Newborn Infants Imitate Adult Facial Gestures

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MELTZOFF, ANDREW N., and MOORE, M. KEITH. *Newborn Infants Imitate Adult Facial Gestures*. CHILD DEVELOPMENT, 1983, **54**, 702–709. Newborn infants ranging in age from 0.7 to 71 hours old were tested for their ability to imitate 2 adult facial gestures: mouth opening and tongue protrusion. Each subject acted as his or her own control in a repeated-measures design counterbalanced for order of stimulus presentation. The subjects were tested in low illumination using infrared-sensitive video equipment. The videotaped records were scored by an observer who was uninformed about the gesture shown to the infants. Both frequency and duration of neonatal mouth openings and tongue protrusions were tallied. The results showed that newborn infants can imitate both adult displays. 3 possible mechanisms underlying this early imitative behavior are suggested: instrumental or associative learning, innate releasing mechanisms, and active intermodal matching. It is argued that the data favor the third account.

Imitation has been demonstrated across a wide range of behaviors and ages in both Western and non-Western cultures (Aronfreed, 1969; Bandura, 1969; Flanders, 1968). A variety of theoretical perspectives have offered accounts of the origins of this capacity (Aronfreed, 1969; Parton, 1976; Piaget, 1945/1962).

Some theorists have asserted that imitation is based on early learning; they claim that the stimulus-response linkages manifest in imitative acts are built up through conditioning and learned associations. In this view, infants are taught to imitate simple acts in everyday interactions with their caretakers.

Although such training might explain the imitation of certain behaviors, it cannot provide a complete account of infant imitation, because young infants also copy behaviors that have not been part of any previous adult-infant interactions. Among such untrained imitative reactions, Piaget (1945/1962) singled out facial imitation as a landmark achievement. Facial imitation was regarded as a particularly important developmental milestone because, unlike manual and vocal imitation, the infant's response cannot be perceived within the same sensory modality as the model's. The stimulus and response cannot be "directly compared." In facial imitation, infants must match a gesture they see with a gesture of their own that they cannot see, a seemingly sophisticated skill that Piaget claimed was beyond the perceptual-cognitive competence of infants younger than 8–12 months of age.

There are disagreements between the learning and Piagetian accounts of imitation. However, they both maintain that young infants, without any special training on the task, should not be able to imitate facial gestures. Both assume that the capacity for facial imitation is forged through considerable postnatal experience—experience that leads infants to "link up" the model's behavior and their own unseen movements (the views differ on the kind of experience that is critical). Most modern theorists adopt some version of these views (Abravanel, Levan-Goldschmidt, & Stevenson, 1976; Gewirtz & Stingle, 1968; Kaye & Marcus, 1978; McCall, Parke, & Kavanaugh, 1977; Paraskevopoulos & Hunt, 1971; Parton, 1976; Uzgiris, 1972; Uzgiris & Hunt, 1975). Thus, whether or not writers agree with Piaget's theoretical explanation for the late development of facial imitation, there is a general acceptance of his observations that such activity is not manifest in the first few

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postnatal months (See Meltzoff & Moore [1983] for a review)

In contrast, we found that infants under 1 month of age can successfully imitate facial gestures (Meltzoff & Moore, 1977) More specifically, we showed that 12–21-day-old infants could imitate lip protrusion, mouth opening, tongue protrusion, and sequential finger movements Three independent studies have now supported our findings of early facial imitation Dunkeld (1978) demonstrated imitation of mouth opening, tongue protrusion, and other facial movements in infants under 4 months old Jacobson (1979) reported that 6-week-old infants match adult tongue protrusions with tongue protrusions of their own Burd and Milewski (Note 1) found that 2–10-week-old infants imitated not only oral gestures but also brow movements [1]

On the other hand, others have been unable to document early imitation (Hayes & Watson, 1981, Hamm, Russell, & Koepke, Note 2, McKenzie, Note 3) These divergent results suggest that there may be important differences in the experimental procedures utilized by the different research teams Elsewhere we reviewed this work and specified some of the methodological shortcomings of the latter group of studies (Meltzoff & Moore, 1983) The chief problems concerned the use of experimental procedures that served to dampen the imitative effect in young infants

We believe that the elicitation, measurement, and interpretation of neonatal imitation is facilitated by a set of procedures that we have described (Meltzoff & Moore, 1983) This experimental paradigm provides solutions to four of the major methodological issues in the study of early imitation It describes techniques for (*a*) distinguishing imitation from a general arousal response, (*b*) guarding against shaping of the imitative response, (*c*) obtaining high resolution records of neonatal lip and tongue movements and developing valid scoring procedures for documenting these fine motor actions, and (*d*) constructing test procedures that are effective in directing the neonate's visual attention to the experimenter's facial movements

The purpose of the present experiment was to apply this experimental paradigm to the study of newborn infants Our 1977 results did not conclusively support the hypothesis that the ability to imitate is present at birth The subjects were 12–21 days old One could still argue either (*a*) that this precocious imitation is itself learned through the intricate mother-infant interaction that occurs in the first postnatal weeks, or (*b*) that it depends upon postnatal maturation of the visual system, the motor system, or the ability to coordinate these two systems In order to assess whether either interactive experience or postnatal maturation is a necessary condition for infant imitation, we tested whether newborn infants (0–72 hours old) could imitate two facial gestures presented by an adult model

Method

Subjects —The following predetermined factors were adopted as admission criteria in this study (*a*) less than 72 hours old, (*b*) full-term (over 36 weeks' gestation), (*c*) normal birthweight (5 5–10 pounds), (*d*) fed within the last 3 hours, no rooting or other signs of hunger for 5 min immediately prior to testing, (*e*) wide-eyed, alert, and behaviorally calm for 5 min immediately prior to testing

The subjects were 40 healthy newborns with no known visual or motor abnormalities They ranged from 42 min to 71 hours old at the time of test, $\bar{X} = 32$ 1 hours, SD = 16 1 Other birth characteristics were birthweight, $\bar{X} = 7$ 7 pounds, SD = 1 0, range 6 1–9 8, gestational age according to the obstetrician's EDC, $\bar{X} = 40$ 5 weeks, SD = 1 6, range 36 6–43 9, 1-min Apgar, $\bar{X} = 7$ 9, SD = 1 0, range 6–9, 5-min Apgar, $\bar{X} = 9$ 0, SD = 0 5, range 8–10 There were 18 male subjects and 22 female subjects The maternity ward served primarily middle- and upper-middle-class whites of the 40 subjects, 37 were white, one was black, and two were Hispanic Over 90% of the subjects' mothers were 20 years old or older, $\bar{X} = 26$ 3 years, SD = 4 9

Testing began on 67 additional infants who did not complete the study for the following reasons falling asleep (30%), crying (27%), spitting or choking uncontrollably (24%), hiccuping (15%), and having a bowel movement during the test session (4%) This loss rate is typical of studies done with newborns (e g , Kessen, Salapatek, & Haith, 1972, Mendelson & Haith, 1976, Salapatek & Kessen, 1966) The specification that an infant was sleeping, crying, etc was not made by the experimenter during the test, but by an independent judge who evaluated the infant's state from the videotape and was kept uninformed about the infant's test condition

[1] After this paper was accepted for publication, Field, Woodson, Greenberg, & Cohen (1982) also reported that neonates imitate "happy," "sad," and "surprised" expressions

Test environment—The laboratory was an isolated experimental room, out of earshot of other crying newborns, in Swedish Hospital, Seattle The infants were examined within a large black-lined test chamber (2 0 m × 1 5 m) The room lights were extinguished during the test A spotlight, situated above (25 cm) and behind (15 cm) the infant, was oriented toward the experimenter's face The experimenter wore a gown made from the same black material as the background, thus reducing reflectance from his body The luminance was approximately 0 6 log cd/m^2 at the experimenter's face, and −1 3 log cd/m^2 on the black background 30 cm to the right of the experimenter's face The cameras were located outside the black test chamber with only their lenses poking through small holes The camera operator silently focused the camera at the beginning of each test The infants showed no tendency to fixate the camera location during the experiment The videotape recorders were housed within a sound-dampening chamber

Apparatus—We used an infrared-sensitive video camera to photograph the infant's oral movements (Telemation TMC-1100SD with a 4352H silicon diode pickup tube and Pichel IR-75 infrared illuminator) This camera and its tape deck (Sony 3650) were devoted solely to recording a close-up picture of the infant's face The camera was focused on the infant's lips, and the full extent of the picture was from the top of the infant's head to 2 5 cm below his or her chin A mirror (30 cm × 30 cm) was situated behind (25 cm) and to the left (18 cm) of the infant's head A second camera and tape deck were used to record the mirror reflection of the experimenter's face (camera Sony 3260, tape deck Sony 3650)

The experiment was electronically timed The timer consisted of a digital display that was located directly above (5 cm) the infant's head, and a companion character generator that electronically mixed the elapsed time (in 0 10-sec increments) onto both videotapes.

Procedure—The infants were carefully handled so that they did not see the experimenter's face until the modeling began All the infants were tested while supported in a semiupright position by a well-padded infant seat. Once the infant was seated, the experimenter slowly moved a white cloth (46 cm × 15 cm) in the spotlight before the infant's eyes for at least 20 sec If the infant fixated the cloth while maintaining a quiet alert state, the experimenter (*a*) removed the cloth, (*b*) put his face in the spotlight 25 cm from the infant's eyes, and (*c*) simultaneously activated the experimental clock The camera operator then signaled the infant's randomly determined test condition to the experimenter, and the modeling began The experimenter thus remained uninformed about the infant's test condition until the moment he started to model the test displays

Each infant was presented with both a mouth-opening and a tongue-protrusion gesture For half the infants, the order of presentation was mouth opening then tongue protrusion, the remainder received the reverse order Pilot work indicated that newborn attention and responsivity were fostered by alternating the adult's gesturing with periods in which the experimenter remained passive Thus we used two 4-min periods Each of these periods consisted of 12 20-sec intervals such that the experimenter alternately demonstrated the gestures (for 20 sec), then assumed a passive face (for 20 sec), and so on At the end of this first period, the identical procedure was repeated using the new gesture The displays were performed in a standardized fashion, at the rate of four times in a 20-sec interval with a 1-sec interact interval (The placement of the experimental clock directly above the subject's head aided the experimenter in timing his gestures without needing to turn from the infant, see Apparatus) There were no breaks or pauses anywhere in the test The experimenter's behavior was thus fixed from the moment the experiment began until the end

Response measures—The videotapes of the infant's face did not contain any record of the gesture shown to the infant The 80 videotaped periods (40 subjects × 2 modeling periods each) were scored in random order by an observer who was uninformed about which gesture had been shown to the infant in any given period

Both the frequency and the duration of infants' mouth openings and tongue protrusions were scored The onset of a mouth opening was operationally defined as an abrupt jaw drop opening the mouth across the entire extent of the lips The termination of mouth opening was defined as the return of the lips to their closed resting position The definition of closed resting position was (*a*) lips closed and touching across the entire extent or (*b*) the minimum separation of the lips exhibited during the pretest exposure to the white cloth, for those infants who always maintained a small crack between their lips For those cases in which a mouth began to close but had not yet reached the closed position when a second mouth opening was initiated, the first mouth opening was terminated with the initiation of the reopening The onset of 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 The termination of tongue protrusion was defined as the retraction of the tip behind 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 The mouthing and tonguing that periodically occurred as part of yawning, sneezing, choking, spitting, or hiccuping were not scored The scorer reviewed the videotapes in real time, slow motion, and if necessary even frame by frame

Assessments of both intra- and interscorer reliability were conducted using 15% of the data, including an equal number of periods from each type of modeling condition (mouth opening and tongue protrusion both as the first and as the second modeled gesture) The intrascorer assessments were conducted 1 week after the data had been scored the first time The scorer was kept unaware of the trials to be used to assess reliability, which has the potential for fostering high scoring precision throughout all the trials (Reid, 1970) Pearson correlations were used to assess reliability on all the infant measures used in the subsequent analyses The *r*'s for the intraobserver assessments were as follows mouth-opening frequency, 99, tongue-protrusion frequency, 99, mouth-opening duration, 99, and tongue-protrusion duration, 99, the *r*'s for the interobserver assessments were, respectively, 92, 96, 96, and 99

Results

The experimental design allows a separation of random oral movements, general arousal, and true imitation The two successive modeling periods involved the same experimenter, gesturing at the same rate, at the same distance from the infant The two periods differed only in the facial gesture presented. Using this design, imitation is demonstrated if infants show significantly more tongue protrusions to the adult tongue-protrusion display than to the adult mouth-opening display and, conversely, more mouth openings to the adult mouth-opening display than to the adult tongue-protrusion display Such a pattern of *differential* responding cannot arise from random activity or a general arousal of infant oral activity by a moving human face

Frequency measures—The frequency of infant mouth openings was greater in response to the mouth-opening display, $\bar{X} = 7\ 1$, than to the tongue-protrusion display, $\bar{X} = 5\ 4$, $N = 38$, $Z = 2\ 26$, $p <\ 05$, Wilcoxon matched-pairs signed-ranks test Similarly, infants produced significantly more tongue protrusions in response to the tongue-protrusion display, $\bar{X} = 9\ 9$, than to the mouth-opening display, $\bar{X} = 6\ 5$, $N = 33$, $Z = 3\ 31$, $p <\ 001$

The pattern of imitative responding at the level of individual subjects is noteworthy Twenty-six infants produced more mouth openings to the mouth-opening display than to the tongue display, 12 produced more mouth openings to the tongue display, and two produced an equal number of mouth openings to both displays For the tongue-protrusion measure, 26 infants produced more tongue protrusions to the tongue-protrusion display, seven produced more tongue protrusions to the mouth display, and seven produced an equal number to both displays

The outcome at the level of individual subjects can be analyzed in detail by taking into account the infants' mouth-opening and tongue-protrusion behaviors simultaneously For example, each individual infant can produce a greater frequency of mouth openings to the adult mouth-opening display (+), to the adult tongue-protrusion display (−), or have an equal frequency of mouth openings to both displays (0) Similarly, each can produce a greater frequency of tongue protrusion to the tongue display (+), the mouth display (−), or have an equal frequency to both (0) Table 1 categorizes all 40 subjects in terms of their response on both behaviors considered simultaneously The top portion of the table displays the results using the frequency measure These data can be analyzed using a one-sample χ^2 test The results are significant, $\chi^2 = 38\ 70$, $df = 7$, $p <\ 001$

The hypothesis of infant imitation can be directly examined by comparing the number of infants falling into the two most extreme cells (++ vs −−) The infants in the ++ cell consistently matched both gestures The in-

TABLE 1

NUMBER OF INFANTS DISPLAYING EACH OF EIGHT RESPONSE PATTERNS FOR THE FREQUENCY MEASURE AND THE DURATION MEASURE

MEASURE	RESPONSE PATTERN								TOTAL N
	+ +	+ 0	0 +	+ −	− +	0 −	− 0	− −	
Frequency measure	16	5	1	5	9	1	2	1	40
Duration measure	20	2	0	8	5	0	1	4	40

NOTE —The response patterns are shown as ordered pairs depicting the two infant behaviors in the order mouth openings, tongue protrusions, + indicates a greater frequency (duration) of an infant behavior to the matching adult display than to the mismatching display, − indicates a greater frequency (duration) of an infant behavior to the mismatching display than to the matching display 0 indicates an equal frequency (duration) of an infant behavior to both displays

fants in the − − cell consistently mismatched both gestures Under the null hypothesis, there is an equal probability of infants falling into one or the other of these two response types The results identify 16 infants with the + + pattern and only one with the − − pattern

Duration measures—The same analyses were performed using the duration measure The duration of mouth opening was longer in response to the mouth-opening display, $\bar{X} = 41\ 0$, than to the tongue-protrusion display, $\bar{X} = 24\ 1$, $N = 40$, $Z = 3\ 39$, $p < 001$, Wilcoxon test Similarly, the duration of infant tongue protrusion was longer to the adult tongue-protrusion display, $\bar{X} = 10\ 7$, than to the mouth-opening display, $\bar{X} = 6\ 5$, $N = 37$, $Z = 3\ 03$, $p < 005$

Again, the pattern of responding at the subject level is noteworthy Thirty of the 40 infants had a longer duration of mouth opening to the mouth-opening display than to the tongue display, 10 had a longer duration of mouth opening to the tongue display, and none had an equal duration For the tongue measure, 25 infants had a longer duration of tongue protrusion to the tongue-protrusion display, 12 had a longer duration of tongue protrusion to the mouth display, and three had an equal duration of tongue protrusion to both displays

The bottom portion of Table 1 categorizes all 40 subjects using the duration measure The one-sample χ^2 test is significant, $\chi^2 = 62$, $df = 7$, $p < 001$ Again the equiprobable extreme cells are of particular interest, there are 20 infants who show the + + pattern and only four who show the − − pattern

Age, order, and sex effects—The infants were tested within a narrow age range of 72 hours The most comprehensive assessment of any relationship between chronological age and imitation is provided by correlations between age and the differential response infants show to the mouth-opening versus tongue-protrusion displays (the data used in these analyses and the others below are the difference scores used in the Wilcoxon tests previously reported) None of the resulting Spearman rank correlations was significant for either the frequency or duration of mouth opening or tongue protrusion The r_s ranged from − 01 to − 24 The correlations with conceptional age within the narrow range tested also failed to reach significance, r_s ranged from 07 to − 26

Similar analyses using the same kinds of data were used to evaluate the relationship between imitation, and order of stimulus presentation and sex Mann-Whitney U tests revealed no significant differences as a function of order for the mouth-opening or tongue-protrusion scores (either for frequency or duration) Mann-Whitney U tests also revealed no significant differences as a function of sex for the mouth-opening or tongue-protrusion scores (either for frequency or duration)

Discussion

The results demonstrate that newborns can imitate adult facial displays under certain laboratory conditions How can we account for the fact that this phenomenon has not been commonly observed and reported by researchers in the past? Both our data and observations provide helpful clues The first and most obvious answer is that we tested only normal alert newborns with a procedure designed to keep them focused on the task Newborns may not perform as systematically under less controlled circumstances

There are also other reasons why newborn imitation might not have been commonly observed in the past, and these are of some theoretical importance They concern the nature of the stimulus that is effective in eliciting the behavior, and the structure and organization of the infant's response.

We found in preliminary work that a constant demonstration of the target gesture was not maximally effective in eliciting imitation. Therefore, in our design the experimenter alternated between the presentation of the gesture and a passive face. We are not certain why our burst-pause procedure is the more powerful, but we can suggest three possibilities.

First, this alternation may allow the experimenter to demonstrate the gesture over a more extended period of time without the infant visually habituating to the adult display. By retaining the infants' active interest, this procedure might simply give infants more time to organize their motor response. Second, this alternation may be especially effective in isolating the modeled action. That is, the change from a burst of tongue protrusion to a passive face and back to a burst of tongue protrusion may focus the infant on what differentiates the two states. If the adult constantly and repetitively demonstrates tongue protrusion, the infant may not register the display in the same way (Moore & Meltzoff, 1978). Third, it is possible that the alternating aspects of the demonstration have some social significance. When an infant perceives a human adult acting, then stopping, acting, then stopping, this may motivate the infant to action rather than mere visual fixation. The special social significance of "turn taking" has been pointed out by several investigators (e.g., Bruner, 1975; Stern, Jaffe, Beebe, & Bennet, 1975) and may be important in eliciting imitation.

There are also aspects of the organization of the response that may have obscured newborn imitation in the past. One interesting aspects is its variability both within and between infants. All infants do not produce a given number of tongue protrusions, each individual tongue protrusion is not a fixed duration, the same form, and so on. Moreover, the imitative response does not burst forth fully formed the moment the infant fixates on the adult's gesture. Indeed, we observed that infants corrected their responses over successive efforts, often beginning by producing small approximations of the model—small tongue movements inside the oral cavity (not scored as imitation according to the operational definitions used here)—and then converging toward more accurate matches of the adult's display over successive efforts.

We next address the primary theoretical issue raised by this research: What mechanism underlies this early imitation? We previously described three possible accounts of early facial imitation: instrumental or associative learning, innate releasing mechanisms, and active intermodal matching to target (Meltzoff & Moore, 1977).

The present data indicate that postnatal learning is not a necessary condition for facial imitation. This does not mean that infants *cannot* be conditioned to imitate, nor that the range of gestures or the meaning imputed to them might not be expanded in important ways through the experience gained in adult-infant interactions. We do not claim that a newborn is as "good" an imitator as a 1-year-old. We merely suggest that the strong view that infants have *no* capacity to imitate at birth is contradicted by the data. Evidently the capacity to imitate is available at birth and does not require extensive interactive experience, mirror experience, or "reinforcement history."

If early learning cannot account for these effects, one must consider the second possibility we proposed, namely, innate releasing mechanisms (Jacobson, 1979). There are two lines of reasoning that lead us to suggest that the concept of an innate releasing mechanism, at least as classically described (Lorenz & Tinbergen, 1938/1970; Tinbergen, 1951), is not a useful heuristic for understanding early imitation. First, young infants imitate not just one, but a range of motor acts. Here we reported imitation of two facial acts. We have previously reported that 2–3-week-old infants can imitate three oral gestures and one manual gesture (Meltzoff & Moore, 1977). Burd and Milewski (Note 1) not only confirmed our findings of early oral imitation but also extended the list of behaviors that can be successfully imitated to include brow movements. Clearly, one cannot postulate a releasing mechanism for imitation in general, and it would seem unparsimonious to conclude that every new behavior that is shown to be imitated by neonates represents another released response.

Second, the morphology and temporal organization of the imitative reaction is different from what one would expect if they were released in the classical sense. A traditional hallmark of released reactions, "fixed-action patterns," is that they are stereotypic, rigidly organized reactions that "run off" independent of feedback mechanisms (Lorenz & Tinbergen, 1938/1970). Studies show that human neonates are capable of performing fairly rigid and stereotypic motor routines (Brazelton, 1973; Prechtl & Beintema, 1964). However, we do not see this kind of stereotypy in these imitative reactions. Infants do not immediately produce a perfect matching response; they seem to correct their response over successive efforts. There is little in the nature and organization of the response that tempts us to describe it as a classic fixed-action pattern that is released by the adult's display.

We believe there is a need for a third alternative that does not reduce to innate releasing mechanisms or learned stimulus-response linkages. The hypothesis we favor is that this early imitation is accomplished through a more active matching process than admitted by the two other accounts. The crux of our view is that neonates can, at some level of processing, apprehend the equivalence between body transformations they see and body transformations of their own whether they see them or not. It is precisely this point that is denied by the other accounts. Both explain early imitation without postulating that the utilization of intermodal equivalences has anything to do with the infant's ability to imitate. After all, neither a "discriminative cue" nor a "sign stimulus" needs to match the response it elicits. Any two gestures could presumably be paired through reinforcement, and released behaviors need not be morphologically similar to the sign stimuli that trigger them (e.g., the chick's food-begging response is released by the adult's mandible patch, not by adult food begging).

In contrast, we postulate that infants use the equivalence between the act seen and the act done as the fundamental basis for generating the behavioral match. By our account even this early imitation involves active matching to an environmentally provided target or "model." Our corollary hypothesis is that this imitation is mediated by a representational system that allows infants to unite within one common framework their own body transformations and those of others. According to this view, both visual and motor transformations of the body can be represented in a common form and thus directly compared (Bower, 1979; Meltzoff, 1981; Meltzoff & Borton, 1979; Meltzoff & Moore, 1977, 1983). Infants could thereby relate proprioceptive motor information about their own unseen body movements to their representation of the visually perceived model and create the match required.

The critical theoretical point is that we do not support the view that young infants have perceptual-cognitive constraints that restrict them to utilizing intramodal comparisons. Instead, we postulate that infants can recognize and use intermodal equivalences from birth onward. In our view, the proclivity to represent actions intermodally is the starting point of infant psychological development, not an end point reached after many months of postnatal development.

Reference Notes

1. Burd, A. P., & Milewski, A. E. *Matching of facial gestures by young infants: Imitation or releasers?* Paper presented at the meeting of the Society for Research in Child Development, Boston, April 1981.
2. Hamm, M., Russell, M., & Koepke, J. *Neonatal imitation?* Paper presented at the meeting of the Society for Research in Child Development, San Francisco, March 1979.
3. McKenzie, B. Personal communication, March 1979.

References

Abravanel, E., Levan-Goldschmidt, E., & Stevenson, M. B. Action imitation: The early phase of infancy. *Child Development*, 1976, **47**, 1032–1044.

Aronfreed, J. The problem of imitation. In L. P. Lipsitt & H. W. Reese (Eds.), *Advances in child development and behavior* (Vol. 4). New York: Academic Press, 1969.

Bandura, A. Social learning theory of identificatory processes. In D. A. Goslin (Ed.), *Handbook of socialization theory and research*. Chicago: Rand McNally, 1969.

Bower, T. G. R. *Human development*. San Francisco: W. H. Freeman, 1979.

Brazelton, T. B. *Neonatal behavioral assessment scale*. London: Heinemann, 1973.

Bruner, J. S. From communication to language—A psychological perspective. *Cognition*, 1975, **3**, 255–287.

Dunkeld, J. *The function of imitation in infancy*. Unpublished doctoral dissertation, University of Edinburgh, 1978.

Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. *Science*, 1982, **218**, 179–181.

Flanders, J. P. A review of research on imitative behavior. *Psychological Bulletin*, 1968, **69**, 316–337.

Gewirtz, J. L., & Stingle, K. G. Learning of generalized imitation as the basis for identification. *Psychological Review*, 1968, **75**, 374–397.

Hayes, L A , & Watson, J S Neonatal imitation Fact or artifact? *Developmental Psychology,* 1981, **17,** 655–660

Jacobson, S W Matching behavior in the young infant *Child Development,* 1979, **50,** 425–430

Kaye, K , & Marcus, J Imitation over a series of trials without feedback Age six months *Infant Behavior and Development,* 1978, **1,** 141–155

Kessen, W , Salapatek, P , & Haith, M The visual response of the human newborn to linear contour *Journal of Experimental Child Psychology,* 1972, **13,** 9–20

Lorenz, R , & Tinbergen, N [Taxis and instinctive behavior pattern in egg-rolling by the Graylag goose (1938)] In K Lorenz (Ed , R Martin, trans), *Studies in animal and in human behavior* (Vol **1**) Cambridge, Mass Harvard University Press, 1970 (Originally published, 1938)

McCall, R B , Parke, R D , & Kavanaugh, R D Imitation of live and televised models by children one to three years of age *Monographs of the Society for Research in Child Development,* 1977, **42**(5, Serial No 173)

Meltzoff, A N Imitation, intermodal coordination, and representation in early infancy In G Butterworth (Ed), *Infancy and epistemology* Brighton Harvester, 1981

Meltzoff, A N , & Borton, R W Intermodal matching by human neonates *Nature,* 1979, **282,** 403–404

Meltzoff, A N , & Moore, M K Imitation of facial and manual gestures by human neonates *Science,* 1977, **198,** 75–78

Meltzoff, A N , & Moore, M K The origins of imitation in infancy Paradigm, phenomena, and theories In L P Lippsitt & C Rovee-Collier (Eds), *Advances in infancy research* (Vol **2**) Norwood, N J Ablex, 1983

Mendelson, M J , & Haith, M M The relation between audition and vision in the human newborn *Monographs of the Society for Research in Child Development,* 1976, **41**(4, Serial No 167)

Moore, M K , & Meltzoff, A N Object permanence, imitation, and language development Toward a neo-Piagetian perspective on communicative and cognitive development In F D Minifie & L L Lloyd (Eds), *Communicative and cognitive abilities—early behavioral assessment* Baltimore University Park Press, 1978

Paraskevopoulos, J , & Hunt, J McV Object construction and imitation under differing conditions of rearing *Journal of Genetic Psychology,* 1971, **119,** 301–321

Parton, D A Learning to imitate in infancy *Child Development,* 1976, **47,** 14–31

Piaget, J *Play, dreams, and imitation in childhood* (C Gattegno & F M Hodgson, trans) New York Norton, 1962 (Originally published 1945)

Prechtl, R , & Beintema, D *The neurological examination of the full-term newborn infant* London Heinemann, 1964

Reid, J B Reliability assessment of observation data A possible methodological problem *Child Development,* 1970, **41,** 1143–1150

Salapatek, P , & Kessen, W Vision scanning of triangles by the human newborn *Journal of Experimental Child Psychology,* 1966, **3,** 155–167

Stern, D , Jaffe, J , Beebe, B , & Bennet, S Vocalizing in unison and in alternation Two modes of communication within the mother-infant dyad *Annals of the New York Academy of Sciences,* 1975, **263,** 89–100

Tinbergen, N *The study of instinct* New York Oxford University Press, 1951

Uzgiris, I C Patterns of vocal and gestural imitation in infants In F J Monks, W W Hartup, & J deWitt (Eds), *Determinants of behavioral development* New York Academic Press, 1972

Uzgiris, I C , & Hunt, J McV *Assessment in infancy* Urbana University of Illinois Press, 1975