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Early Imitation Within a Functional Framework: The Importance of Person Identity, Movement, and Development

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Abstract

Facial imitation was investigated in infants 6 weeks and 2 to 3 months of age. Three findings emerged: (a) early imitation did not vary as a function of familiarity with the model—infants imitated a stranger as well as their own mothers; (b) infants imitated both static facial postures and dynamic facial gestures; and (c) there was no disappearance of facial imitation in the 2- to 3-month age range, contrary to previous reports. Two broad theoretical points are developed. First, a proposal is made about the social and psychological functions that early imitation serves in infants' encounters with people. It is argued that infants deploy imitation to enrich their understanding of persons and actions and that early imitation is used for communicative purposes. Second, a theoretical bridge is formed between early imitation and the "object concept." The bridge is formed by considering the fundamental role that identity plays in infants' understanding of people and things. One of the psychological functions that early imitation subserves is to identify people. Infants use the nonverbal behavior of people as an identifier of who they are and use imitation as a means of verifying this identity. Data and theory are adduced in favor of viewing early imitation as an act of social cognition.

Keywords

imitation; faces; cross-modal; memory; mental representation; categorization; object identity; mother–infant interaction; theory of mind

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Classic developmental theories consider the imitation of facial actions to be a landmark achievement that first emerges at about 8 to 12 months of age (e.g., Piaget, 1962). It is not that younger infants are considered nonimitative, but rather that there is a specific delay or deficit in facial imitation in particular. Other types of imitation, notably hand movements, are said to occur with facility before 6 months. The special psychological problem posed by facial imitation is that infants must connect the self and other in a unique way: They must match an act they see another perform with one of their own that they cannot see. The mechanism underlying other types of imitation such as manual imitation is not difficult to imagine: Infants can see both the model's hand and their own hands, and thus direct visual guidance is possible. Such visual guidance is impossible for facial imitation: How do infants bridge the gap between a visible and nonvisible face?

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Perhaps because this question poses such a challenge, most theorists found it convenient to accept the view that facial imitation first becomes possible at about 1 year. There have been few principled accounts, however, of why facial imitation should first emerge at that particular age and not earlier. Piaget (1962) addressed this issue by saying that facial imitation was not an isolated reaction but was embedded within other aspects of infant cognition. In particular Piaget saw a deep connection between imitation using nonvisible body parts (faces) and the capacity to find nonvisible objects (Stage 4 object permanence). Although there are numerous differences between the tasks, Piaget's insight was that their synchronous emergence at 8 to 12 months was causally related, not merely correlative. Both tap an underlying advance in the capacity to go beyond strictly sense-based impressions. One can imagine more socially rooted hypotheses, but this is the classical cognitive explanation for the emergence of facial imitation at 8 to 12 months of age.

Meltzoff and Moore (1977) challenged the consensus about the late emergence of facial imitation by reporting that 12- to 21-day-old infants imitated tongue protrusion, mouth opening, and lip protrusion. A further study (Meltzoff & Moore, 1983a) replicated these findings of early imitation and showed that this was an innate capacity: The mean age of the subjects in the latter study was 32 hours old, and the youngest was 42 minutes old at the time of test. Other work from our laboratory showed that neonates were not restricted to oral imitation (Meltzoff & Moore, 1989; see also Meltzoff & Moore, 1977, Study 1). The early matching effect has now been replicated and extended in new directions by independent investigators using a variety of test techniques. Numerous studies have replicated the tongue-protrusion and mouth-opening effects in infants less than 2 months old (Abravanel & Sigafoos, 1984; Fontaine, 1984; Heimann, Nelson, & Schaller, 1989; Heimann & Schaller, 1985; Jacobson, 1979; Kaitz, Meschulach-Sarfaty, Auerbach, & Eidelman, 1988; Legerstee, 1991; Reissland, 1988; Vinter, 1986). Early matching has also been reported for emotional expressions (Field et al., 1983; Field, Goldstein, Vaga-Lahr, & Porter, 1986; Field, Woodson, Greenberg, & Cohen, 1982) and a variety of other gestures, including eye blinking, cheek movements, and hand gestures (Fontaine, 1984; Vinter, 1986). It has been reported that there may be individual differences in the tendency to imitate (Abravanel & Sigafoos, 1984; Field et al., 1986; Heimann, 1989, 1991; Heimann et al., 1989) and that imitation is specific to people, with inanimate objects failing to yield matching responses (Abravanel & DeYong, 1991; Legerstee, 1991), although the data are mixed on the latter point (Jacobson, 1979). Thus, the phenomenon of early matching reported by Meltzoff and Moore has been upheld and broadened: A range of adult facial displays does elicit similar behavior in infants. The issue now becomes how best to characterize the infant's reaction. What is the mechanism underlying early matching? What function does it serve? What meaning does it have for the infant? What motivates them to copy in the first place?

There are two principal schools of thought on how to interpret the findings. For the purposes of sharpening the debate, we will dub these the "reflexive" and "social-cognition" views. They suggest different mechanisms for linking the adult's act and the infant's, as well as a different functional significance and meaning of the behavior. Regarding mechanism, the first view holds that the adult's display automatically triggers or "releases" a preset motor packet analogous to the way that a sudden postural change causes a Moro reaction (Abravanel & Sigafoos, 1984; Bjorklund, 1987; Jacobson, 1979). According to the second view, the intermodal equivalence between the adult's act and the infant's is taken into account by the infant (Meltzoff & Moore, 1977, 1983a, 1989; Meltzoff, Kuhl, & Moore, 1991). Regarding functional significance and meaning, the reflexive view proposes that early imitation does not serve any intrapsychic function for the infant. In contrast, Meltzoff and Moore (1985) held that young infants deploy imitation as a means of enriching their apprehension of people through reenacting their actions, and that even in early infancy imitation is used for social-communicative purposes. We suggest that early facial imitation is interwoven within a larger fabric of intentionality, representation, cross-modal coordination, and communication. It is diagnostic of early social cognition, not reflexive motor movement.

We report here experiments on the nature and functional significance of early imitation that manipulated three important factors: person, movement, and age. We were interested in exploring how imitation is used by the child and the function it serves in encounters with people. Thus, the question immediately arose as to whether young infants would differentially imitate mothers versus strangers. To date, there has been no systematic work directly comparing the efficacy of strangers versus the mother in eliciting early imitation. Are young infants more advanced in their imitation of mothers? One might predict that infants would imitate the familiar, affectively laden mother with greater facility than a stranger. The opposite view has its attractions. A stranger might elicit superior imitation as part of infants' exploring the interactive "properties" of this unknown entity. From a methodological perspective, it is useful to investigate the generalizability of the matching effect across people. Our experiments not only used a stranger, but also the infants' own mothers as demonstrators in a laboratory setting.

Second, these experiments explored the importance of stimulus motion to early imitation by presenting both dynamic gestures and static postures as models. Is there any evidence that 6-week-old infants can mimic static *facial forms* in addition to the *dynamic gestures* that are usually presented? Previous work with static postures revealed null results using newborns (Vinter, 1986); older infants might respond differently. We investigated two questions: (a) Is a static display a sufficient stimulus for eliciting imitation? and (b) If so, is the matching response so finely differentiated that, for example, static mouth-opening displays will yield *longer* mouth-opening acts than would a dynamic mouth-opening demonstration? The latter would suggest that temporal aspects of the display can be mimicked in addition to the spatial aspects (gestural types), which is relevant to the issue of underlying mechanism. Such a fine-grained correspondence to the model would not be compatible with the idea that imitation is a global reflex.

The third focus is on developmental changes in imitation. A cardinal finding used to support the reflexive model is the report that imitation occurring in the neonatal period disappears or declines at approximately 2 to 3 months of age (e.g., Abravanel & Sigafoos, 1984; Bjorklund, 1987; Field et al., 1986; Fontaine, 1984; Maratos, 1982). These data are often assimilated to the reflexive view by proposing that the initial imitation drops out in concert with the inhibition of other reflexive responses. However, the actual data are more complex. For example, using emotional expressions as stimuli, Field et al. found no absolute disappearance of imitation at any age tested in the first 6 months (age range tested = 2–6 months). It is possible that emotional expressions follow a different time course or are mediated by different processes than the elementary facial gestures of mouth opening and tongue protrusion: Some sort of affect contagion or empathic mood matching may be responsible for the duplication of these emotional expressions during the "drop-out" period. The simple but powerful fact is that, to date, no one has been successful in eliciting tongue-protrusion and mouth-opening imitation in the 2- to 3-month-old age group, and this has fueled the reflexive account for these gestures. We examined the reported absence of such imitation at this age by using a new test paradigm, one specifically designed to motivate imitation in infants in ways that will be described later. On the basis of a new study with 2- to 3-month-olds, we suggest that older infants' social-communicative efforts often displace imitative responding to simple facial gestures. We argue that the apparent drop out of these gestures is not due to a change in competence as postulated by the reflexive account, but rather to performance changes that can be reversed using novel designs that pose cognitive challenges to these older infants. Field et al. (1986) were cognizant of this possibility: "Future studies are needed to determine whether these apparent decreases in imitative behavior are real or simply an artifact of a limited paradigm" (p. 421).

Pilot Experiment: Proposal for a Relation Between Imitation and Rules for Object Identity

The manipulation of person, movement, and age were all straightforward extensions of work in the literature. However, using these manipulations in the pilot experiment led to some new hypotheses about the meaning and use of imitation for the child. We now believe that infants use imitation as a tool to help resolve issues concerning person identity. When an adult plays an imitation game with an infant, the infant remembers the person–act link and uses it when reencountering the person at a different time. In particular, the infant will often "probe" the person by producing the appropriate gesture.

These ideas about infants using imitation to probe the identity of a person emerged because in the pilot experiments ($N = 48$), we presented infants with two models: the mother and a stranger. Infants saw one person perform the mouth-opening demonstration and then the second person perform the tongue-protrusion demonstration. Infants acted in an interesting and surprising way when the first person disappeared and the other person appeared and began presenting the new gesture. Infants often stared at the second person and then intently produced what the *first* model had demonstrated. For example, the mother would demonstrate a mouth-opening gesture and the infant might provide some small reaction, but when the mother departed and the tongue-protruding stranger appeared, then suddenly, the infant would respond with a cluster of intensive mouth openings. We took this to mean that the sight of the adult gesture was not a simple trigger, because it was the "wrong" gesture that seemed to be triggered: Infants were not matching what was present before them, but what they remembered being shown.

We began to think it was the infant's interpretation of the stimulus and not the literal stimulus in front of them that was critical in governing these early reactions. Intensive study of the data records and videotapes revealed an interesting dichotomy among the subjects. The data revealed that the subset of infants who were imitating the current person in front of them were the ones who had visually tracked the entrances and exits of the people. The infants who had not visually tracked the approaches and departures tended to be the ones who responded with a burst of the previous person's gesture when confronted with the new person. The idea that emerged was that the infants who had not visually tracked the switch in people were thereby put in a state of conflict or ambiguity as to the identity of the new person (a face was presented in the same place as the first, but looked different; was it a new or the old person?), and they were using the previous person's gesture as a nonverbal probe of identity. As will be discussed later, this idea introduces a fundamentally new way of conceiving of the functional aspects of early imitation. It also suggests ways of modifying the two-person procedure to sharpen infants' responding. The next experiment was designed to ensure that infants had multiple, nonconflicting cues for identifying the experimenter and mother as separate people.

EXPERIMENT 1

The pilot experiment suggested that 6-week-old infants performed poorly on a two-person imitation situation when they did not track the movements of the different people who were to be imitated. The essential change between the pilot experiment and Experiment 1 was to ensure that all infants visually tracked the movements of the people so that they had full evidence that the person who was serving as the model had changed. With reduced conflict about the identity of the person, we predicted that infants would more systematically match what they presently saw. At a theoretical level, the logic for this change is tied to previous work concerning the criteria for object identity over time, how one distinguishes a fundamentally new object from an old object with its features (and thus appearance) changed. Michotte (1962; Thinés, Costall, & Butterworth, 1991) and Gibson (1966, 1979) might describe the object transitions and substitutions that occurred in the pilot work (and many naturalistic situations) as follows: There is an object in front of the infant, then after a period with broken sensory contact (for infants who did not track the adults), infants encounter an object of similar overall configuration in the same place as the first one. Michotte discovered that even adults are confused about the identity of objects under such conditions: Is it the same object with transformed features or a different object in the same place? We reasoned that if infants in the pilot experiment had identity questions of this sort, then the new procedures, in which infants are led to visually track the exchanges, would help clarify the situation. Philosophical analysis has established that such spatiotemporal tracking of objects is critical for determining their true identity (Strawson, 1959; Wiggins, 1967, 1980); visual tracking of objects has been found to be a powerful factor in young infants' determination of object identity (Bower, 1982, 1989; Moore, Borton, & Darby, 1978; Moore & Meltzoff, 1978; Piaget, 1954).

In Experiment 1, the pilot procedures were modified to require that infants visually track the movement of each adult to and from the test chamber. Using this procedure, we tested whether 6-week-old infants could differentially imitate in such a two-person situation, whether they could switch actions to follow what each person demonstrated. The more specific aims of the experiment were to evaluate whether one person (mother or stranger) was the superior elicitor of imitation, and similarly, whether the movement factor had a significant effect on infants' responding.

Method

Subjects—Subjects were 32 infants with a mean age of 6.12 weeks old (range = 5.71–6.43, *SD* = .23). They were recruited from the University's computerized subject pool containing primarily white middle-class families. Pre-established subject characteristics for admission into the study were: normal birthweight (2.5–4.5 kg), normal length of gestation (40 ± 3 weeks), and no known visual or motor disorders. The mean birthweight was 3.59 kg (range = 2.67–4.45, *SD* = .39). The mean length of gestation was 40.30 weeks (range = 37.71–42.14, *SD* = 1.00). All but one of the subjects were white. Twenty-five additional infants were tested but dropped from the study due to fussing (11), hiccoughing, spitting, choking uncontrollably (10), sleeping (1), or having a bowel movement during the test (3).

Test Environment and Apparatus—Testing took place within a two-room suite. One room was a waiting area where parents could feed and change their infants; the other contained a three-sided test chamber. The walls of the chamber were lined with gray paper, and the ceiling was papered with the same material. The infant sat in the open end of the chamber and faced the rear wall, which was 2.6 m away. The rear wall had a small hole cut in it to allow for videotaping by an assistant who stood behind it. A small light located above (25 cm) and behind (15 cm) the infant was used to spotlight the experimenter's face during the test. The experimenter's face was directly in front of the infant's at a distance of about 30 to 35 cm. The luminance of the experimenter's face was approximately 1.04 log cd/m^2, and the luminance of the background 2.5 cm to the right of the experimenter's face was approximately 1.01 log cd/m^2. The subject's reactions were videotaped by a camera focused on the infant's oral region, with an image from the top of the infant's head to about 5 cm below the chin. The experiment was electronically timed by a character generator, the output of which was digitally displayed in a small box located directly above the infant's head and also fed into the video recorder, such that the elapsed time (in 0.10-s increments) was electronically mixed in as a permanent time code for scoring purposes.

Stimuli and Experimental Design—The study used a repeated-measures design in which each infant acted as his or her own control. Each infant was exposed to two gestures, mouth opening and tongue protrusion. Each infant was exposed to two actors, mother and stranger. For each infant, one of the actors (mother or stranger) demonstrated one type of gesture (mouth opening or tongue protrusion), and the other actor demonstrated the other gesture. Each actor presented the specified gesture in both movement formats: once as a dynamic gesture (e.g., the mouth was opened and closed at a prescribed rate) and once as a static gesture (e.g., the mouth was simply held open). Counterbalancing was achieved by systematically alternating the displays such that a mouth-opening trial was always alternated with a tongue-protrusion trial. This yielded the following eight test sequences (in which, *MO* = adult mouth-opening trial; *TP* = adult tongue-protrusion trial; mom = mother as the model; stranger = stranger as model; dyn = dynamic display; stat = static display):

$MO6_{(mom/dyn)}$	$\rightarrow$	$TP_{(stranger/stat)}$	$\rightarrow$	$MO_{(mom/stat)}$	$\rightarrow$	$TP_{(stranger/dyn)}$
$MO_{(mom/stat)}$	$\rightarrow$	$TP_{(stranger/dyn)}$	$\rightarrow$	$MO_{(mom/dyn)}$	$\rightarrow$	$TP_{(stranger/stat)}$
$MO_{(stranger/dyn)}$	$\rightarrow$	$TP_{(mom/stat)}$	$\rightarrow$	$MO_{(stranger/stat)}$	$\rightarrow$	$TP_{(mom/dyn)}$
$MO_{(stranger/stat)}$	$\rightarrow$	$TP_{(mom/dyn)}$	$\rightarrow$	$MO_{(stranger/dyn)}$	$\rightarrow$	$TP_{(mom/stat)}$
$TP_{(mom/dyn)}$	$\rightarrow$	$MO_{(stranger/stat)}$	$\rightarrow$	$TP_{(mom/stat)}$	$\rightarrow$	$MO_{(stranger/dyn)}$
$TP_{(mom/stat)}$	$\rightarrow$	$MO_{(stranger/dyn)}$	$\rightarrow$	$TP_{(mom/dyn)}$	$\rightarrow$	$MO_{(stranger/stat)}$
$TP_{(stranger/dyn)}$	$\rightarrow$	$MO_{(mom/stat)}$	$\rightarrow$	$TP_{(stranger/stat)}$	$\rightarrow$	$MO_{(mom/dyn)}$
$TP_{(stranger/stat)}$	$\rightarrow$	$MO_{(mom/dyn)}$	$\rightarrow$	$TP_{(stranger/dyn)}$	$\rightarrow$	$MO_{(mom/stat)}$

Four infants (two of each sex) were randomly assigned to each of these eight sequences. Each trial (e.g., $MO_{(mom/dyn)}$) was of 90-s duration. Previous research indicated that infant attention and responsivity were maximized if a short period of adult gesturing was alternated with a short pause (Legerstee, 1991; Meltzoff & Moore, 1983a, 1983b; Meltzoff et al., 1991). Thus, within a 90-s trial, the adult displayed the target act for 15 s and then presented a neutral face pose for 15 s, and so on for the 90-s period. For the dynamic gestures, the prescribed rate of gesturing was four times in the 15-s interval; for the static displays, the actor simply held a pose (full mouth opening or full tongue protrusion) for the 15-s interval.

In order to maximize the perceptual distinction between the mother and the stranger, the stranger was the opposite gender of the mother (an adult male), wore a pair of glasses if the mother did not typically wear them, and adopted a different hairline than the mother (accomplished by wearing a fitted, knit cap if she had bushy hair that stood out from the skull line). All three of these factors—gender, glasses, and external hairline—have been designated as salient cues for facial discrimination and recognition in experiments ranging from neonates to adults (Bushnell, 1982; Carey & Diamond, 1977; Fagan & Singer, 1979; Haith, Bergman, & Moore, 1977; Young & Ellis, 1989).

Procedure—The infants did not see the stranger's face (the "experimental stimulus") before the test, so that it would remain novel. Rather, a research assistant greeted the parents and provided instructions about the mechanics of the upcoming test. While seated in the waiting area, the assistant asked the mother to practice mouth opening and tongue protruding at the prescribed rate, which was done while the infant was turned away and thus could not see her acts. The mothers were instructed that these facial gestures were to be presented silently and that they were not to laugh, talk, smile, nod, make mock-surprise faces (uncontrolled mouth openings) or lick their lips (uncontrolled tongue protrusions) during the test. Mothers were also asked not to engage in facial games with their infants in the waiting room before the test so as not to "bore" their infants with such games, and the research assistant ensured that these directions were followed. Finally, mothers were instructed that to enter and exit the three-sided test chamber they and the stranger would both need to proceed in a similar way. The adults were seated on a stool with wheels (much like a dentist's or pediatrician's stool) before they entered the test chamber. The stool held them at the correct height so that their faces were approximately at eye level with the infants. The subjects' attention was attracted to the adult by gently shaking a rattle and calling the infant's name while the adult was seated on the stool and still at the edge of the test chamber. Once the subject fixated the adult, he or she rolled in on the stool to the spot in front of the child from which the gesture was presented. After presenting the gesture of 90 s, the adults rolled out of the test chamber continuing the same path that they had used to come in. The mother entered and exited on a path in the opposite direction of the stranger (direction of entrance and departure randomized across infants), so there was no shared path of motion for the mother and stranger. It was required that infants visually track the adults' movement to and from the test chamber. The adult only moved as quickly as allowed by the infant: If the adult began to roll to or from the test chamber and the infant looked away from the adult, the adult temporarily stopped and attracted the infant's attention. Attention was attracted by shaking a rattle or calling the infant's name. Once the infant refixated, the adult continued.

After the mother was satisfied that she understood the full procedure (maternal instructions typically took about 15 min), the infant was carried to the test chamber. A standard 90-s acclimation period was used for all infants. Infants were seated comfortably in the infant chair (a padded seat inclined 30° off the horizontal) and then left on their own to explore visually the homogeneous gray test chamber. Some infants would catch sight of the screen edges and a very few would notice the camera lens, but most seemed to habituate rapidly to the new surround. At the end of the 90-s acclimation period, the fixed-time stimulus-presentation sequence commenced.

Scoring and Behavioral Definitions—The videotapes of the subjects consisted of close-up images of the infants' faces with no picture or record of the adult's display. The subjects were coded in a random order by a scorer who remained blind to which actor or gesture had been shown to the infant in any given segment. A microanalytic scoring procedure was used in which the scorer viewed the videotapes in real time, slow motion, and frame by frame at her choosing. The scorer's task was to record all instances of infant mouth openings and tongue protrusions, identifying them by the time code that was part of the videotape record. Operational definitions of the target behaviors were provided. They were adapted from Meltzoff and Moore's (1983a, 1989) scoring criteria, but modified slightly to accommodate the older age of the subject.

The onset of a "tongue protrusion" was operationally defined as a clear forward thrust of the tongue such that the tongue tip crossed the back edge of the lower lip. For those cases in which the tongue was being retracted but was not yet behind the lip when a second tongue thrust occurred, the first tongue protrusion was terminated with the initiation of the second. A "mouth opening" was defined as a separation of the lips that had four characteristics: (a) initiated by an abrupt drop of the jaw; (b) lips opened along the entire width including the corners of the mouth so that space (in the form of a black region on the video monitor) could clearly be seen; (c) executed in a unitary motion so that the lip separation was greater than or equal to the width of the lower lip; and (d) fulfilled the foregoing criteria in silence and more than 1.5 s before a vocalization was produced (such acts look like a separate behavioral unit and not simply a concomitant of vocalizing, cooing, or calling out). The termination of a mouth opening was defined by the end of the closing movement of the lips or the initiation of another criterial mouth opening. Any infant behavior that occurred during occasional yawning, sneezing, choking, spitting, or swallowing was not counted by the scorer.

Dependent Measures and Analysis Plan—Four measures served as dependent variables: (a) frequency of infant tongue protrusion, (b) frequency of infant mouth opening; (c) overall duration of infant mouth opening (total time that the infant exhibited mouth opening, measured in seconds to one decimal place); and (d) longest mouth-opening act (the infant's longest single mouth-opening act, measured in seconds to one decimal place). These measures were calculated for each of the infant's four 90-s trials, and in the case that the analysis called for combining the data across two trials, the data were summed (e.g., the frequency of tongue protrusion across two trials was the sum of the frequencies in each of the two separate trials). No attempt was made to obtain the two duration measurements for the infant tongue protrusions.

Intra- and interscorer agreement was assessed by rescoring 12 randomly selected 90-s trials (approximately 10% of the study). Agreement was high for each of the four infant measures as assessed by both correlations and the kappa statistic. The correlation between the original and reliability scorings for the 12 trials averaged .94 across the measures, ranging from .84 to .99. The kappa statistic is an index of agreement that incorporates a correction for chance and assesses point-to-point agreement in the scoring records (Applebaum & McCall, 1983; Bakeman & Gottman, 1986; Cohen, 1960). Values greater than .75 are considered to be excellent agreement (Fleiss, 1981). The obtained values averaged .86, ranging from .80 to .93.

In line with most other studies of early imitation, the bulk of the analyses relied on nonparametric statistical approaches, because the assumptions underlying parametric statistics could not clearly be met using these behavioral measures on young infants (e.g., Abravanel & Sigafoos, 1984; Fontaine, 1984; Heimann et al., 1989; Heimann & Schaller, 1985; Meltzoff & Moore, 1977, 1983a, 1989; Vinter, 1986). One-tailed tests were used to assess whether infants' reactions to the adult gesture were in accord with the hypothesis of infant imitation.

Results

Overall Results: Repeated-Measures Analyses—The overall results provided evidence for imitation (Table 1). The number of infant tongue protrusions was significantly greater to the TP demonstration than to the MO demonstration, $z = 2.58$, $p < .01$, using a Wilcoxon matched-pairs signed-ranks test. Infants produced a greater number of mouth openings to the MO demonstration than to the TP demonstration, but this did not reach significance, $p < .13$, Wilcoxon test. The duration of the infant mouth-opening measure was greater to the MO demonstration than to the TP demonstration, $z = 1.80$, $p < .05$, Wilcoxon test. Finally, the longest mouth-opening act was greater to the MO demonstration than to the TP demonstration, $z = 1.77$, $p < .05$, Wilcoxon test.

A more detailed analysis of imitation at the level of individual subject is provided by simultaneously taking into account two different categories of infant behaviors (tongue protrusions and mouth openings). With regard to tongue protrusions, each infant can produce a greater frequency of tongue protrusions to the adult TP display (indicated as a "+"), or to the MO display (indicated as a "–"), or can produce an equal frequency of tongue protrusions to both displays (indicated as a "0"). Similarly, for mouth openings, each infant can produce a greater frequency of mouth openings to the MO display (+) or to the TP display (−), or can produce an equal frequency to both (0). Infants who produced more tongue protrusions to the TP display and more mouth openings to the MO display were classified as "+ +" responders, and so on. An exhaustive categorization of the 32 subjects in terms of their individual response frequency patterns is presented in the first row of data on Table 2. A one-sample chi-square test shows that the distribution of the 32 subjects across the response patterns cannot be accounted for by chance, $\chi^2(5, N = 32) = 23.88$, $p < .001$. The hypothesis of imitation is most stringently tested by comparing the number of infants falling into the most extreme cells of this distribution (+ + vs. −−). The subjects who were categorized as ++ had, by definition, systematically switched their behavior and matched both adult displays. Conversely, infants who were categorized as −− had systematically mismatched both displays. Under the null hypothesis, there is an equal probability of infants falling in either the ++ or the −− category. The data reveal 15 infants with the + + profile as compared to 6 with the −− profile, $p < .05$ using a binomial test, thus providing support for the hypothesis of imitation. The same analyses can be conducted using the duration of infant mouth opening and the longest mouth-opening act (instead of frequency) to measure the infant mouth-opening response. Both yield significant effects, with the extreme cells (+ + vs. −−) being 16 versus 4, $p < .01$, and 15 versus 4, $p < .01$, respectively (Table 2).

First Trial Data: Independent Groups Comparisons and Interactions Between Factors—The type of adult display shown in the first 90-s trial was counterbalanced across subjects. These "first trial" data can be analyzed to assess whether separate groups of infants significantly varied as a function of treatment during the first 90-s exposure. It also makes sense to decompose the first trials into finer subdivisions, for example, examining whether the imitation effect was stronger to the mother than to the stranger, or to the dynamic versus static displays. The value of the first trial data for answering such questions is that infants have not yet seen the other types of demonstrations, and thus the eliciting properties of a single type of display taken in isolation can be directly determined.

To assess the main effects of imitation in the first trial data, the subjects who saw the tongue protrusion ($n = 16$) were contrasted with the subjects who saw the mouth opening ($n = 16$). As can be seen in Table 3, infants produced more tongue protrusions to the TP demonstration than to the MO demonstration, $z = 1.70$, $p < .05$, Mann-Whitney *U* test. There was no significant difference in mouth-opening frequency as a function of demonstration, although the effect was in the predicted direction ($p < .13$, Mann-Whitney test). The other measures of infant mouth opening were more discriminating. Infants produced a longer duration of mouth opening to the MO demonstration than to the TP demonstration, $z = 1.71$, $p < .05$, Mann-Whitney test. Also, the longest mouth-opening act was greater to the MO demonstration than to TP demonstration, $z = 1.88$, $p < .05$, Mann-Whitney test.

These first trial data can also be used to examine the interactions between the stimulus manipulations in this experiment. It is not possible to investigate interactions between factors using a nonparametric analysis of the data (Siegel, 1956), but an analysis of variance (ANOVA) serves this purpose and will yield interpretable results even if the assumptions underlying this approach are not fully satisfied, especially if there are independent groups with the same number of cases in each sample as is the case in this experiment (Hays, 1981;

Winer, 1971). Such an approach was adopted here to examine the influence of person and movement on imitative responding. A three-way ANOVA was conducted using person (mother/stranger) × movement (dynamic/static) × gesture (mouth opening/tongue protrusion) demonstrated to the subject.

The results reveal no three-way interactions (person × movement × gesture) for any of the infant measures (tongue protrusions or the three mouth-opening measures), with all Fs$(1, 24) < 1.0$, and ps ranging from .38–.90. The data displayed in Table 4 address the person × gesture interaction; they assess whether infants imitiate mothers more than strangers. The ANOVA revealed no person × gesture interaction for the tongue-protrusion measure, $F(1, 24) < 1.0$, $p > .95$. As can be seen, the frequency of tongue protrusion was greater to the TP demonstration than to the MO demonstration in the case in which the mother served as model ($M = 6.50$ vs. 3.75); this was also true in the case that the stranger served as the model ($M = 7.00$ vs. 4.00). In both cases, the scores of infants presented with the TP demonstration exceed those presented with the MO demonstration, as predicted by the hypothesis of imitation. The same analyses were run using the measure of mouth-opening frequency, duration, and longest act, and again no person × gesture interaction emerged, with all Fs$(1, 24) < 1.0$, and ps ranging from .60 to .92. Reference to Table 4 shows the reason quite clearly: Whether one isolates just the mother as model or just the stranger as model, the effects are all in the same direction. There is more infant mouth opening to the mouth opening gesture than to the tongue protrusion gesture, as predicted by the hypothesis of imitation, and this is true regardless of who serves as model. In summary, Table 4 presents eight opportunities for examining the gesture effect (two persons × four measures), and all of those eight contrasts are in the direction predicted by the hypothesis of imitation. Thus, imitation is not modified by which person serves as the model.

The ANOVA approach also yielded information concerning a movement × gesture interaction. This interaction was not significant for the tongue-protrusion measure, $F(1, 24) < 1.0$, $p > .52$, or for the mouth-opening frequency, $F(1, 24) = 2.03$, $p > .16$, or mouth-opening longest act, $F(1, 24) = 2.63$, $p > .11$. However, there was a trend toward a movement × gesture interaction for the mouth-opening duration measure, $F(1, 24) = 3.38$, $p < .08$. Inspection of the data (Table 5) indicates that this was because the $MO_{(stat)}$ manipulation elicited extremely long mouth-opening durations. Pair-wise comparisons showed that the $MO_{(stat)}$ group produced significantly longer mouth-opening durations than did each of the other groups taken individually (all ps < .05 by Mann-Whitney tests), and identical results were obtained using a parametric Newman-Keuls test. On average, the duration of infant mouth opening to $MO_{(stat)}$ was 14.66 s, which was more than twice that to the $MO_{(dyn)}$ ($M = 5.24$ s) and almost four times that to either $TP_{(stat)}$ ($M = 3.75$ s) or $TP_{(dyn)}$ ($M = 3.86$ s). This pattern of results indicates that infants were responsive to both the durational and form characteristics of the displays: They responded to the adult's static MO demonstration with significantly longer mouth-opening durations of their own; they did not respond to the adult's static TP demonstration (or other displays) in this manner. The most extreme mouth-opening durations were in response to the mouth-opening-in-static-form demonstration.

EXPERIMENT 2: EXPLORING DEVELOPMENT—EXTENSION TO 2- TO 3-MONTH-OLDS

Previous work suggested that there is a “drop-out” of facial imitation after the early period, beginning at approximately the second or third postnatal month (e.g., Abravanel & Sigafoos, 1984; Bjorklund, 1987; Maratos, 1982). A variety of theoretical interpretations have been offered, but the time course and explanation for this phenomenon is not settled. The specific purpose of the second experiment was to see how infants in the 2- to 3-month age range would fare in a study of facial imitation using the current design. Would the new procedures developed in Experiment 1 be useful in motivating imitation in this older age group? Or would the results fall to chance, as suggested in the previous reports, and if so, could we discern why?

Method

Subjects—The subjects were 16 infants ranging in age from 9.29 to 12.29 weeks old (M = 10.59, SD = 1.00). They were recruited in the same manner and met the same selection criteria for birthweight and length of gestation as described in Experiment 1. One additional selection criterion became obvious before the experiment began, in piloting this extension to older infants. It became clear that at this age some parents had developed habitual facial routines, sometimes including tonguing and mouthing games with their infants. Such parent–child games have been amply described in the social-developmental literature (Bruner, 1975; Papoušek & Papoušek, 1986; Stern, 1985; Trevarthen, 1979). Obviously, an experiment on facial imitation using the mother as the stimulus would be confounded if the mother already had a well-rehearsed routine of this type. Piaget (1962) avoided developing oral routines with his subjects and called trained mimicry “pseudoimitation.” Following Piaget’s logic, the parents of prospective subjects were interviewed to see if they had developed games in which they commonly mimicked their infants’ mouth openings or tongue protrusions, and those who did were not admitted into the experiment in order to avoid Piaget’s pseudoimitation. The mean birthweight of the final sample was 3.59 kg (range = 3.12–4.42, SD = .33). The mean length of gestation was 40.62 weeks (range = 37.71–42.86, SD = 1.39). All the subjects were white. An additional three infants were tested but were dropped from the study due to excessive fussing.

Stimuli, Design, Procedure, and Scoring—The stimuli, design, and procedure were identical to Experiment 1. The subjects were scored from videotape as previously described. Intra- and interobserver agreement were assessed by rescoring a randomly selected 15% of the trials. Scoring agreement for the four infant measures as assessed by correlations averaged .97, ranging from .93 to .99, and by kappas averaged .88, ranging from .79 to .97.

Results

The repeated-measures design yields strong evidence for imitation at this age, as shown in Table 6. There was a significantly greater number of tongue protrusions to the TP demonstration than to the MO demonstration, $z = 2.76$, $p < .01$, Wilcoxon test. Similarly, there was a greater number of mouth openings to the MO demonstration than to the TP demonstration, $z = 2.31$, $p < .05$, Wilcoxon test. There was significantly longer duration of mouth opening to the MO than to the TP demonstration, $z = 2.17$, $p < .05$, Wilcoxon test. An infant's longest mouth-opening act tended to be produced in response to the MO as opposed to the TP demonstration, $z = 2.10$, $p < .05$, Wilcoxon test.

The imitation effect can also be examined in more detail at the level of individual subjects, as described in Experiment 1. Each individual infant can produce a greater frequency of tongue protrusions to the adult TP display (+), or to the adult mouth-opening display (−), or can produce an equal frequency to both displays (0). A similar casting can be done for the mouth-opening responses. Infants who produced more tongue protrusions to the TP display and more mouth openings to the MO display were classified as "+ +" responders, and so on. Table 7 (p. 496) exhaustively categorizes the 16 subjects as a function of their individual response patterns. The hypothesis of imitation is most stringently tested by comparing the number of infants falling into the most extreme cells of this distribution (+ + versus −−). Subjects categorized as ++ had switched their behavior and matched both adult displays; conversely, infants categorized as −− had systematically mismatched both displays. Under the null hypothesis, it is equiprobable for infants to fall into either the ++ or the −− cell. The data reveal 7 infants with the ++ profile as compared to only 1 with the −− profile, $p < .05$ using a binomial test. The identical analysis can be conducted using the duration of infant mouth opening or the longest mouth-opening act (instead of frequency) to quantify the infant mouth-opening response. The resulting profiles are also shown in Table 7; both yield significant effects, with the extreme cells (+ + vs. −−) being 9 versus 2 and 8 versus 1, respectively, both *p*s < .05.

The first trial analyses in this experiment were not discriminative, possibly because the first trials did not benefit from using each infant as his or her own control, which was utilized in the foregoing repeated-measures tests, and because the overall number of subjects for the independent groups comparisons was small ($n = 8$ seeing TP vs. 8 seeing MO). The main effects assessing imitation were in the predicted direction for each of the four behavioral measures, but none showed significant differences, all *p*s > .23, Mann-Whitney tests. There were no main effects either for person (mother vs. stranger) or for movement (dynamic vs. static) for any of the four infant measures, all *p*s > .45, Mann-Whitney tests; interactions could not be assessed because the cell sizes were too small.

GENERAL DISCUSSION

This research contributes three empirical findings to the early imitation literature: (a) early imitation does not significantly vary as a function of familiarity with the model—infants imitate a stranger as well as their own mothers; (b) infants can imitate static facial postures as well as dynamic gestures; and (c) there is no necessary loss of facial imitation at 2 to 3 months of age due to a drop out of neonatal reflexes—using this design, infants in this age group imitated as well or better than did younger subjects. Beyond these empirical findings, we will develop arguments concerning the function that early imitation serves in infants' encounters with people. In particular, the connection between imitation and person identity is elaborated, and evidence is adduced for viewing imitation as an act of social cognition rather than a fixed reflex. We will sketch a model in which imitation serves an *identity function.* In our view, imitative reenactments and the sharing of behavioral states are a fundamental means by which young infants know and communicate with "persons" as opposed to "things."

The Role of Person and Movement

One question examined in this research was whether the person who served as the model, mother or stranger, had a significant impact on imitation. This was directly tested using the first trial data in Experiment 1. For this comparison, the infants only saw one person: for half, it was the mother; for the other half, it was the stranger. The results showed significant imitation in the first trials, and moreover, that the imitative effect was not modified by whether the model was mother or stranger. This finding is of interest for both theoretical and methodological reasons. Methodologically, it is valuable to know that a group of "experimenters" who were essentially uninformed about the purpose of the experiment, and who each visited the laboratory for an hour or less, are as effective in eliciting the response as the trained experimenter. It demonstrates a generalizability of the effect across the people who serve as models. Theoretically, it is noteworthy that for infants in this young age group, imitating requires no special relationship or attachment to the person or even perceptual familiarity with the person's face. The person who served as model made no significant difference to imitative responding, although infants this age can discriminate their own mother from a stranger (Bushnell, Sai, & Mullin, 1989; Field, Cohen, Garcia, & Greenberg, 1984; Walton, Bower, & Bower, 1992; S. de Schonen, personal communication, 1992). Thus, the basis of imitation lies in stimulus attributes that are shared by both familiar maternal faces and a novel male face. It seems likely, however, that at some point in infancy, familiarity with a person and especially the shared interactive experience with that person would influence how imitation is used in that dyad; such a developmental change in imitative reactions would be interesting to examine in longitudinal work (Bandura, 1969; Bower, 1979; Uzgiris, 1981; Watson, 1972).

The research also investigated infants' reactions to static facial displays. The first-trial results of Experiment 1 showed that the average duration of infant mouth opening to the MO demonstration was 14.66 s, more than twice that to the $MO_{(dyn)}$ demonstration (5.24 s) and nearly four times that to either the $TP_{(stat)}$ or $TP_{(dyn)}$ demonstrations (3.75 s and 3.86 s, respectively). Two inferences can be drawn. First, the finding that $MO_{(stat)}$ elicited longer infant mouth opening than $TP_{(stat)}$ indicates that the form of the gesture (mouth opening vs. tongue protrusion) is critical even in the context of a nonmoving display. The increase in mouth-opening duration is not attributable to the "static-ness" per se, as if all static facial postures are indistinguishable to infants and result in lengthy infant mouth openings: Both $MO_{(stat)}$ and $TP_{(stat)}$ were equally static, and yet the former elicited 14.66 s of the target response and the later only 3.75 s, which differed significantly. Second, temporal parameters are not wholly ignored by the infant. When the type of gesture is controlled, infants produced significantly longer mouth opening to one kind of adult mouth opening (static) than the other kind of mouth opening (dynamic). In brief, the infants matched both the form and the temporal aspects of the adult's demonstration. This is relevant for theory because so fine a differentiation between such closely related displays—two different types of mouth openings—is neither predicted by, nor compatible with, the notion of early imitation as a simple global reflex.

The results also weigh against a strong version of the hypothesis that imitation in the first few months of life is based *solely* on a visual analysis of movement per se and that form information plays a negligible role (e.g., Vinter, 1986). Vinter's data showed no imitation of static gestures in new-borns averaging 4 days old (although the same study found significant imitation of moving gestures). Our data show that 6-week-old infants are capable of imitating static postures. Three developmental changes could account for this. First, between 4 days and 6 weeks of age there could be growth in peripheral systems; visual constraints could prevent newborns from extracting the relevant form information from nonmoving faces, in which case they would not be expected to imitate them (cf. Banks & Salapatek, 1981; Braddick & Atkinson, 1988). Second, there may also be growth in perceptual-motor "translation" capacities and the understanding of human acts. Six-week-olds may be able to match target postures without seeing the transitions: For 6-week-olds, a final configurational state may adequately specify the temporally organized body transformations needed to achieve the end state, although it does not do so innately. Third, nonmoving faces may lack social meaning for newborns; they may be objects to stare at but not to interact with. By 6 weeks, infants may interpret even static facial postures as socially relevant human acts that support social responding.

The finding that imitation can be tapped using duration measures (overall duration of mouth opening and longest act) casts new light on previous research. Most previous work has been limited to measuring movement frequency. Our results show that the duration measures are a more discriminating measure of mouth-opening imitation. We can now see that the exclusive reliance on frequency, the weakest of the measures used in these experiments, might account for null effects in some past studies (see also Meltzoff & Moore, 1983b). The duration code potentially provides a way of improving the sensitivity of future studies of early imitation. At a more theoretical level, there is no a priori reason to assume that infants will encode adult MO demonstrations in terms of frequency versus duration of the act. Indeed, the fact that infants were so attentive to mouth-opening duration invites an interesting speculation: Because people talk to infants (repeated mouth openings), the most novel aspects of the experimental stimulus may be the slow, long-duration aspects of the mouth-openings, and this may be true even of the dynamic demonstrations (which are performed far more slowly than speech articulations). Infants may be picking out and imitating aspects of the display based partly upon what they have experienced as "normal" and "expected" acts for human faces, underscoring the way in which imitation may be influenced by early interpersonal experience and development.

On Imitative Drop-Out: The Role of Social-Communicative Factors

In Experiment 2, using 2- to 3-month-olds, the data from the overall tests using subjects as their own controls provided strong evidence for imitation. We did not find imitation everywhere, however; the first-trial data were not discriminative, and observations of the infants suggest why. These older infants had expectations about face-to-face encounters and were especially likely to "greet" people when they first saw them, trying out motor routines as if to engage in a nonverbal interchange (cf. Bruner, 1975, 1983; Brazelton & Tronick, 1980; Fogel, 1991; Stern, 1985; Trevarten, 1979; Trevarthen & Marwick, 1986). The motor routines varied across children, probably depending on family games, but the variability worked to undermine the first-trial, between-subjects comparisons.

The literature contains two principal accounts of the “drop out” of facial imitation in the 2- to 3-month age range; this research suggests a third interpretation of the same data. According to the first view, neonatal imitation is based on simple reflexes; development brings reflexive inhibition, hence the drop out (Abravanel & Sigafoos, 1984; Bjorklund, 1987). A second view is that the neonatal period can be described as one of perceptual unity (Bower, 1982, 1989); development brings a differentiation into the separate modalities, hence early imitation (along with neonatal reaching, auditory-visual spatial location, and other skills) drops out and is later reconstituted through a coordination of the now-differentiated modalities. Both the reflexive and the modality differentiation views highlight the inevitable, maturationally based drop out of facial imitation.

The third view suggested here is that *social factors* play a more central role in the previously reported disappearance of imitation (cf. Field et al., 1986; Kugiumutzakis, 1985). From an observational viewpoint, the most striking developmental change in infant responding was that the older infants initially tried out all sorts of games on the adult (Piaget, 1952, 1954, would call them “magical procedures”) and pursued them more vigorously than the younger infants. Such social games and solicitations serve to obscure imitation in this older age group initially, although after the initial social solicitations, infants generally settled down and engaged in imitation. Our repeated-measures design is thus more effective than a one-time test, because it measured the infant over an extended period and used each infant as his or her own control. This solved two problems presented by this older population, high intersubject variability and the initiation of social games with the experimenter. Relatedly, the gestures were shown in time-locked manner rather than being contingent on infants’ behavior. This format may help shift older infants away from their routinized social-interactive games (e.g., smiling and cooing; see Watson, 1972) and focus them on watching and reacting to the particular experimental gestures under test.

Another possible reason for the efficacy of the experimental design is that it specified for the infant the category of adult behavior that was being demonstrated. Why should an older, socially adept infant focus on a single elementary act, for example, a mouth opening? Cohen and Caputo (1978) argued that multiexemplar variation will serve to “instruct the infant to respond to some feature or attribute common to all members of the category” (p. 1). The use of multiexemplar variation has proven to be a powerful stimulus manipulation (Cohen & Strauss, 1979; Fagan, 1976, 1979; Hayne, Rovee-Collier, & Perris, 1987; Kuhl, 1983; Reznick & Kagan, 1983; Ruff, 1978; Walker, Owsley, Megaw-Nyce, Gibson, & Bahrick, 1980). Yet, in all studies reporting imitative drop out, infants were presented repetitions of an act with no variation. Such designs would not be expected to emphasize the “mouth openness” of the display for the infant. The current design provided each infant with within-category variation (both static and dynamic exemplars of the same underlying behavioral category). Simultaneously, and at least as importantly, the design highlighted intercategory differences. Person 1 performed one type of gesture (the mouth opening or tongue protrusion, but not both), and person 2 performed the other gesture. Thus, a specific gesture was paired with a specific person. In all the previous repeated-measures studies used with this age group, one experimenter performed both gestures, which can confuse infants and dampen imitation.

We are thus suggesting that older infants initially respond to people by engaging in social games. These games supersede infant imitation, hence the apparent drop out. The current procedures served to focus the older infants on the narrower imitation task by using a noncontingent demonstration, highlighting intercategory differences, and providing variation in the exemplars of the target action. We conclude that the previously reported drop out is not due to a fundamental loss of imitative competence but to the fact that social and motivational factors mask that competence.

Linking Imitation, Identity, and Representation: Towards a New Theory of the Function of Early Imitation

By putting together what we know from both the pilot and final experiments, we can now offer some new ideas about the meaning, motive, and functional significance of early imitation. These ideas situate early imitation within a broader psychological framework than simple reflexes. We intend to show how infant imitation contributes to theories of early social cognition and informs discussions about infants' earliest and most basic notions of persons.

A comprehensive view of early imitation needs to explain the conditions under which infants imitate, as well as those in which they do not. The reflexive account falls short in this regard. Imitation is not always elicited either in our work or that of others; it does not behave like an automatic and ubiquitous reflex. A model that considers imitation an act of primitive social cognition fares better by stressing the functional uses of imitation to infants. The pilot experiment revealed that infants who did not visually track adults as they appeared and disappeared, inspected the new person, and then intently performed the actions shown by the *previous* person. This suggests to us that the adult gestures are not simple sign stimuli that automatically trigger the infant's behavior, because the wrong act is often "triggered" by the sight of the new gesture. In contemplating this pattern of counterimitation (we now see it as deferred imitation), we have found it useful to consider two interrelated ideas: (a) young infants do not have a fully developed system for determining person identity; and (b) infants use actions, including facial gestures, as part of assimilating, "knowing," and communicating with a person.

Part 1 concerns infants' *rules for identity.* It holds that young infants may have questions about the identity of the person in a two-person situation. We attempted to clarify this by having the two people look different; however, there was no requirement that infants in the pilot experiment fully track the adults as they walked to and from the test chamber, and this may have led to ambiguity about the identity of the person. Indeed, philosophical analysis has shown that featural differences in objects, or for that matter featural similarity, is no guarantee as to the true identity of the objects (Hirsch, 1982; Strawson, 1959).[1] Two

[1]The type of identity we are highlighting is not at the level of feature discrimination and visual appearance per se. Rather, it concerns what philosophers call numerical or particular identity (Strawson, 1959) and we have called unique identity in the context of object-concept development (Moore & Meltzoff, 1978). The examples used in the text should help to further clarify this issue.

encounters with an object may appear different and yet be of the same object; conversely, two encounters may look the same and be of different objects. For example, two featurally identical coffee cups may be different objects; conversely, a person wearing a kerchief does not become a different entity, but merely the self-same person, featurally transformed. Logically, object and person identity are not reducible to featural similitude. Thus, it is plausible that infants can be confused about the identity of persons in a multiperson situation involving their appearance and disappearance. In fact, this would not be an uncommon event for young infants (Moore & Meltzoff, 1978). What action might they take to clarify such conflicts?

Part 2 concerns infants' *use of nonverbal gestures to clarify ambiguities about the identity of persons.* This point draws on the Piagetian-Wernerian notion of knowing-through-action (Piaget, 1952; Werner & Kaplan, 1963). According to that thesis, the young infant does not apprehend an object, for example, a rattle, as a fully differentiated and categorized object, but rather as a somewhat undifferentiated form-function unit, as "something-that-shakes or is-shakable." Perceptual objects are not fully differentiated or known independent of the actions they afford. When infants see a rattle again they will try to shake it as a way of understanding or recognizing it. By analogy we propose that when infants reencounter a person, they try to reinstitute the action that was connected with this person as a way of apprehending the person. If infants are confused or ambiguous about the identity of a new person who is perceptually present, they will be particularly motivated to test whether this person has the same behavioral properties as the old one, whether he or she acts the same, because the body actions and expressive behavior of people are identifiers of who they are. We are thus hypothesizing that one function of early imitation is to probe the identity of the person in front of the infant. We think infants use nonverbal gestures as the functional equivalent of the query: "Are you the one who does tongue protrusion?"

This functional use of imitation explains why the infants who did not track the change in demonstrator in the pilot experiment were so intent on duplicating the absent person's gesture. It was their way of comparing the past person with the present person, to probe whether identity was maintained despite a change in appearance or whether this was a new person. Experiment 1 was designed to reduce identity ambiguity by supplementing the featural information with spatiotemporal information about person identity. The new procedures ensured that the adults moved on two distinctly different paths and that infants fully tracked the movements of the adults to and from the test chamber. The adults were different both by featural and by spatiotemporal criteria. Thus, there was no question as to their different identity, and in this case, a significant number of infants switched responses so as to mimic the new person.

The foregoing theoretical analysis of the multiperson situation may also explain some aspects of imitation when only a single person is used. It has been reported that infants respond poorly if the adult repeatedly and unceasingly presents the target gesture (Meltzoff & Moore, 1983a, 1983b, 1985), a point also noted by Legerstee (1991). For this reason, we use a "burst-pause" procedure in which the experimenter alternates between a set of target gestures and a passive-face pose. We believe that the burst-pause procedure is especially effective because when the adult stops gesturing, the infants are confronted with a mismatch between their current perception of the model and their memory representation. We think the infant generates a matching response in order to reinstate the absent event (the gesturing), to make it perceptually present again. Thus, the pause in the adult's behavior gives the infant a problem to work through: the conflict between the world-as-represented and the here-and-now as presented to the visual system. This mismatch between perception and representation motivates the infant to action, and consequently, observable imitation. It is just because young infants can act from stored memories of absent realities—just because their behavior is not based solely on the stimulus before them—that their imitative acts may sometimes go unnoticed.

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TABLE 1

Infant Behaviors as a Function of the Adult Displays (6-Week-Old Infants)

	MO Display		TP Display	
Infant Behavior	***M* (*SD*)**	**Median**	***M* (*SD*)**	**Median**
Tongue Protrusions	6.69 (5.91)	4.50	10.84 (9.15)	7.50**
Mouth Openings				
Frequency	5.88 (6.97)	3.00	4.88 (6.12)	2.00
Duration	13.40 (15.87)	7.30	10.35 (14.82)	4.25*
Longest Act	6.04 (6.49)	4.35	4.34 (4.34)	3.45*

Note. $N = 32$. Significance assessed by Wilcoxon matched-pairs signed-ranks tests.

* $p < .05$.

** $p < .01$.

TABLE 2

Number of Infants as a Function of Response Pattern (6-Week-Old Infants)

Infant Behaviors	Response Patterns[a]							
	+ +	+ 0	0 +	+ −	− +	0 −	− 0	− −
Tongue protrusion and mouth opening (frequency)	15	4	0	4	1	2	0	6
Tongue protrusion and mouth opening (duration)	16	0	1	7	3	1	0	4
Tongue protrusion and mouth opening (longest act)	15	1	1	7	3	1	0	4

[a]Response patterns based on ordered pairs depicting the two infant behaviors in the order: tongue protrusions, mouth openings.

+ = a matching response, − = a mismatching response, 0 = an equal response to both displays. Each row in the table adds to 32, because there were 32 subjects in the experiment.

TABLE 3

First Trial Data as a Function of the Adult Displays (6-Week-Old Infants)

	MO Display		TP Display	
Infant Behavior	***M* (*SD*)**	**Median**	***M* (*SD*)**	**Median**
Tongue Protrusions	3.88 (5.16)	2.00	6.75 (5.88)	5.00*
Mouth Openings				
Frequency	4.06 (4.20)	3.00	2.19 (2.32)	2.00
Duration	9.95 (9.47)	9.20	3.81 (4.70)	2.60*
Longest Act	4.13 (4.34)	3.20	1.73 (1.44)	1.70*

* $p < .05$, Mann-Whitney U tests; $n = 16$ versus $n = 16$.

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TABLE 4

First Trial Means (Standard Deviations) Showing Effects of Person × Gesture (6-Week-Old Infants)

	Mother		Stranger	
Infant Behavior	**MO**	**TP**	**MO**	**TP**
Tongue Protrusions	3.75 (3.99)	6.50 (5.63)	4.00 (6.41)	7.00 (6.50)
Mouth Openings				
Frequency	4.25 (5.26)	2.50 (2.93)	3.88 (3.18)	1.88 (1.64)
Duration	10.19 (11.05)	4.82 (6.28)	9.71 (8.35)	2.79 (2.36)
Longest Act	3.80 (2.58)	2.00 (1.82)	4.46 (5.79)	1.46 (0.98)

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TABLE 5

First Trial Means (Standard Deviations) Showing Effects of Movement × Gesture (6-Week-Old Infants)

	Dynamic		Static	
Infant Behavior	**MO**	**TP**	**MO**	**TP**
Tongue Protrusions	4.62 (6.63)	6.13 (6.20)	3.13 (3.44)	7.37 (5.90)
Mouth Openings				
Frequency	2.50 (2.73)	2.38 (2.50)	5.63 (4.98)	2.00 (2.27)
Duration	5.24 (5.71)	3.86 (4.95)	14.66 (10.43)	3.75 (4.77)
Longest Act	2.29 (2.36)	1.72 (1.64)	5.97 (5.21)	1.74 (1.33)

TABLE 6

Infant Behaviors as a Function of the Adult Displays (2- to 3-Month-Old Infants)

	MO Display		TP Display	
Infant Behavior	***M* (*SD*)**	**Median**	***M* (*SD*)**	**Median**
Tongue Protrusions	9.44 (6.84)	8.00	13.81 (10.02)	11.00**
Mouth Openings				
Frequency	6.81 (5.29)	6.50	4.63 (4.76)	3.00*
Duration	15.44 (15.10)	11.40	7.57 (8.41)	5.05*
Longest Act	7.48 (8.57)	4.25	3.59 (2.65)	3.00*

Note. $N = 16$. Significance assessed by Wilcoxon matched-pairs signed-ranks tests.

* $p < .05$.

** $p < .01$.

TABLE 7

Number of Infants as a Function of Response Pattern (2- to 3-Month-Old Infants)

	Response Patterns[a]							
Infant Behaviors	**+ +**	**+ 0**	**0 +**	**+ −**	**− +**	**0 −**	**− 0**	**− −**
Tongue protrusion and mouth opening (frequency)	7	4	1	2	1	0	0	1
Tongue protrusion and mouth opening (duration)	9	1	1	3	0	0	0	2
Tongue protrusion and mouth opening (longest act)	8	2	1	3	1	0	0	1

[a]Response patterns based on ordered pairs depicting the two infant behaviors in the order: tongue protrusions, mouth openings.

+ = a matching response, − = a mismatching response, 0 = an equal response to both displays. Each row in the table adds to 16, because there were 16 subjects in the experiment.