural phenomenon: positive results have been reported in the US (Abravanel and Sigafoos 1984; Field, *et al.* 1982); Canada (Legerstee 1991); France (Fontaine 1984); Switzerland (Vinter 1986); Sweden (Heimann and Schaller 1985; Heimann *et al.* 1989); Israel (Kaitz *et al.* 1988); and rural Nepal (Reissland 1988). In short, the basic phenomenon reported by Meltzoff and Moore has now been documented by independent investigators, in different settings, using a variety of different procedures. At a phenomenological level, the finding of early facial imitation seems secure. Attention has now shifted from debates about the existence of early matching to a search for the mechanisms underlying this behaviour and its role in development, Meltzoff and Moore (1992).

There are several psychological mechanisms that might underlie this behaviour. The hypothesis suggested by Meltzoff and Moore is that imitation is based on infants' capacity to register equivalences between the body transformations they see and the body transformations they only feel themselves make. On this account early imitation involves a kind of cross-modal matching. Infants can, at some primitive level, recognize an equivalence

between the body transformations they see and the body transformations they only feel themselves make. On this account there is a primitive *supramodal body scheme* that allows the infant to unify acts-as-seen and acts-as-felt into a common framework. Meltzoff and Moore have argued that early imitation fits in with a larger network of perceptual and social-cognitive abilities that is also tapped by studies showing infant matching of facial movements and speech sounds (Kuhl and Meltzoff 1982, 1984) and other intermodal phenomena (Bower, 1977, 1982, 1989; Meltzoff and Borton 1979). We suggest that the supramodal body scheme revealed by early imitation provides the foundation for the development of the notion of persons and self-other equivalences in infants, as elaborated later in this chapter (see Meltzoff, 1990*b*; Meltzoff and Moore 1992).

USING OTHERS AS A SOURCE OF INFORMATION ABOUT ACTIONS ON OBJECTS: DEFERRED IMITATION AND MEMORY

The foregoing research with neonates concerns imitation of basic body movements. Such imitative behaviours reveal a capacity to map internal states on to externally perceived behaviour, a kind of aboriginal mentalism. The states that are so mapped, however, could not be construed as referential in any way. There is no sense in which either the bodily movements that are imitated, or the proprioceptive sensations and motor plans, involve anything outside the child or the other person. Later in development, however, we can see signs of what might be called 'proto-referential' imitation: imitation begins to be used as a mechanism for learning about how objects work. Children treat adults as a source of information about objects—they look to adults for guidance when they are uncertain how a particular novel object works, in a manner somewhat analogous to more traditional cases of social referencing (Campos and Stenberg 1981; Klinnert *et al.* 1983). Adult pedagogy often takes the form of showing the child that the object can be used in a peculiar new way. Certainly before language can be used with the child, much of the explicit teaching about the world by parents is done via showing the child what to do and trying to elicit a decent reproduction of the activity. Of course, the adult's goal is not just to get the child to 'mindlessly' perform the act on-line, merely mimicking the act when the adult is performing it and failing to access this new information at a later time, after a significant delay. The parents' goal is to bequeath something to the child, to have the child incorporate it into his or her repertoire, in a sense to truly make it his or her own. In the experimental literature, the ontogenesis of these phenomena is deeply related to the problem of 'deferred imitation'.

Children who do not treat adults as a source of information about the world, who do not learn from observing the acts of others (perhaps because they cannot map between the self and the other), would be at a developmental disadvantage. At what age do normally-developing children begin to

profit from deferred imitation? The classical view derives from Piaget, who thought that deferred imitation emerged contemporaneously with pretend-play, high-level object permanence, and productive language, at about eighteen to twenty-four months of age. We shall return to this potential connection between deferred imitation and pretend-play, partly motivated by Leslie's (1987, 1988, 1991) thesis that pretend-play is related to children's theory of mind, and partly because the recent data provide some new insights about the relation between play and imitation. To set the stage for this discussion we first provide a brief overview of some new studies on deferred imitation in normal children.

Meltzoff has conducted a series of studies on deferred imitation in infants ranging from nine to twenty-four months old. One of the studies with fourteen-month-olds has three interesting features: (a) it tested imitation after an exceedingly long delay, one week; (b) infants were required to remember not just one demonstration, but to keep mind multiple models—six different displays; (c) at least one of the acts was completely novel to the children. In particular, one object was a small wooden box with a translucent orange plastic panel for a top surface. The novel act demonstrated was for the experimenter to bend forward and touch the panel with the top of his forehead.

In this study, six different actions, each involving a different object, were shown to the infants (Meltzoff 1988*a*). Infants in the imitation group were shown all six actions on the first day of testing. They were then sent home for the one-week delay. Upon returning to the laboratory, the infants were given the objects one at a time to play with, and their behaviour was videotaped to determine how many of the target actions they reproduced. Two types of control groups were used. The control infants followed the same procedure as infants in the imitation condition, except that they did not see the target actions modelled on day 1, and so they had no memory of what to do with the toys. Like the infants in the imitation group, these control infants also visited the lab after a one-week delay. For the 'baseline' control group, the adult did not show the children the test toys on day 1, and simply talked pleasantly to the mother and child. This group assessed the spontaneous likelihood of the infants producing the target acts when they returned to the lab for the second visit. For the 'adult-manipulation' control group, the adult actively played with each of the objects during the first visit, but did not demonstrate the target acts themselves. This controlled for the possibility that infants might be induced into producing the target behaviour if they saw the adult approach and play with each object, even if the exact target action was not modelled.

The results provided clear evidence for deferred imitation. Of the 12 children in the imitation group, 11 duplicated three or more target behaviours on day 2, whereas only 3 of the 24 control subjects did so ($p < .0001$).

What is most striking is the aptitude these young infants exhibited for duplicating the novel act of using the forehead. Fully 67 per cent of the infants in the imitation condition produced this behaviour, as against none in the control conditions ($p < .0001$). Similar results have been reported showing deferred imitation in nine-month-old infants (Meltzoff 1988*b*), and these basic effects of imitation after a delay have been replicated and extended by Bauer and Mandler using a variety of tasks in infants between one and two years of age (Mandler 1990).

In the research discussed so far, an adult served as the model. In such cases the infants are directly mimicking with their own bodies acts that were seen in 3-D space with a minimum of differences between the the adult's actions and the imitative act. It is also of interest whether infants can perform deferred imitation when there is 'distancing' (Werner and Kaplan 1963) between the self and the display to be copied. Television presents a miniature, two-dimensional depiction of actions in three-dimensional space. Meltzoff (1988*c*) found that fourteen-month-olds could also perform deferred imitation (24-hour delay) of particular object manipulations they had seen on TV, even when they had only seen the novel object on television and were not exposed to the real, 3-D variant until twenty-four hours later. These results suggest that for toddlers imitation is not highly stimulus-bound, and can be accomplished even in the face of some distancing and generalization. More speculatively, the argument can be offered that these results also begin to address the developmental roots of children's capacity to use 'models' of reality to guide their action in space (DeLoache 1987, 1989; Perner 1991). The imitation-from-TV test would seem to be related to, but a developmentally lower-order task than, DeLoache's intriguing studies on the use of scale model analogies by children. In the case of TV displays, the child needs to learn something in one problem space, a miniaturized depiction of reality by the TV, and project it on to its own actions in 3-D space with no direct comparison between the two. (The children first saw the act done by an adult on TV and then after a 24-hour delay they were given the real object for the first time. During the test, the TV model was absent. So children had to apply what they had learned from seeing the 'other' act in miniaturized, 2-D format to their own behaviour with a 3-D toy in a new situation; for further discussion about what is involved here, see Meltzoff 1990*a*).

Older children and even adults learn more easily when the model is perceived to be more 'like me'. Hanna and Meltzoff (1989, 1990) conducted studies of peer imitation, in which infants were given the opportunity to watch and learn from other similar-aged playmates. In these studies some infants were trained to become 'infant experts' at particular tasks. Other infants, 'infant novices', observed these experts. In the 1989 experiment, the novice fourteen-month-old infants watched the expert fourteen-month-olds manipulate objects. A five-minute delay period was interposed, and then the

novices were presented with the test objects. The results showed that of the infants who watched the experts, 80 per cent produced three or more of the five targets modelled, as opposed to only 1 of 20 control infants ($p < .0001$). The striking level of success in these peer-modelling studies raises the (somewhat counterintuitive) possibility that in some cases infants may actually learn better from observing their peers than from the pedagogical forays of parents. Perhaps toddlers peers as more 'like me', and therefore the incorporation of the other's action as a basis for self-action is facilitated.

One wonders whether deferred imitation might be highly context-dependent at this age. Perhaps toddlers later re-enact actions only if they are in the same environment as they were when they first saw the demonstration. Imitation would be highly situation-bound. To test this we extended the peer-imitation paradigm (Hanna and Meltzoff 1990). The novices saw the expert perform actions in the laboratory. After a two-day delay, an adult experimenter went into the child's home and laid out the test objects. The results again showed strong evidence of deferred imitation. Infants who had previously watched the peer produced significantly more of the target acts than did controls—this despite the displacement in time (a two-day delay), space (the home context differed from the lab), and associated cues (the adult experimenter who tested the child at home was different from the experimenter used in the lab). This type of flexibility in observing others and then applying this knowledge in novel settings is characteristic of normal infants. It seems quite likely that children with autism would be more context-bound and would be less likely to generalize to novel situations anything they managed to pick up from another's modelling.

In these cases of deferred imitation children not only map perceived movements on to their own internal proprioceptive sensations and motor plans, they also do so with reference to objects. Not only do they seem to think 'this person is like me', but also to think that their responses to this object ought to be like the other person's. This suggests the beginnings of a shared attitude toward objects, in a way that is similar to the social referencing (Campos and Stenberg 1981; Klinnert *et al.* 1983) and joint-attention behaviours (Butterworth 1991; Butterworth and Jarrett 1991) that also appear at about this age in normally developing children. This synchrony in development may not be fortuitous.

MUTUAL IMITATION GAMES: A TEST OF 'LIKE ME' RECOGNITION IN INFANTS

Thus far we have shown that infants, from birth on, respond to the behavior of others by producing similar behaviour of their own, and we have suggested that this indicates a mapping between the behaviour of the other and the infant's own behaviour and internal states. If this is true the process should, as it were, run both ways. That is, infants should not only imitate adults, but should also recognize when the adult is imitating them. It is, after all, equally true in this case that the infant's behaviour and the adult's are equivalent.

A series of experiments were conducted in which an adult purposely imitated the child, with the goal of determining if the child could recognize that his or her own behaviour was being adopted by the adult (Meltzoff 1990*b*). We wanted to know if fourteen-month-old infants could recognize such self-other correspondence, and if so, the psychological basis for this recognition.*

There were three converging experiments. The first investigated whether or not infants showed any interest in seeing that their own behaviour was adopted by another person. Two adults sat across a table from the children. All three participants were provided with replicas of the same toys. Everything the child did with his toy was directly mimicked by one of the adults, who had been assigned as the imitator. If the child slid the toy on the table, the imitating adult slid his toy on the table in the same manner. It was as if the adult were tethered to the child, a puppet under the child's control. The second adult was not so tethered. This adult sat passively, holding the toy loosely on the table top.

We thought that if children could recognize that their actions were being matched, they would prefer to look at the imitating adult and also smile at him more. We also thought that children would investigate this relationship between the self and the other by experimenting with it. For example, children might modulate their acts by performing sudden and unexpected movements to check if the imitating adult was still conforming to their actions. This is a way of 'catching the adult out', a way of experimenting with the relationship between self and world.

The results showed that infants had an overwhelming preference for the imitating adult over the non-imitating adult. Infants looked significantly longer at the imitating adult, there were more smiles directed toward the imitating adult, and infants directed more 'test' behaviour at the imitating adult. Of course, this study alone does not establish that infants can recognize the self–other equivalence engendered when another human acts just 'like me'. Infants may simply be attracted to any adult who actively manipulates a toy, without invoking any detection of like-me equivalence.

* In a loose sense, we set up an experiment in which we could study infants' reactions to what Searle (1983) calls 'world to mind' relationships. The world (the imitating adult) could be modified and manipulated in accordance with the child's whim. Is the infant interested in this? What criteria do the child use to determine that the events in the world correspond to the child's own action: temporal contingency information or the structure of the action?

In a follow-up study, the general procedure was similar to that of the first study, but the control experimenter did not remain passive. Instead, this adult actively manipulated the toys. Furthermore, we wanted the adult not only to be active, but to do 'baby-like' things with the toys, so that no preference for the imitating adult could be based solely on a differentiation of adult versus infantile actions. We accomplished this by putting two TV monitors behind the infants, one monitor displaying the current infant and the other displaying the video record of the immediately preceding infant. The job of each adult was to mimic one of the infants on the TV monitors. Both adults performed in perfectly infantile ways, but only one matched the perceiving infant. Could the infants recognize which adult was a reflection of themselves, and which was acting like another baby? The results again showed that infants looked longer at the person who acted just like them, smiled more often at that person, and directed more testing behaviour toward him.

These effects cannot be explained as simple reactions to activity, for both adults were active. Nor can they be explained by saying that the infants recognized a generic class of baby-like actions, for both experimenters were copying the acts of babies. It would seem that the subjects are recognizing the *relatedness* of the actions of the self and the actions of the imitating other.

What is the basis for recognizing this sort of interpersonal relatedness? Two kinds of information are available, temporal contingency information and structural equivalences. On the first alternative, the child need only detect that whenever he does X the adult does Y. The child need not detect that X and Y are in fact equivalent, only that they are temporally linked. The second alternative is that the child can do more than recognize the temporal contingency between self and other. In particular, the child may be able to recognize that the actions of the self and other have the same form—that the adult is behaving 'just like me', not 'just when I act'.

To distinguish these alternatives a third study was conducted in which the purely temporal aspects of the contingency were controlled by having both experimenters act at the same time. This was achieved by having three predetermined pairs of target actions. Both experimenters sat passively until the infant performed one of the target actions on this list. If and only if the infant exhibited one of these target actions, both experimenters began to act in unison. The imitating adult performed the infant's act, and the control adult performed the other behaviour that was paired with it from the predetermined target list. What differentiates the two experimenters is not the purely temporal relations with the acting subject, but the structure of their actions *vis-à-vis* the subject.

The results showed that the infants looked, smiled, and directed more testing behaviour at the adult who imitated them. Thus even with temporal

contingency information controlled, infants can recognize the structural equivalence between self and other. In a very real sense, infants can recognize the reflection of themselves in an 'other'.

Normal children's games with their parents are often reciprocal in nature. The infant bangs a table top, the parent bangs in return, and so on. Theorists have emphasized the *temporal patterning* of these exchanges, the conversation-like turn-taking they embody (Bruner 1975, 1983; Stern 1985; Trevarthen and Marwick 1986). Without minimizing the importance of timing, our experiments highlight the importance of the commonality in the structure of the bodily movements. The new data show that when temporal contingency information is equated, young children still can detect which of two adults is conforming to the child's own behaviour. Moreover, these data demonstrate that when normally-developing children are given a choice, they preferentially attend to the adult who is matching them, and also smile more at this adult. The children respond socially, with increased looking and smiling, to an adult who is acting in the same way/manner/form that the infant is. Even before spoken language, normal infants seem to notice and appreciate this 'meaningful contact' with an other.

It is possible that children with autism have, among other deficits, an impairment in the capacity for recognizing the cross-modal isomorphisms between their own body movements and the movements of others; this would be compatible with Rogers' and Pennington's (1991) theory of autism. If so, such children might find such interactions less predictable and enjoyable than normally developing children. This would be unfortunate, because mutual-imitation games are a unique and important constituent of early interpersonal growth. Adults are both selective and interpretative in the behaviour they reflect back to the child. They provide interpretative imitations to their infants' reflections that capture aspects of the infant's activity, but then go on beyond it to read in intentions and goals to that behaviour. The infant may wave an object, but the parent interprets this as waving in order to shake, and therefore waves intensely enough to shake the toy and produce a sound. This, in turn, leads the infant beyond his or her initial starting-point. Likewise, selected actions, especially those that are potentially meaningful in the culture, will be reflected back more often than others, as part of a larger process that Bruner (1975, 1983) has called 'parental scaffolding'. Children who had a disturbance in the ability to recognize interpersonal sharing at the level of motor imitation would not profit from such scaffolding in the same way as normally developing children. Thus, deficits in motor imitation and/or the cross-modal body scheme that underlies it could have extended developmental consequences.

IMITATION AND DEVELOPMENTAL PSYCHOPATHOLOGY–DOWN'S SYNDROME AND AUTISM

Unlike autistic children, children with Down's syndrome seem quite social; they smile at people and seem to enjoy interactions with them. Imitation has rarely been tested experimentally in this population (but see Dunst 1990), and the capacity for deferred imitation in particular has not been assessed.* Rast and Meltzoff (1991) adapted Meltzoff's deferred-imitation paradigm so that it could be used with young Down's syndrome children. A total of 48 children between the ages of twenty and forty-four months old were tested. A five-minute delay was used between the modelling period and the test of imitation. All the children were also given object-permanence tests to evaluate relations between the emergence of deferred imitation and high-level object-permanence skills.

As expected, the children were delayed in their understanding of object permanence. On average these children passed the A-not-B task (passed at about one year of age in normally developing children), and failed more complex tasks. Despite this retardation on object permanence, there was strong evidence for deferred imitation within the sample. We also divided the sample into 'young' (20–24 months) and 'old' (25–44 months) children. Deferred imitation was evidenced in both age-groups, though it was slightly stronger for the older children. It is highly relevant for theory that the young group succeeded on deferred imitation, although not one of the young children passed high-level object-permanence tasks typical of 'stage 6' functioning (serial invisible displacements).

This pattern of results is quite baffling for classical theory, which postulates that deferred imitation (re-enacting an invisible action from memory) and high-level object permanence (determining the location of a now-invisible object) emerge contemporaneously and are developmentally interdependent (Piaget 1952, 1962). On classical theory, one is led to ask why deferred imitation should be spared in Down syndrome children and object permanence retarded. At a more general level, such a pattern of results would support the idea of 'developmental deviance' in Down's syndrome children, inasmuch as two achievements that are synchronized in normally-developing children are broken apart in this syndrome. On this view, Down's syndrome children do not progress through the normal stages in a slowed-down manner, but rather show selective retardation in some areas (object permanence) and not others (deferred imitation).

* There are many studies of object permanence, play, categorization, memory, and other infant skills in Down's syndrome children, but fewer experimental studies of imitation. In the studies that have assessed immediate imitation, controls of the type discussed in the foregoing sections have not been used, which means that it is difficult to distinguish true imitation from simpler types of social learning (see Meltzoff 1988*d* for a detailed discussion of the necessary controls for isolating true imitation versus social facilitation, stimulus enhancement, and so on).

Looked at from the viewpoint we have developed here and elsewhere (Meltzoff 1990*a*), however, the Down's syndrome pattern does not show 'deviance' from the normal pattern. We have presented evidence that the classical theory had profoundly underestimated imitative capacities, that capacities which were once thought of as late to emerge are actually building-blocks for development, and occur far earlier than has been assumed. In particular, we found that deferred imitation did not first arise in the 18–24-month age-group, but could be readily elicited in 9–14-month-old children. What this means is that the Down syndrome results match the pattern found in normally-developing children quite closely: infants can perform deferred imitation well before solving 'serial invisible displacement' tasks on object permanence, and this appears to be true both in the normal and in this atypical population.* This underscores the necessity for inter-disciplinary collaborations between those working with normal and atypical populations (Cicchetti 1989, 1990; Rutter & Garmezy 1983). If we are misinformed about the 'normal pattern' of psychological growth, we may mistake delay for deviance, and obscure underlying developmental patterns.

This immediately raises the question of autism, which does seem to be a case of developmental deviance. In relation to matched controls (often Down's syndrome children), autistic children show an impairment in social relations and communicative functioning. Autism seems to be a syndrome in which there are specific deficits, and not merely general retardation, although there is debate about the specificity of the impairments, as well as their origins and development (Baron-Cohen 1988, 1989, 1990, 1991*a*; Dawson and Lewy 1989*a*, *b*; Frith 1989; Hobson 1989, 1990*a*, *b*, *c*, 1991; Leslie 1987, 1988, 1991; Rogers and Pennington 1991; Mundy and Sigman 1989; Sigman 1989; other chapters in this volume). As frank 'outsiders' to the field, we tread with caution; none the less, there does seem to be something that can be added to the current debate by taking seriously the lessons from normally-developing and Down's syndrome children that have here been discussed.

In particular, we have presented data and thoughts as to the foundational role that imitation and cross-modal co-ordination play in the normal development of social and cognitive abilities. In a nutshell, we have proposed that the first act of common-sense psychology is the perception: 'here is something like me.' A disturbance to this primordial sense of kinship should

* Indeed the nine- to fourteen-month-old normally-developing children who solved our deferred imitation tasks would be predicted to be at about the A-not-B stage of object permanence, (finding an object from memory) just as was found in the Down's syndrome population. For a discussion of differences between object permanence and deferred imitation, see Meltzoff 1990*a*.