

# The Role of Movement in Eliciting Early Imitations

Annie Vinter

*Istituto Scientifico Stella Maris, Pisa, Italy*

VINTER, ANNIE. *The Role of Movement in Eliciting Early Imitations*. CHILD DEVELOPMENT, 1986, 57, 66-71. The role of movement in triggering early imitative responses is examined in this study. The sample consisted of 36 newborns (median age = 4 days). 16 were presented with 2 dynamic models (tongue protrusion and hand opening-closing), 12 were presented with the static form of these same models, and the remaining 8 constituted a control group. Only infants in the first condition reproduced the models at significant levels. However, infants in the static condition fixated the experimenter longer than those in the dynamic one. The results are discussed in terms of neurophysiological findings concerning the control of neonatal behaviors and early perceptual capacities.

Despite the current controversy about whether imitative responses on the part of the newborn are a robust phenomenon and, if so, what underlying mechanisms may properly be inferred (Hayes & Watson, 1981; Koepke, Hamm, & Legerstee, 1983; McKenzie & Over, 1983), there is a growing body of evidence demonstrating the presence of such responses soon after birth (Dunkeld, 1978; Field, Woodson, Greenberg, & Cohen, 1982; Maratos, 1973, 1982; Meltzoff & Moore, 1977, 1983). It seems evident that in order to advance the theoretical issues further, we need to attain as fine a description of this phenomenon as possible and consider the morphology of imitative responses as well as the relevant properties of the models that elicit them. To date, newborns' imitations have been described as selective, precise, immediate, global, and integrated, in the sense that a movement is reproduced not in isolation but as an integral part of a more complex behavioral sequence (Trevarthen, 1982; Vinter, 1985a, 1985b). The work of Jacobson (1979) suggests that from the perspective of stimulus properties, form and movement should be fundamental in triggering imitations. Jacobson selected five models, three of them being produced by inanimate objects. At 6 weeks, she found tongue protrusion to be elicited as much by a person's protruding tongue as by a pen moving toward and away from the in-

fant's mouth; a moving ball was less effective in triggering this response. Similarly, a dangling ring lifted up and down above the infant's hand was as effective as the adult model in eliciting hand opening and closing at 14 weeks. These results suggest that movement and, to some extent, the shape of the model are meaningful dimensions in eliciting imitations. The current study was designed to examine this notion further by asking whether movement is required to trigger imitative responses to a human model at birth. In other words, is the newborn as capable of reproducing the static positions as the movements of an adult?

Kinetic stimulus properties are critical for the newborn's capacity to detect objects and to evoke visual attention (Haith, 1978). Neurophysiologically, kinetic information is processed in a different way from information about the positions or states of objects. A system of "central vision," evolved to analyze the forms and details of objects, is differentiated from a system of "peripheral vision," devoted to the analysis of object displacements and spatial relations (Paillard, 1980; Schneider, 1968; Trevarthen, 1968). According to Bronson (1974), the newborn's visually guided behaviors would fall under the control of the "secondary" visual system that functions to process peripheral information; the

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"primary" visual system, which is principally involved with central information, is not functional in the neonate. Such predominance at birth of the secondary subcortical visual system over the neocortically mediated central vision ("primary") system could help us to understand the importance of movement in early imitation.

## Method

**Subjects.**—Thirty-six newborns (18 girls) without any delivery or birth complications participated in the study. Conception age ranged from 38 to 41 weeks ( $M = 40.2$  weeks) and postpartum age from 2 to 5 days (median = 4 days); birth weights ranged from 2,900 to 4,230 grams ( $M = 3,522.6$ ,  $SD = 498$ ).

**Setting.**—All infants were observed in a small room adjoining the nursery of Pisa Hospital (Italy). The subject was placed in an infant seat, and the rigid back was inclined at an angle of about 45°. The experimenter, who had a video monitor and a chronometer in her visual field, faced the infant in such a way that her face (or hand, depending on the experimental condition) was 15–20 cm from the subject's eyes.

A camera (Sony AVC-3250 CE) situated at about 30° to the left of the infant recorded the child's head and facial movements. A second camera about 35°–40° to the right recorded the infant's hand and arm movements as well as either the face or the hand of the experimenter (depending on the behavior being modeled). The signals from the two cameras were combined by a mixer (Sony CMW-110 CE), relayed to a timer (FOR-A Co., VTG-33), recorded (JVC HR-366 OEB), and sent to a control monitor (Sony PMV-200 CE).

The subjects were observed shortly after they had been fed in order to avoid tongue protrusions that could be attributed to hunger. They were examined when they achieved a state of quiet or active awakefulness (state 3 or 4 of Precht's scale; Precht, 1974).

**Design and procedure.**—The infants were randomly assigned to one of three groups, each composed of an equal number of boys and girls: (1) a "movement" group ( $N = 16$ ), (2) a "static" group ( $N = 12$ ), and (3) a control group ( $N = 8$ ).

Infants in the movement group were presented with two models performed by an adult—the movement of tongue protrusions and that of opening-closing the hand. The experimenter repeated the given movement 9–10 times during a 25-sec period, then remained still, with mouth or hand closed, for 25 sec. The entire sequence was repeated four times. For infants in the static group, the experimenter maintained a protruding tongue or an open hand for 25 sec, and then remained for 25 sec with a closed mouth or hand. The entire sequence was repeated three times.<sup>1</sup> The facial and manual model sequences were labeled "facial phase" and "manual phase" for both subgroups.

In both experimental groups, once the baby was comfortably seated, a 50-sec "observation phase" began in which the experimenter faced the infant without moving. The experimenter then performed either the facial or the manual model in three (static group) or four (movement group) repetitions of the full 50-sec sequences. A second 50-sec observation phase followed before presentation of the other of the two models. All subsequent comparisons between a modeling phase and an observation phase used the immediately preceding observation phase for contrast.

Infants in the control group were recorded for 8½ min (the average duration of observation for the two experimental groups) while the experimenter faced them without moving. The recording was subsequently segmented into 50-sec periods corresponding to the observation phases and the facial and manual phases experienced by the experimental groups.

**Measures.**—The frequency of the following behaviors was coded: (1) semiprotrusions (tongue between the lips), (2) complete protrusion (tongue extended beyond the lips), (3) partial opening-closing of the hand (defined as a whole act that must be completed within a maximum of 3 sec), (4) complete opening-closing of the hand. The duration of all "protrusions," "mouth closed," "hand open," and "hand closed" postures was established. Additionally, the orientation of the child's line of vision was coded as "on" or "off" the experimenter, and "eyes closed" in half-second intervals.

Twenty-four records were coded by two judges working independently; for the re-

<sup>1</sup> The sequence was repeated only three times in the static group (rather than four, as in the movement group) because work with the movement group, which was conducted first, indicated that two or three repetitions were sufficient to attain significant results.

maining 12 the two worked together. Masking the relevant part of the television screen rendered them blind to the experimental group and phase they were coding. Calculated on the basis of the independent judgments, agreement on the various measures ranged between 80% and 87%.

## Results

Overall differences in frequency of tongue protrusions and hand opening-closing in the three groups were examined first by means of the Kruskal-Wallis test (partial and complete acts were combined for this analysis).<sup>2</sup> No significant differences in either act were obtained during the observation phases (with  $df = 2$  and  $N = 36$ ,  $\chi^2$  for tongue protrusions = 2.78 and for hand opening-closing = 2.06;  $p > .05$  in both instances). However, a significant difference among the three groups in tongue protrusions was established during the facial phase,  $N = 36$ ,  $\chi^2(2) = 12.93$ ,  $p < .01$ , and in hand opening-closing during the manual phase,  $N = 36$ ,  $\chi^2(2) = 18.03$ ,  $p < .01$ . The data are plotted in Figure 1.

Specific between-group differences were next examined by the Wilcoxon test in order to establish whether production of the imitative responses was specifically linked to the presentation of the appropriate model in the movement group only. Regarding reproduction of the facial model, frequency of tongue protrusions was significantly higher in the movement group during the facial phase than during either the observation or the manual phases ( $T = 0$ ,  $p < .01$ , and  $T = 2.5$ ,  $p < .01$ , respectively;  $N = 16$ ). For the static group, it was significantly higher in the facial phase than in the observation phases ( $N = 9$ ,  $T = 4.5$ ,  $p < .05$ ), but no significant difference was obtained between the facial and manual phases ( $N = 12$ ,  $T = 30$ ,  $p > .05$ ). In the control group, none of the differences between the artificially divided phases were significant. For the manual model, the frequency of hand opening-closing was higher in the movement group during the manual phase than in either the observation ( $N = 14$ ,  $T = 10$ ,  $p < .01$ ) or the facial phase ( $N = 16$ ,  $T = 7.5$ ,  $p < .01$ ). No significant between-phase differences were obtained for either the static or the control groups (all  $p$  levels  $> .05$ ).

The duration of the infants' tongue protrusions and hand openings in segments in

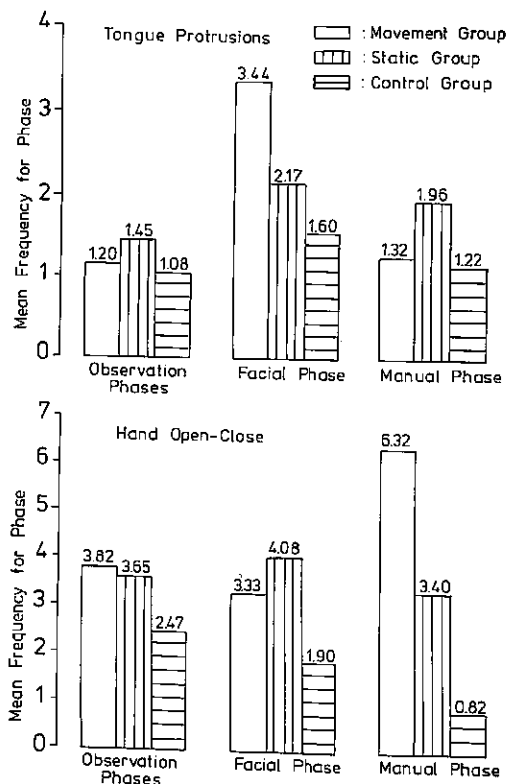


FIG 1.—Frequencies of tongue protrusions and hand openings-closings for the three subject groups in each experimental phase.

which the model was performing the protrude tongue or open hand action, versus those in which her mouth or hand was closed, was examined in order to assess the extent to which the infants were attempting to exactly duplicate the model's position. No significant between-segments duration differences (assessed by  $t$  test) emerged for either the facial or the manual response. Similarly, no significant differences were found in the mean duration of the protruded versus retracted tongue postures (or open vs. closed hand) when the entire facial (or manual) phase was considered.

The mean proportions of time that the infants in each of the two experimental groups looked at the experimenter during the observation, manual, and facial phases are shown in Table 1. Within each group, the between-phase differences are not significant, except between the observation and the manual phases in the static group:  $t$  test,  $t(11) = 1.85$ ,

<sup>2</sup> Separate analyses of only partial and only complete responses result in essentially identical findings, with the latter measure providing somewhat stronger evidence of imitation than the former (Vinter, 1985b).

TABLE 1  
MEAN PERCENT OF TIME LOOKING AT THE  
EXPERIMENTER DURING THE DIFFERENT PHASES

PHASE	GROUP	
	Movement	Static
Observation .....	22.25	31.60
Facial .....	28.30	50.75
Manual .....	26.50	61.40

$p < .05$ . However, between-group comparison shows significantly more looking by the static than the movement group during both the facial and manual phases (Mann-Whitney test;  $U = 44$ ,  $p < .05$ , and  $U = 56$ ,  $p < .05$ , respectively). More detailed analysis of these data reveals that neonates in the static group spent much more time looking at the experimenter when her hand was open than when it was closed (72.70% vs. 50.10%,  $p < .01$ ). Similarly, they looked more at the experimenter when she was protruding her tongue than when her mouth was closed (58.30% vs. 43.20%,  $p < .10$ ). Finally, the movement group neonates looked more at the experimenter when she was performing the models than when she was passive, whatever the experimenter phase (facial phase: 41.63% vs. 14.97%,  $p < .01$ ; manual phase: 39.62% vs. 17.38%,  $p < .05$ ). The mean percentage of time neonates kept their eyes closed was less than 18% whatever the experimental phase or group.

## Discussion

The results of this study highlight the role of movement in eliciting neonatal imitation. Infants exposed to kinetic facial and manual actions emitted higher rates of the modeled act in the interval during which it was modeled than in any other condition, thus supporting the contention that their behavior was imitative.<sup>3</sup> In contrast, infants exposed to the static version of the same act failed to show evidence of selective reproduction of the modeled behavior; they did, however, spend relatively more time visually fixating both the facial and the manual models.

<sup>3</sup> Note that four conditions must be met to support the contention that a response is imitative: the rate of emission must be significantly higher during the modeling interval than (1) the spontaneous rate of emission, (2) the rate of this response after the presentation of other modeled behaviors, (3) the rate observed in a control group over the same period, and (4) the rate of a similar behavior that does not significantly increase after the presentation of the model. For instance, to assert the existence of a specific imitation of the tongue protrusion movement, the rate of mouth opening-closing should not increase after the presentation of the tongue protrusion model; otherwise, only a nonspecific capacity to imitate general mouth movements may be assumed.

These results are in agreement with some current findings in the literature. Field et al. (1982) and Meltzoff and Moore (1983), the only authors to have demonstrated the existence of imitation in infants aged less than 1 week, both used kinetic models, although Field et al.'s situation was more complex. In this research, the experimenter adopted a facial expression with significant emotional content for a certain length of time (the model was therefore static) but presented the infant with this expression several times in succession, while making sure that the baby was looking at her at the moment when each of the expressions was adopted. Thus, in this research, the models were both static and dynamic.

Nevertheless, if movement appears to be a fundamental property for eliciting imitative responses at birth, it cannot be concluded that movement is necessary to trigger all of a newborn's matching behaviors. Condon and Sander (1974) and Meltzoff and Borton (1979), for example, have demonstrated such behavior at birth without using a kinetic model. The latter authors found the neonate to be able to match a seen nipple with a sucked nipple on the basis of the object's texture. Movement may be an important property of the stimulus for eliciting matching behaviors that involve actions from the infant. From this perspective, it is relevant to record that early prehension is best elicited by moving objects (Bower, Broughton, & Moore, 1970; von Hofsten, 1982; Rader & Stern, 1982).

We found the neonates to fixate the static model longer than the dynamic one. This result is certainly in part a consequence of the integrated aspect of the imitative responses at birth. Vinter (1985a) showed that tongue protrusion is strongly associated with lateral head movements (which obviously modify the infant's line of regard), and that hand opening-closing is linked to arm movements (extension or abduction and flexion or adduction). Furthermore, even if we did not analyze such relations, arm movements are likely to be linked with head movements, as, for example, in the tonic neck reflex. Infants in the movement group in fact produced much more lateral head movement than neonates in the

other group. The intragroup differences in looking time at the experimenter are easier to interpret. With regard to the movement group, these differences make it clear that movement attracts the newborn's visual attention, since he or she looks longer at the experimenter when the models are performed than during the passive periods. The differences in contour density and contrast intensity between the hand-open and hand-closed positions can explain why static group neonates look longer at the hand-open position than at the other. Why, however, did the neonates not imitate the postures of the experimenter, even though they fixated her? It could be suggested that movement led to a higher level of arousal, which is more effective for encoding information and thus for eliciting imitation. The arousal power of movement in neonates is known, in fact, from a large number of studies. But we doubt that the production of a behavior is a simple function of arousal level.

A neurophysiological hypothesis may be suggested. Kinetic information is processed essentially by the system of peripheral vision, which, according to Bronson (1974), might be under the control of a secondary subcortical visual system. On the other hand, the analysis of forms and details of objects (or information about the states, the positions, or the postures of the objects) is elaborated centrally and necessitates a neocortical mediation. The distinction to be highlighted here is between a neocortical and a subcortical mediation of the neonate's behaviors. Several authors (Bronson, 1974, 1982; Gibson, 1981; Trevarthen, 1979) consider that the newborn's behavioral repertoires are controlled by subcortical structures. Bronson (1982) elaborates this point of view by taking into account different sources of data, for example, patterns of myelination or neural damage in adults and primates. The newborn appears to be in a transitional period during which neocortical mediation is just emerging. According to Atkinson (1983), whereas it is impossible to deny the existence of some cortical activities in the first 2 months of life, most of the neonate's behaviors are nevertheless under subcortical control. Data coming from the discrimination of orientations, the visual evoked potentials, suggest a rudimentary cortical activity. But it seems difficult to establish whether this activity develops rapidly between 1 and 2 months or is present from birth. On the other hand, data relative to color vision, binocular function, and control of visual attention give support to the subcortical thesis.

From this perspective, the collicular structures—in particular, the superior colliculus—are of prime interest. The superior colliculus is an important center of sensorimotor integration that receives visual, auditory, and somatosensory information (Goldberg & Lee Robinson, 1978; Ingle & Sprague, 1975; Stein, 1984). Descending efferent tracts are sent to a variety of regions involved in orienting the eyes, head, and limbs. The organization of sensory representations and "motor" organization are topographic, but above all there exists a complete overlap of the diverse sensory topographies as well as of sensory and motor topographies. This characteristic is important if we examine the possibility that imitation ability may be controlled by such a structure at birth. Clearly, the occurrence of imitation indicates that newborns possess a representation that permits matching between their own actions and the visual appearance of the same actions executed by others. To define these neonatal representations is still an open problem (Bower, 1974; Mounoud, 1979; Mounoud & Vinter, 1981), particularly the extent to which they may be based on some innate mechanism releaser (Eibl-Eibesfeld, 1979; Jacobson, 1979). But from the perspective of subcortical control of neonatal imitation ability, the topographic organization of a structure such as the superior colliculus may provide a neurophysiological basis for the notion of neonatal representation. Obviously, detailed studies of the conditions under which particular types of acts are or are not imitated are still needed. Abravanel and Sigafos (1984) showed the duration of model presentation to be important in eliciting imitation. But several points remain obscure: the influence of the rhythm rate under which models are performed, to what extent different acts of the same category (e.g., manual models) are specifically reproduced, and in what sense neonatal imitation is specific to the relationship with human partners in contrast to objects. Such problems need to be examined before theoretical discussion can advance.

## References

- Abravanel, E., & Sigafos, A. O. (1984). Exploring the presence of imitation during early infancy. *Child Development*, 55, 381-392.
- Atkinson, J. (1983). *How does infant vision change in the first three months of life?* Paper presented at the meeting of the First Groningen Study Group on Developmental Neurology, Groningen.

- Bower, T. G. R. (1974). *Development in infancy*. San Francisco: W. H. Freeman.
- Bower, T. G. R., Broughton, J. M., & Moore, M. K. (1970). Demonstration of intention in the reaching behavior of neonate humans. *Nature*, *228*, 679-681.
- Bronson, G. (1974). The postnatal growth of visual capacity. *Child Development*, *45*, 873-890.
- Bronson, G. (1982). Structure, status and characteristics of the nervous system at birth. In P. Stratton (Ed.), *Psychobiology of the human newborn* (pp. 99-118). New York: Wiley.
- Condon, W. S., & Sander, L. (1974). Neonate movement is synchronized with adult speech: Interactional participation and language acquisition. *Science*, *183*, 99-101.
- Dunkeld, J. (1978). *The function of imitation in infancy*. Unpublished doctoral dissertation, University of Edinburgh.
- Eibl-Eibesfeld, H. (1979). Human ethology. *Behavioral and Brain Sciences*, *1*, 9-10.
- Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expressions by neonates. *Science*, *218*, 179-182.
- Gibson, K. R. (1981). Comparative neuro-ontology: Its implications for the development of human intelligence. In G. Butterworth (Ed.), *Infancy and epistemology* (pp. 52-84). Brighton, Sussex: Harvester.
- Goldberg, M. E., & Lee Robinson, D. (1978). Visual system: Superior Colliculus. In R. Bruce Masterton (Ed.), *Handbook of behavioral neurobiology* (Vol. 1, pp. 119-166). New York: Plenum.
- Haith, M. M. (1978). Visual competence in early infancy. In R. Held, H. Leibowitz, & H. L. Teuber (Eds.), *Handbook of sensory physiology: Vol. 3. Perception* (pp. 311-356). Berlin: Springer-Verlag.
- Hayes, L. A., & Watson, J. S. (1981). Neonatal imitation: Fact or artifact? *Developmental Psychology*, *17*, 655-660.
- Hofsten, C. von. (1982). Eye-hand coordination in newborns. *Developmental Psychology*, *18*, 450-461.
- Ingle, D., & Sprague, J. M. (1975). Sensorimotor function of the midbrain tectum. *Neurosciences Research Program Bulletin*, *13*, 95-110.
- Jacobson, S. (1979). Matching behavior in the young infants. *Child Development*, *30*, 425-430.
- Koepke, J. E., Hamm, M., & Legerstee, M. (1983). Neonatal imitation: Two failures to replicate. *Infant Behavior and Development*, *6*, 97-102.
- Maratos, O. (1973). *The origin and the development of imitation during the first six months of life*. Unpublished doctoral dissertation, Geneva University.
- Maratos, O. (1982). Trends in the development of imitation in early imitation. In T. G. Bever (Ed.), *Regressions in mental development: Basic phenomena and theories* (pp. 81-101). Hillsdale, NJ: Erlbaum.
- McKenzie, B., & Over, R. (1983). Young infants fail to replicate facial and manual gestures. *Infant Behavior and Development*, *6*, 85-89.
- Meltzoff, A. N., & Borton, R. W. (1979). Cross modal matching by human neonates. *Nature*, *282*, 403-406.
- Meltzoff, A. N., & Moore, K. M. (1977). Imitation of facial and manual gestures by human neonates. *Science*, *198*, 75-78.
- Meltzoff, A. N., & Moore, K. M. (1983). Newborn infants imitate adult facial gestures. *Child Development*, *31*, 78-84.
- Mounoud, P. (1979). Développement cognitif: Construction de structures nouvelles ou construction d'organisations internes. *Bulletin de Psychologie*, *36*, 107-118.
- Mounoud, P., & Vinter, A. (1981). Representation and sensorimotor development. In G. Butterworth (Ed.), *Infancy and epistemology* (pp. 200-235). Brighton, Sussex: Harvester.
- Paillard, J. (1980). The multichannelling of visual cues and the organization of visually guided response. In G. E. Stelmach & J. Requin (Eds.), *Tutorials of motor behavior* (pp. 134-145). Amsterdam: North Holland.
- Precht, H. F. R. (1974). The behavioral states of the newborn infant. *Brain Research*, *76*, 1304-1311.
- Rader, N., & Stern, J. D. (1982). Visually elicited reaching in neonates. *Child Development*, *53*, 1004-1007.
- Schneider, G. E. (1968). Contrasting visuo-motor functions of tectum and cortex in golden hamster. *Psychologische Forschung*, *31*, 52-62.
- Stein, B. E. (1984). Development of the superior colliculus. *Annual Review of Neurosciences*, *7*, 95-125.
- Trevarthen, C. (1968). Two mechanisms of vision in primates. *Psychologische Forschung*, *31*, 299-337.
- Trevarthen, C. (1979). Neuroembryology and the development of perception. In F. Falkner & J. M. Tanner (Eds.), *Human growth: A comprehensive treatise* (pp. 55-112). New York: Plenum.
- Trevarthen, C. (1982). The primary motives for cooperative understanding. In G. Butterworth & P. Light (Eds.), *Social cognition: Essays on the development of understanding* (pp. 77-109). Brighton, Sussex: Harvester.
- Vinter, A. (1985a). *L'imitation chez le nouveau-né*. Paris and Neuchâtel: Delachaux et Niestlé.
- Vinter, A. (1985a). *L'imitation chez le nouveau-né*. naissance: Elle existe, mais que signifie-t-elle? *Canadian Journal of Psychology*, *39*, 63-80.