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Born to Learn: What Infants Learn from Watching Us

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Imitation is a powerful form of learning commonly used by children, adults and infants. A child's enthusiasm for imitative behavior prompts parental attention and interaction, and provides a mechanism for transmitting appropriate cultural and social behavior. Although simple imitative behavior is evident in the postnatal period, by around 14 months infants remember and repeat actions they observe in adults, other children, and on television. Imitation games provide early experience in mapping the similarities between self and other. Behavioral imitation, empathy, and moral sentiments may be part of the same developmental pathway.

Introduction

Parents are being assaulted with information about their role in child rearing. Some headlines claim "parents don't matter." Others lead parents to feel guilty because they matter too much — early experience is destiny. Society is asking questions about the origins of thought, emotion, language, and personality. How should developmental scientists respond?

First, we should realize that the spotlight is on us. From the White House to the state legislature, there is interest in research on early learning. Discoveries reported in *Science* and our professional meetings are rapidly picked up by the media. Research about the mental life of babies no longer creeps quietly into the professional literature.

Second, basic researchers do not have to give up their day job to respond to society's call. Our studies of child development needn't promise to cure teenage violence. There is plenty of room for those who want to stay close to the laboratory to study the basic mechanisms of learning and psychological development. Today's cutting-edge research turns into tomorrow's applications, and we can communicate that to policymakers.

Third, we can play a role in communicating the empirical discoveries to parents and health-care professionals. This does not mean distorting the research. Rather, we should treat mothers as intelligent consumers of information. Sharing the scientific discoveries can help them in two ways. Learning that babies and young children think, want, intend, and even perform their own mini-experiments helps people see and enjoy babies in new ways. After all, such discoveries keep scientists going late at night, why shouldn't it

do the same for parents?[1]. Also, communicating research and the scientific process can inoculate parents from the pseudo-science that surrounds them. We may not be able to stop the emergence of institutes that claim to build better babies but we can intrigue parents and policymakers in the value of genuine science. If astronomers can intelligently discuss the origins of the universe in newspapers carrying astrology, we can discuss the origins of mind despite the pseudoscientific promises of those who claim to create super-babies with pumped up IQs and aesthetic tastes.

The goal in this paper is to organize a body of knowledge on early learning that should be useful for health-care providers and policymakers. The new research shows that infants are carefully watching our actions and committing them to memory. Babies naturally do as we do, not as we say. And what they see influences their behavior even after long intervals. Parents matter because babies are learning from us. Young children, even infants, look to us for guidance. This empirical research fascinates parents and has policy implications [2].

Born to Learn

Human beings are the most cognitive complex and behaviorally flexible of animals. Evolution has used an unlikely trick for achieving this state. Relative to most other animals we are born "immature" and helpless [3,4]. Our extended period of infantile immaturity confers us with benefits. It allows us to learn and adapt to the specific physical environment into which we are born. Instead of relying on fixed reflexes adapted for a narrow ecological niche, our learning capacities allow us to colonize a wide range of ecological niches, from the Arctic to the Equator, modifying our dress and shelter accordingly. Also, it allows us to learn about the social environment. We organize ourselves into more different kinds of social groups, different cultures, than other species. Human cultures differ in terms of food, beliefs, and customs. Evolution's trick is that we are born to learn. Learning is to behavioral psychology what brain plasticity is to the neuroscience.

Not surprisingly, we have evolved a special and very powerful form of learning. That special form of learning is "imitation," the ability to learn behavior from observing the actions of others. Imitation is so commonplace among adults and children that it is often overlooked in infancy, but infants make good use of imitation. Understanding imitation in infancy changes the way we look at infants. In so doing, it changes the way we look at ourselves, because we begin to see ourselves reflected in the behavior of our youngest children.

The Value of Imitative Learning in Infancy

It is obvious that infants do not have the skills of adults, what accounts for the developmental change? There are at least four sources of behavioral change in infancy: maturational changes in the sensory, motor, and cognitive system, trial and error learning, independent invention and discovery, and imitative learning. The first three sources of behavioral change have been widely celebrated in the developmental literature, often at the expense of the fourth. A review of supporters of the first three reads like a *Who's Who* in psychology. Maturation was celebrated by Gesell in his famous studies on infancy at Yale. Trial and error learning was championed by Skinner. Independent invention and solitary discovery lay at the center of Piaget's theory. Missing from this list is a strong advocate for imitative learning. Bandura has emphasized the role of social learning in school-age children, but even he did not trace the origins of imitation back to infancy.

Imitative learning is useful for infants. It is more flexible and responsive to cultural norms than Gesell's maturation. It is safer than Skinnerian trial and error learning (who would want their own baby restricted to learning from dangerous errors?). It is faster than relying on Piagetian solitary discoveries. Our research program has been devoted to showing the importance, power, and functional significance of imitation to preverbal children [5,6].

Learning to Use Novel Tools by Imitation

Human beings are consummate tool users, and some have argued that this played an important role in our evolutionary history. We use levers, wheels, and computers which enhance our natural powers. Evolutionary biologists used to think that tool use was unique to humans. Modern studies of animal behavior show that chimpanzees and other animals sometimes use simple tools to achieve their ends. Jane Goodall found that chimpanzees use sticks to fish for nutritious termites, for example.

Research has now shifted from simple documentation to finding out how animals learn to use tools. Mother chimpanzees do not deliberately instruct their young in the art of stick manufacture and use, and there is only scant evidence that the young learn by imitating their elders. Instead, the babies learn at first by picking up discarded sticks and enjoying a few remaining morsels. This gets them close to the termite nest while holding the tool, and trial and error learning and independent discovery cement the skill[7].

In contrast, the human dyad is composed of parents who intentionally teach and babies who are prolific imitators. For the purposes of this chapter, I want to focus on the babies, because they imitate even when we do not deliberately teach them. Consider the Western baby's favorite toy — the toy telephone.

There is nothing "natural" about holding objects to our ear while we speak to invisible people. However, our babies use toy telephones in this manner.

They also pretend that other objects, like bananas, are telephones. Why do Western babies act this way? It is not due to maturation, trial and error learning, or independent discovery. It is attributable to imitative learning. Babies watch as we drop everything and dash to pick up the ringing telephone. Some of us carry telephones in our cars, on our belts, or in our purses. They must be important objects to command so much attention, so they are among the baby's favorite playthings.

We can conduct laboratory studies showing that very young infants observe and remember the way we use objects. In one study, 14-month-old infants were shown how to perform particular actions on six novel objects. Each of the actions was demonstrated, but the experimenter never used the words, "do what I do" or "copy me." He simply performed the actions on the objects and then put the objects away. The infants were not allowed to touch the objects but were confined purely to watching what the adult did. This insured that there was not any reinforcement or shaping by the adult. A 1-week memory delay was then interposed to assess whether the experience of watching the adult had an effect on the child's behavior [8].

One of the actions was intentionally designed to be quite unusual. The object was a flat box with a yellow top panel. The adult looked at it, and then leaned forward and touched it with the top of his head, which made the top panel light up (Fig. 1). The experimental question was whether the infants would imitate what they saw the adults do.

To make certain it was imitation, two other groups of infants were tested. Infants in Control-1 were not exposed to the adult model. They were simply given the toys to play with. This tested whether infants this age would produce the target actions spontaneously or by chance. Infants in the Control-2 group watched the same adult manipulate the same objects for the same length of time as in the Imitation group– however, the adult did not demonstrate the target behaviors. This group controlled for the possibility that the infants would be "generally interested" in the toy because the adult was seen manipulating it, and that production of the target behavior resulted from trial and error.

The results demonstrated imitation after the 1-week delay. Infants in the Imitation group produced significantly more of the target acts than did infants in either of the control groups. Moreover, infants even performed the novel action of head touching (Fig. 1). Fully 67% of the infants in the imitation group leaned down and touched the panel with their forehead when they were first presented with it after the 1-week delay. This is dramatic evidence for the power of imitative learning. None of the 24 control infants spontaneously leaned forward and touched the panel with their heads. This experiment illustrates that infants carefully watch what we do and repeat those actions when they are given a chance.

Figure 1. A 14-month-old infant imitating the a novel action of touching a panel with the forehead Infants often react with a smile, as shown in photo 6.

How Lasting are the Effects of Early Social Experience?

What babies do, and how they behave with objects, often depends on what they have seen others do. Questions about how long their imitative learning lasts can be addressed by studies of what is called "deferred imitation." In one study, we demonstrated actions on objects for 14- or 18- month-ols infants and then imposed a 2-month or 4-month memory delay [9]. The infants remembered and imitated up to the 4-month delay, and they did so regardless of their age when they first acquired the information.

The results taught us something interesting about infant forgetting. Infants are not like (proverbial) elephants: They *do* forget. Fig 2 shows that with increasing delay, there was a decline in imitative performance (although performance after the 4-month delay was still above control group levels). The results also reveal that the sharper drop off was between the immediate and 2-month delay, rather than the 2- and 4-month delays. It thus seems that infant memory is like adult memory in that respect. Not all events make it into long-term memory (as shown by the large difference between the immediate and 2-month performance) but once an event is locked into long term memory it is long lasting, and only gradually fades.

The mothers who accompanied them were truly amazed at the duration of their child's memory. By their own report, they began to realize that what their baby saw them do made a long-lasting impression on the child, and this altered their conceptions about what was going on in their babies' minds.

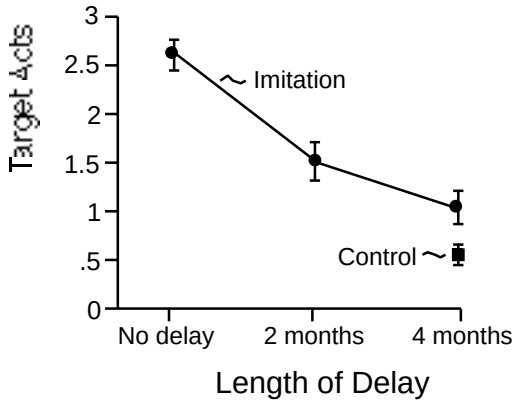

Figure 2. Mean number of target acts produced as a function of memory delay. Infants remembered even after the 4-month delay, showing significantly higher performance than the controls at each delay.

Early Memories Can be Accessed in New Contexts

Another question that arises concerns whether early memories are highly constrained or generalizable. An example makes this clear. In a series of studies Rovee-Collier showed that 3- to 6-month-old babies can learn to kick their feet to make a mobile move [10]. She also discovered that if she inserted a delay of a few days, the babies would remember to kick when they saw the mobile again. These young babies looked pretty sophisticated. Further research, however, showed stunning limitations. The memory was highly context bound. Everything had to remain exactly the same for the infant to demonstrate memory. If infants were trained to kick in one crib and then moved to another crib where they saw the same mobile, their earlier experience had no effect. They had to learn all over again to kick to make it move. If the crib was moved to another room, they also failed to remember. The clinching experiment showed that even if babies were tested in the exact same crib in the same room but with a different pattern on the crib liner, their performance dropped to chance. They stared blankly at the mobile as if they had never seen it before just because they now saw it in a new context.

I wanted to test whether imitative memory was context bound. If so, when infants learned something in the living room, they should not be able remember and imitate it in the kitchen. Such context-bound learning could be interesting in the laboratory, but it would not have very far reaching implications in everyday life.

In our study, infants watched an adult demonstrate actions on objects within an odd-looking tent [11]. The tent was constructed of orange and white polka dots and extended from floor to ceiling filling the infants entire field of view (Figure 3). Mothers were asked to wear a blind-fold so that they were kept blind to what the infant saw. A series of three studies was conducted with 12-month-old infants.

In Experiment 1, infants were randomly assigned to one of six independent groups. Infants in the two control groups did not see the target demonstrations so that the likelihood that they would produce the target acts by chance could be assessed. In the four experimental groups, length of delay (3-minute or 1-week) was crossed with context (no context change or context change). The context change infants saw the initial demonstrations in the polka-dot tent and were subsequently tested in the plain laboratory room. In the no-context-change infants saw the initial demonstration in the plain room and were subsequently tested for memory in that same room.

The results were clear. Infants produced significantly more target acts after both the 3-minute and the 1-week delay and they did so equally well, whether or not they changed context. Although there was a significant reduction in performance after the 1-week delay, showing forgetting, infants in the 1-week delay still produced significantly more target acts than the controls.

In the next experiment we instituted a larger, more ecologically-valid change in context by conducting the experiments in the infants' homes. Infants in the imitation group saw the adult demonstrate target actions at the kitchen table, on the living room floor, or other familiar play spaces. Infants in the control group were also visited at home by the experimenter but did not see demonstrations. After a 1-week delay, infants came into the laboratory and

Figure 3. The polka-dot tent. Infants who learned in this context transferred their knowledge to more ordinary rooms.

were tested by a different experimenter. Thus infants were tested in a novel context by a novel adult. The results showed that infants in the imitation group produced significantly more target acts than controls, again demonstrating long-term memory and generalization across a change in context.

Finally, we increased the length of the memory delay to 4 weeks. The results showed that 12-month-olds remembered the actions they saw for 4-weeks and easily generalized across the change in context. Taken together, this research established that imitative learning can be recovered in new settings. What infants see adults do affects their behavior even when we are not there to watch them. They carry the lessons they learn from us wherever they go.

Learning from Peers in Day-care Center

The ecology of child rearing is changing in the United States. With the increase of women in the work force, infants are spending increasingly more time with peers in day-care settings. This raises the question – Do infants learn from and imitate the their peers in day-care centers and other sites? In al previous experiments, adults were used as models. In the next series of studies we moved into the field, examining peer imitation in day-care centers and homes [12].

The first study developed a controlled procedure for assessing peer imitation. Fourteen-month-old infants observed "tutor infants," 14-month-olds previously trained to play with the toys in novel ways. After observing the peer play with five objects, the "student infants" left the test room. They returned 5-minutes later and were presented with the test objects in the absence of the peers. The results showed imitation (see Figure 4). A second study used a day-care setting. The "tutor infant" was strapped into a car seat and driven to a variety of day-care sites. As the naive infants sat around a table, drinking juice, sucking their thumbs, and generally acting in a baby-like manner, the tutor picked up and acted on novel toys in particular ways. The naive infants were not allowed to approach or touch the toys. After a 2-day delay, a new experimenter (not the one who had accompanied the tutor) brought a bag of objects to the infants' homes and laid them out on a convenient table or floor. Neither the parent nor this new experimenter had been present in the day-care center 2 days earlier. The only person who knew what actions had been demonstrated was the "student-infant" him- or herself. The results showed significant imitation.

The fact that infants readily imitate actions they see performed by peers in day-care, and will bring those lessons home with them, indicates that imitation may play a role beyond the laboratory. Evidently, even prelinguistic infants are influenced by their peer groups at school.

Figure 4. (A) An "tutor infant" demonstrates how to pull apart a novel toy. (B) After a delay, the "student infant" imitates from memory of the peer's action.

Does it Matter that Infants Watch TV?

Of today's American homes, 99% have at least one TV set [13]. According to a Nielsen report, the average 2- to 5-year-old views about 28 hours per week of TV. There is evidence for purposive, selective, and systematic viewing in children between 2 and 3 years of age [14], and research has revealed that by 3 years 75% of American children can name their favorite TV program [15]. No wonder the American Academy of Pediatrics issued new recommendations about children's TV viewing in the summer of 1999.

Although little work has been done concerning the amount of TV viewing by children under 2 years of age, home observations of infants reveal TV viewing interspersed throughout the infant's day. Perhaps the most striking empirical evidence for the impact of TV on infants comes from work on TV exposure and early language. In one study, a 23-month-old listening to a commercial jingle suddenly began to croon, "Coke is it, Coke is it, Coke is it." Another repeated "Diet Pepsi, one less calorie" [16].

This suggests that the audio track of TV may be picked up by infants, but it does not show that the visual images have a similar effect. There is little difference between "real" and "TV" speech, but not so with the visual modality. Television pictures present a miniaturized, two-dimensional depiction of three-dimensional space. Mae West did not want to appear on TV because she despised being reduced to anything less than full size.

Can infants relate the activities they see on a miniature, 2D screen to the real, 3D world? To answer this it is not enough to know that infants are fascinated by TV. They may be attracted to the visually changing mosaic of

colors. Visual attention does not mean that they "understand" or can "decode" what they see.

I used infants' tendency to re-produce events to get at this question [17]. I tested imitation from TV in a total of 120 infants at two ages, 14 and 24 months. In an immediate imitation condition, infants watched an adult's action on TV and were allowed to copy with little delay. In the deferred imitation condition, infants watched the action on TV, but were not presented with the real toy until they returned to the lab after a 24-hr delay. The results showed significant imitation at both ages and that 14-month-olds imitated after the 1-day delay (see Fig 5).

The real objects were not in the infant's perceptual field during the televised display, so they did not have the opportunity of looking back and forth between the TV depiction and the real objects. Nonetheless, the results showed that infants used their memory of the TV action as a guide for how they should behave with the objects when they were exposed to them in the real world. In this sense, we can say that infants can understood the actions they saw on TV and mapped them to the real 3D world.

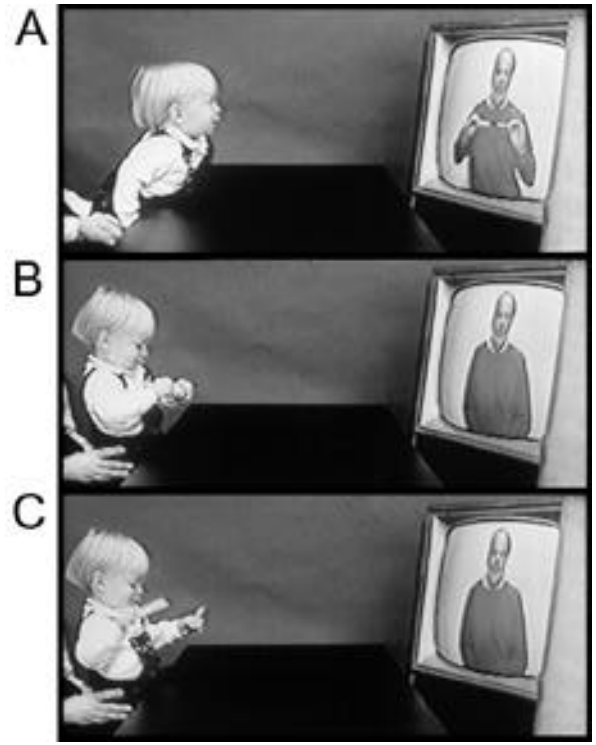

Figure 5. Infants as young as 14 months old imitate what they see on TV.

Admittedly, the test action was very simple and was purposely performed in a slow and deliberate manner. But knowing these results changes one's attitude. It is relevant to the debate of whether we should show young children television depicting violent uses of knives, guns, or other weapons that may be around the house [18,19]. At least under ideal viewing conditions such as those used in the laboratory experiment, infants can learn from TV and will repeat what they see there. It is sobering.

Good-Enough Models: Infants Understand Our Intentions

In the studies discussed so far, the adult always demonstrated a well-formed act. The adult touched his head on a panel or pulled apart an object several times in plain view of the infant. In everyday interactions with children, however, we are hurried, and harried, and we do not behave perfectly. We often make mistakes and fail to complete our acts. The adult viewer "smooths over" this sloppiness. We hardly see the slips and mistakes, but rather "see through" to what the adult was trying to do. Similarly, in language we often resort to, "You know what I mean," because we expect that from our interlocutor. The fact that we expect to see through meanings is apparent when we interact with computers. Computers take everything literally: "You stupid computer, don't you know what I mean!" The eerie literalness of computers makes them all the more inhuman.

At what age do babies begin to read what we "mean to do" even if we don't successfully do it? When can they begin to understand the intentions lying behind our bumbling behavior? To address these questions, I traded on the infant's proclivity for imitation, but I used it in a new, more abstract way. I was not interested in whether the infants imitated the literal surface behavior shown to them, but whether they read beyond the literal surface behavior to re-enacted something more abstract — the aim, intention, or goal of the act — even if it was not seen.

In this experiment 18-month-old infants were shown a series of unsuccessful acts [20]. For example, the adult tried to perform a behavior, but his hand slipped. Thus the object was not transformed in any way, and the goal-state was not achieved. For other acts, the adult accidentally under- or overshot his target. To an adult, it was easy to read the actor's intentions. The experimental question was whether infants also read through the surface behavior. The infants, who were too young to provide verbal reports, informed us how they interpreted the event by what they imitated. The results showed that infants could infer the goal of the act, even though it was never seen or achieved. Most infants re-enacted what the adult meant to do, not what the adult actually did do.

This experiment indicates that infants can pick up information from the failed attempts of human actors. What if infants see the same movements

produced by an inanimate device? A device was built that did not look human but nonetheless could mimic the movements of the actor. The device had pincers that "grasped" the dumbbell on each end (just as the human hand did) and then pulled outward. These pincers then slipped off one end (just as the human hand did). The pattern of movements and the slipping motions were closely matched to the human hand movements (see Figure 6).

The infants were riveted by both displays; visual attention to the displays exceeded 98% for both. They were not more frightened by one display than the other. The groups differed significantly, however, in their tendency to produce the target act. Infants who saw the human's failed attempt were six times more likely to produce the target than infants in the other group. In fact the infants who saw the movements of the inanimate device behaved virtually identically to infants in a baseline control group.

It appears that by 18-months infants are already beginning to adopt an "intentional stance" toward their fellow human beings. They make an important differentiation between the acts of humans and the movements of inanimate devices. Human acts are not interpreted as mere movements in space, the transformations of an automaton with no deeper meaning. When they see an action they "read beyond" what was literally done, and infer the goal or intention that lies behind it. This intention-reading skill we found in the laboratory also plays itself out in everyday life. It is probably why we feel that normally developing infants "get the gist" of what we are doing. Even though we may not act perfectly, toddlers respond to what we mean to do, rather than what we literally do. I have argued that this intention reading is an essential baby step toward the development of a theory of mind, the idea that other humans do not just behave but have internal thoughts, emotions, and desires. [21-24] In my view, the development of understanding the intentions of another person may be a crucial first step along this developmental pathway [25,26].

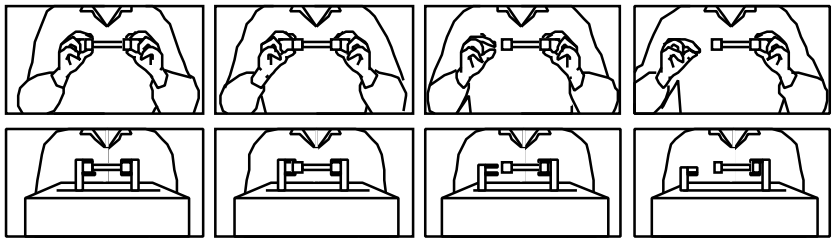

Figure 6. Human demonstrator (top panel) and inanimate device mimicking these movements (bottom). Infants attributed goals and intentions to the person but not to the inanimate device.

Infants Enjoy Being Imitated: The Nature of the Imitation Game

The social-developmental literature has reported that sensitive, middle-class parents play hours of imitation games with their babies. Infants shake a rattle and parents shake back; infants vocalize and parents do likewise. In the literature the turn-taking aspect of these games is emphasized, the "rhythmic dance" between parent and child [27-30]. But there is more to these games, however, than the timing. There is an additional value in the similarity of *form* in the participants' behavior. Reciprocal imitative games provide the infant with special information about how they are like other people and how others are like them.

The salience of such behavior matching was tested in a series of studies with 14-month-olds [31]. In these studies the infant sat across a table from two adults. One of the adults matched everything the infant did, and the other busily matched the behavior of a previous infant. Thus, both adults were acting like perfect babies, but only one adult was acting just like the subject being tested. The results showed that infants directed more visual attention and smiled more at the person who was imitating them. They preferred an adult who was playing a matching game.

Why did they prefer the adult playing the imitation game? At issue is whether infants prefer people who are acting "just *like* they act" (structural congruence) or "just *when* they act" (temporal contingency). To distinguish these alternatives I did another study in which both adults' actions were equally contingent on the infant's. Both experimenters sat passively until the infant performed one of the target actions on a predetermined list, and then both experimenters began to act in unison. One of the adults matched the infant, the other performed a mismatching response. The results again showed that the infants looked and smiled more at the matching adult. This proves that infants are sensitive to being imitated per se, not simply to the temporal contingencies.

This demonstration has several implications for clinical and applied work. In naturalistic interactions parents speak in high-pitched, sing song "Motherese." Within the speech literature it is often remarked that the high fundamental frequency and pitch swoops may be alerting [32]. Given the current research, an additional reason that "Motherese" may be preferred by infants is that it is closer to the form of their own vocal productions. From a broader perspective, there may be deep psychological reasons why infants find mutual imitation games satisfying. It is interesting that therapists and marriage counselors often advise people to mirror back the thoughts and feelings of their partners. Patient: "I feel good about making that decision." Therapist: "You feel good?" Being imitated, having one's own behavior be reflected by another, is a very salient experience for adults and facilitates communication. What we have discovered is that for the littlest humans, mirroring back behavior is also salient and affectively pleasing. It is no wonder then that parents and children

gleefully play mutual imitation games for long periods. If imitation is the sincerest form of flattery, infants and young children, like adults, apparently like to be flattered.

Innate Imitation

So far I have discussed research in children in the second year of life – but imitation does not start there. Research in our laboratory has shown that there is a primitive capacity to mimic the actions of others starting from the neonatal period. In 1977, our research showed that 2- to 3-week-olds imitated tongue protrusion, mouth opening, lip protrusion, as well as simple finger movements (see Fig 7) [33]. Because these findings did not fit with classic theory, they were initially the topic of much discussion in the field. The findings of early behavioral matching have now been replicated and extended in this country and cross-culturally in more than 24 different studies [34]. The effects are secure. The question is "how do infants do it?"

One possibility is that they learn to imitate very rapidly, during face-to-face interaction with their mother in the first few weeks of life. To test this we investigated newborns in a hospital setting. The average age of the infants tested was 32 hrs old, and the youngest infant was only 42-minutes-old at the time of the test. The results again showed successful imitation [35,36]. Evidently, some primitive capacity for behavioral matching is present at birth.

Figure 7. Imitation is natural to babies. These photographs show imitative responses in 2- to 3-week-old infants.

Our hypothesis is that neonatal imitation is mediated by a process of "active intermodal mapping". The crux of this hypothesis is that imitation, even early imitation, is a matching-to-target process [37,34]. The goal or behavioral target is specified visually. Infants' self-produced movements provide proprioceptive feedback that can be compared to the visually-specified target. Active intermodal mapping proposes that such comparison is possible because the perception and production of human movements are registered within a common "supramodal" representational system. Thus, although infants cannot see their own faces, their faces are not unperceived by them. They can monitor their lip and tongue movements through proprioception and compare this felt activity to what they see. Metaphorically, we can say that perception and production speak the same language; there is no need for "associating" the two through prolonged learning because they are intimately bound at birth. In this view, infants may use imitation for subsequent learning; but they do not have to learn to imitate in the first place.

Conclusion: Some Developmental Speculations on the Role of Early Social Experiences

We are now in a position to examine the innate structure infants bring to their first encounters with people and how this starting state is transformed through interpersonal interaction.

Let's start at the beginning. When a human act is shown to a newborn baby, it may provide a primordial "aha" experience. Human acts are especially relevant to infants because they look like the infant feels himself to be and because they are things infants can intend. They may register: "Something interpretable: That seen event is like this felt event." On this view, it is not simply the features of the adults that are special for infants but the way the body moves and its relation to the self. Because human acts are seen in others and performed by the self, the infant can represent the other as "like me." Thus the newborn is not a social isolate but is provided with a bridge connecting self and other. The imitation of bodily movements is a mechanism for making a primitive connection between self and other right from the beginning of infancy.

Imitation is not only an initial toe-hold in self-other mapping, but also provides a means for elaborating it. The same cognitive machinery that enables infants to imitate allows them to recognize when the social other is imitating them.

Human parents often act as good therapists, mirroring (and interpreting) the infants thoughts, feelings, and behaviors. When parents select certain behaviors to respond to in this way, it has significance not only because of the temporal contingencies involved, but because infants can recognize the structural similarity between the adult's acts and their own. Imitative play thus offers a special channel for early communication, in which the timing and the

form of the behavior give both partners an opportunity to share in the exchange. Mutual imitation produces a powerful impression in both the infant and caretaker that they have psychologically "made contact," that they are in relationship.

Infants' ability to detect that something out there in the world is like them and can do what they do has cascading developmental effects. The reciprocal imitation games between parents and infants serve a didactic function prompting infants to elaborate a sense of self and self-other correspondences beyond the neonatal level. The developmental progression would be from seeing a person as someone who behaves as they do, to seeing a person as someone who shares deeper equivalences (such as goals, desires, and intentions) – and further along the developmental pathway — as someone deserving empathy and moral rights equivalent to one's own.

Imitation is thus thoroughly reciprocal both for the baby, parent, and researcher. It is a channel through which we can learn about the infants' mind, but also an avenue by which they come to understand ours. Infants are born to learn, and they learn at first by imitating us. This is why imitation is such an essential and far-reaching aspect of early development: It is not just a behavior, but a means for learning who we are.

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