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Imitation over a Series of Trials without Feedback: Age Six Months*

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The 6-month-old infant is capable of imitation superior to previous reports, when he or she controls the timing of the model presented. By meeting the experimenter's gaze, 34 infants elicited a rhythmic burst of five mouth movements, opening and closing. After many trials a majority of the infants themselves produced a burst of two or more such movements. Although no universal sequence of acts emerged from the data, a sequence of accommodation was observed: (1) an orienting to the experimenter; (2) a series of imitations of single features of the model, beginning with mouth movements; (3) a string of two or more features of the model; and finally (4) integrating the features into bursts of mouth opening and closing. The findings are regarded as consistent with Piaget's general view of sensory-motor development. However, these subjects over a series of trials gradually imitated movements they could not see themselves make. The sequence of accommodation resembled the sequence of stages usually found in the development of imitation, when imitation is defined as an immediate response to one or two presentations of a model.

If a relatively novel sequence of movements is presented one or two times to an infant about 6 months of age, he or she is unlikely to imitate the movements immediately with any significant precision. To be sure, a smile will often elicit a smile, and a shaking of the head or arms will often elicit a shaking of the arms or head. But the form of the infant's immediate response is not particularly matched to the form of the model; it is difficult to distinguish the form of responses after the model's presentation, from similar movements produced by the infant spontaneously in the absence of a model. Furthermore, it is easiest to increase the frequency or intensity of movements in which one happens to find the infant already engaged. Thus immediate imitation in this period of development looks very similar to what Baldwin (1895) called the secondary circular reaction. Piaget (1951) also defined a stage of secondary circular reactions; he noted that his infants did not accommodate their actions to his modeling unless

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the modeling was similar to their own immediately preceding behavior, and unless they could see themselves making the movements.

It is fairly well established that infants even in the first month of life will reliably respond to movements of an adult's tongue or lips, with movements of their own tongues or lips. This has been noted by Meltzoff and Moore (1977), Uzgiris (1972), and Maratos (1973), and is a common experience of many who have interacted with young infants. Preyer (1889) and Guillaume (1971) noted a decline in this sort of nonspecific mouthing imitation between the 2nd and 7th months. While it may well be important that such a response in the first few months of life should have evolved in a species for which the mouth later plays several crucial social roles, it is no more remarkable than other neonatal reflexes or, for example, the pecking responses of a herring gull chick to a red spot on its mother's beak (Tinbergen, 1961). Although the initial response elicited in the case of the human infant happens to resemble the stimulus, there is no systematic accommodation of the young infant's mouthing to that of the adult.

The facts are very different if one changes the procedure in two ways. By allowing the infant to control the presentation of the model – for example, by initiating a sequence of mouth movements every time he or she makes eye contact with the experimenter – and by continuing for dozens of trials, we can get 6-month-olds to make significant accommodations to a model, even when they have no visual feedback from their own movements and no other form of feedback from the model. In our data, at age 6 months, there appears to be systematic accommodation to the model when the infant is allowed to control the presentations and continue over many trials. This finding has significant implications. Piaget has described the development of the accommodation function over many months, from recognitory assimilation or simple reflection of an aspect of the modeled behavior, to reciprocal assimilation (the coordination of features) and finally immediate, covert accommodation. The usual interpretation of Piaget (though not, we believe, the best one) is that imitation is itself a faculty which develops gradually in the sensory-motor period. Our present findings, however, suggest that the infant's progress in imitation is more a matter of improved speed in assimilating schemas, and of a growing repertoire of schemas.

The basic phenomenon, the elicitation of striking degrees of imitation simply by allowing the infant to alternate his or her own attempts with repeated observations of the model, can be found with hand movements of various kinds, vocalizations, rhythmic activities, and even sensory-motor problem-solving tasks (Kaye, 1970, 1971). The inspiration for trying this method came from a variety of sources: the imitation literature (Valentine, 1930); observations of alternation between responses such as looking and sucking (Bruner & Bruner, 1969); studies of face-to-face dialogues between mothers and infants (Brazelton, Koslowski, & Main, 1974); and our own observations of turn-taking (Kaye, 1976, 1977, in press). This study deals with one example of the phenomenon: the imitation of mouth movements the infant cannot see himself make.

On the basis of informal observations, we designed the study to test two hypotheses:

1. That accommodation to the model is systematic, involving selective imitation of particular features of the model in a consistent order across many subjects. Although our informal observations convinced us that infants at this age gradually approximate the form of the model over a series of trials, it is also true that not every trial is an improvement over the previous one. We hoped to quantify the degree of match to the model, and also to discover whether infants add features of the model to their own schemas in any consistent order.

2. That the development of an act over many trials (in this case the imitation of our modeled mouthing movements) would correspond to the stages through which immediate imitation seems to progress over many months, in studies where the infant is only given one or two trials in which to respond at each age. Studies attempting to elicit imitation of various kinds of activity at different ages (Uzgiris, 1972; Maratos, 1973) may reveal the relative difficulty of the various tasks but, we think, do not reflect the infant's cognitive limits. Changing the method of presentation of the model, giving the infant time in which to respond, and continuing for many trials can yield much more impressive results. However, there may be a direct correspondence between the two types of data: suppose the young infant goes through a sequence of steps in attempting to imitate some behavior at a particular age. This sequence may culminate in imitation which is sufficiently accurate to meet criterion. The age at which the infant can quickly reach criterion varies with different actions. We hypothesized that the developmental order of those actions previously interpreted as a sequence of stages in the development of imitation itself, would instead correspond to the stages through which the infant passes over the course of trials, in imitating any act.

METHOD

Subjects

Subjects in this study were 40 Caucasian infants between the ages of 26 and 28 weeks. All 21 male and 19 female infants had been delivered in Columbus Hospital, Chicago, without complication and after normal full-term pregnancies. They and their mothers were participants in a longitudinal study which began in the ninth month of pregnancy. The project involved observation in the hospital as well as four visits to the home, at 2, 6, and 13 weeks as well as the one at 26 weeks. Almost without exception the senior author had seen the infant and mother either at the hospital or the 2-week visit, and at none of the other visits. He was therefore a stranger to the infant, and the following procedure came at the beginning of the session before he had interacted with the infant in any other way.

Baseline and Treatment Sequence

The senior author walked slowly toward the mother who held her baby facing him. As he took the infant, the mother moved 3 to 6 m away (depending upon the arrangement of the home) so that she would not be a distraction. The experimenter sat in a straight chair with the infant in his lap, held under the arms and facing him. Each session was videotaped with a camera 2 m to the experimenter's right, capturing slightly less than a profile of his face and slightly more than a profile of the infant's face when they were looking directly at one another. Using a Zoom lens, the cameraman located the area bounded by the front of the experimenter's face, the infant's full head and upper body, and the infant's hands. From time to time within each session the cameraman sacrificed hand movements for the sake of a larger image of the infant's face.

For the first 2 min (less if the infant verged on crying), the experimenter engaged in normal, flexible interaction and vocalization. He responded to vocalizations or social expressions, initiated smiling, and in general attempted to gain and maintain the infant's attention. At the end of this "baseline" period he dramatically altered his behavior. Whenever the infant's eyes met his, he immediately made a series of five open-and-close mouth movements, like a goldfish, with a slight popping sound. Visually this display looked identical to "MA-MA-MA-MA-MA" without the vocalization: its duration was 3.5 sec. Every time the infant's gaze left the experimenter's eyes and returned (so long as it returned after the experimenter had completed the whole series), he repeated the model. Sometimes the first trial or two required calling the infant's name or jiggling his body to get him to make eye contact. Otherwise, and for all subsequent trials, the experimenter refrained from smiling, talking, etc. Although the timing of his behavior was controlled by the infant's eye movements, its form was in no way contingent upon any aspect of the infant's behavior. Trials continued so long as the infant cooperated; the maximum number was 63 trials, which took 9.3 min, and the median number was 20.

We will describe the typical response of babies to this procedure in the following section. It should be mentioned here that all subjects clearly caught on to the turn-taking game, and to the fact that the adult's behavior was under their control, within one or two trials. This inference is based on the fact that by the third trial and thereafter, they simply flicked the model on by a quick eye movement and then looked at the experimenter's lips in anticipation of the stimulus. Six subjects were dropped from the analysis, however, because of intense crying during the baseline and the first two trials.

Data Quantification – Coding

The videotapes were coded by the second author, who had seen none of the subjects themselves nor the data nor videotapes of earlier visits. Our unit of analysis was a "trial." Each trial began when the infant met the experimenter's

TABLE 1
Coding Category Definitions

A.	Categories 1–13 are mutually exclusive, recorded in sequence within each trial.
1–5	Movement into one of the following positions from another position: *Closed* – lips pressed together in a line, without puckering *Rest* – mouth open, relaxed *Intermediate* – mouth somewhat widened; teeth (if any) visible *Wide* – looks capable of swallowing a ping-pong ball *Puckered* – mouth rounded, lips creased in a circle
6–10	Movement *within* any of above positions
11	*Fingers* – fingers or hand to mouth, no visible mouth movements
12	*Cheek movements*
13	*Hid* – mouth cannot be seen due to head movements away from the camera or other obstruction
B.	Categories 14–18 occur simultaneously with those above.
14	*Smile* – bright smile (not counted also as mouth movement)
15	*Tongue* – tongue visible between lips, need not protrude
16	*Vocalizations* – with or without mouth movement; excluding cries
17	*Crying or fussing* – presence on trial rather than discrete cries
18	*Drooling* – presence on trial, not discrete drools
C.	Categories 19–22 and 24–26 were coded on a second viewing of the videotape.
19	*Self-adapts* – all gross movements of the body including tensing-relaxing, extension, bouncing, twisting, leaning, head lowering, arching, and jerking
25	*Arm and hand* – coded only when occurring in bursts (see below)
20	*Reach to E* – attempt to touch experimenter's face, arm, or shirt
21	*Open-and-close* – opening and closing, or closing and opening at least 4 digits of either hand in a continuous movement
22	*Hand to face* – subject touches own face, ears, nose, etc.
D.	Categories 23–32 were coded in conjunction with certain of the preceding categories.
23	*Mouth bursts* – 2 or more pairs of opening and closing movements of the mouth within any position or from one to another
24	*Self-adapt bursts* – 2 or more identical gross body movements in rapid succession
25	*Arm and hand bursts* – 2 or more gross articulations such as pounding, tapping, or flailing, in rapid succession
26	*Open-and-close bursts* – 2 or more hand movements as defined in item 21, in rapid succession
27	*Vocalization bursts* – 2 or more vocalizations in rapid succession
28–32	*Beats* – the number of beats (2 or more) in each burst

eyes and triggered a stimulus presentation, and ended when the next trial began. The following coding procedure facilitated sequential analysis across trials.

The coder watched until an event in Table 1 occurred; she then stopped the videotape to record. While transcribing mouth movements, vocalizations, smiles, tongue movements, and drools, the coder was not able to attend to other body movements. To record them, she viewed the videotape a second time. This meant that the order of occurrence of body movements relative to mouth movements within any given trial was not coded. Timing the durations of the baseline and trials was done at a third viewing.

Features Analyzed

Marcus (1976) details our analysis of data with respect to the 27 behavioral categories in Table 1. For the present analysis, many of these were condensed into categories representing the main features of the model stimulus. All types of mouth movement (categories #1–10) were collapsed into one category and summed for each trial. Rhythmic bursts were collapsed into three categories: mouth bursts (#23), vocalization bursts (#27), and nonoral bursts (#24–26). Open-and-close hand movements (#21) were considered imitation of the open-and-close features of the model. Of the remaining categories, only self-adapts (#19), reach-to-E (#20), and smiling (#14) were included in the analysis. Since these were not features of the model, they provided a test of general behavior changes between baseline and trials.

Reliability

To establish coding reliability, the junior author trained two other coders. One was trained before the actual coding began, and the other (senior author) was trained when coding was nearly completed. At this time, the junior author also recoded three videotapes which she had done two months earlier. Five videotapes were randomly selected for measuring intercoder reliability with the two extra coders. Percentage of agreement was the ratio of the number of occurrences agreed upon by both coders to half the *total* number of occurrences (i.e., the mean) recorded by the two coders. Both intracoder reliability (showing that categories were maintained through the period of coding) and intercoder reliability ranged between .87 and 1.00 for different variables, when occurrences were defined in a yes-or-no fashion on each trial.[1] Agreement as to whether

[1]Reliability was sometimes lower on a particular videotape, when the number of occurrences was low. If an event actually occurs three times and is seen only twice by each coder, agreement for that session may be 1.00 if the same two instances are seen but only .50 if each coder misses a different one of the three.

there were four mouth movements or five on a given trial, etc., were in the range .70 to .85. Agreement for a few fine categories such as "within resting" (#7) was unacceptably low.

This coding system was difficult. How short an interval between movements was short enough to define a burst, and how much parting of the lips constituted the "rest" position for one subject as compared with another, were matters of intuitive judgment. There is no question that many events were missed, including those which simply occurred off-camera. The phenomena we observed live and on videotapes were robust enough to surface in the data despite these sources of unsystematic error.

RESULTS

The stimulus presented consisted of the following features: (1) a rhythmic burst of (2) five (3) open-and-close movements (4) of the mouth, (5) with a popping sound. We define imitation as the occurrence of any of these, singly or in combination, at a higher rate than during the baseline. *Accommodation* suggests something more: a systematic improvement over trials, in the subject's match to features of the stimulus. Whether anything permanent is learned as a result is a still further question, not asked in the present study.

Since no vocalization accompanied the stimulus, vocalizations were not considered to be imitations of features of the model; however, bursts of vocalization were grouped with bursts of arm movements, self-adapting movements, etc., as imitating the rhythmic-burst features.

Table 2 shows the rates of each type of behavior during the modeling trials as compared with the baseline. Statistical significance in each case was based upon a t-test matching every subject's baseline rate against his or her average rate over all modeling trials. It is apparent that the infants imitated, enacting the features of the stimulus at a significantly higher rate during trials than during the baseline. It is also clear, as the control behaviors show, that the increased rate of feature behavior was not due merely to excitement or disinhibition over the course of the session. We should emphasize that there was no reinforcement of imitation at any time. The experimenter's behavior was in no way contingent upon the infant's mouth, arm, hand, or body movements or vocalizations. As for the infants' prior experience, it would be unreasonable to suppose that they had been reinforced for making mouth movements similar to ours, in response to the particular arbitrary pattern we chose. All of the mothers were quite surprised by the experimenter's behavior in this study. Some reported playing games in which their infants would imitate some action or sound (such as saying "AAAH") but the behavior cited was not similar to the pattern we presented.

We were particularly concerned to find any consistent sequence of events between the first trial and a "successful" ~~imitation~~, a mouth burst. A reasonable

TABLE 2
Mean Rates of Occurrence (per minute) during Baseline and Trials (N=34)

	Baseline		Trials		Matched t-test	
Feature	Mean rate	SD	Mean rate	SD	$t_{(33)}$	$p <$
Mouth movements	5.135	3.216	9.963	5.726	5.10	.001
Rhythmic bursts (vocalization & nonoral)	.643	1.008	1.467	1.406	3.53	.01
Open–close hand	.364	.853	.698	1.263	1.40	N.S.
Mouth bursts	.058	.195	.527	.799	3.40	.01
Control behaviors						
Self-adapt	.555	.743	.529	.300	.21	N.S.
Reach to E	.752	1.172	.921	1.499	.58	N.S.
Smiling	.041	.063	.037	.049	.29	N.S.

way to simplify the data for this purpose was to look only at the first occurrence of each category. The order in which categories first occurred is shown in the left-hand columns of Table 3. The right-hand columns of Table 3 indicate the numbers of subjects reaching feature criteria, with the median trial numbers by which they did so. Roughly two-thirds produced a mouth burst (combining features 1, 3, and 4) on at least one trial. Ten of these 22 subjects repeated it on 3 or more different trials.

It is clear that the most salient feature of the experimenter's modeling was that his mouth was moving. Only 12% of subjects produced open-and-close hand movements or nonoral rhythmic bursts on a trial preceding their first mouth movement. This is not completely surprising since mouth movements were fairly frequent on the baseline. The rate of mouth movements became significantly higher once the trials began (Table 2) but we cannot say that the very first mouth movements on Trial 1 were necessarily imitation.

As second steps toward accommodation, different infants took alternative paths. Some progressed directly to mouth bursts, as shown in the second column of Table 3. Some made rhythmic bursts of arm movements, vocalizations, or self-adapting movements. Open-and-close hand movements, if seen at all, tended to come later.[2] This suggests a sequence of features (mouth movement–rhythmic burst–open-and-close hand movements) but only three subjects actually followed

[2]This may be an artifact of the videotaping procedure. Open-and-close movements of at least the left hand were always visible if they occurred on the baseline, but the camera zoomed closer for imitation trials and sometimes missed the true first occurrence of hand movements. Both how soon the first open-and-close movement occurred and the frequency of such movements during trials were thus underestimated.

TABLE 3
Subjects Imitating Features of the Model (N=34)

Feature	1st feature imitated[a]	2nd feature[b]	Meeting criterion Total subjects	% of N	Median trial of occurrence[c]
(4) Mouth movement	30	3	34	100	1
(1) Rhythmic bursts	9	7	26	76	4
(3) Open-close hand	4	1	16	47	9
(1, 3, 4) Mouth burst	2	12	22	65	10
(5) Popping sound	0	0	1	3	16

[a]Or tied for first (on same trial).

[b]Omits subjects who appear twice in previous column.

[c]For those subjects meeting each criterion.

this full sequence, and none of these ever produced a mouth burst. One subject introduced all three features on the first trial, and did produce a mouth burst on Trial 12. In short, the typical infant imitated mouth movements immediately, then imitated one or both of the other main features of the model, but neither of these was obligatory. In fact, eight subjects produced their first rhythmic bursts and eight produced their first open-and-close hand movements after their first burst of two or more mouth movements.

We see therefore that the change in the rates of occurrence of each category over trials was not consistent for all subjects. However, accommodation to a model need not be reflected in a linear increase of rate with which some feature of the model is imitated, since once a constituent is mastered there may be no need to practice it while attending to other features. This point is discussed at greater length later.

A particularly striking observation on many of our videotapes is the combination, on the same trial, of nonburst mouth movements and nonmouth rhythmic bursts. These were usually paired sequentially rather than simultaneously, as though the infant were enacting "mouth–burst" or "burst–mouth." The data showed that trials containing rhythmic bursts averaged just over three mouth movements (N = 26 subjects, 161 trials) while the same subjects' other trials averaged fewer than two mouth movements, $t(24) = 2.62, p < .02$. Examination of the data showed that vocalization bursts were rare and could not have accounted for this juxtaposition of mouth movements with nonmouth rhythmic bursts. With respect to open-and-close hand movements, there was neither a tendency toward juxtaposition with the other features, nor any mutual exclusion.

The number of beats per burst was an additional feature of the modeled behavior. When infants' mouth movements met the criterion for bursts, the number of beats averaged 3.0, fewer than we were modeling. There was no consistent increase over successive mouth bursts. The average number of beats in other rhythmic bursts was also 3.0, and again this mean neither increased nor decreased over trials. However, there was a great deal of variability both between and within subjects in the number of beats per burst. We are not confident of the reliability of these counts; bursts tend to trail off so that a fourth, fifth, or sixth beat may be so delayed as to be of questionable standing.

We explored differences between the 12 infants who did not reach the "mouth burst" criterion, the 12 who did so on one or two trials, and the 10 who achieved mouth bursts on at least three different trials. Differences emerging from comparisons of the rates of each type of behavior were consistent with our subjective impressions, and are being examined further in our current work. The less successful infants seem to have been those who responded in a social manner, expressing their excitement in self-adapting activity and in more smiling even during the baseline. The more successful were those who quickly became still when the trials began and focused upon features of the model. Although less active during trials, their activity was more varied. It was not unusual for an infant to try three or four different kinds of rhythmic burst, as well as successful mouth bursts.

A general picture of infants' behavior in the situation is better acquired by viewing our videotapes or replicating the procedure with one or two subjects of one's own. We present a brief summary here. The infant's behavior changed instantly with the onset of the first modeling trial. There was orienting, stilling, a quizzical facial expression. By the second or third trial the infant showed clearly, by anticipatory eye movements, that he or she was intentionally controlling the stimulus. While watching the stimulus, the infant was typically still; trials on which the infant started to act before the experimenter had finished were exceptional, and so were trials on which the infant triggered the next trial before becoming still again. Trials varied in length. There were sequences of short trials in which the infant did nothing but elicit the model several times; there were trials in which the infant's turn was about as long as the experimenter's; and there were longer trials in which the infant ran through more than one imitated feature. During these longer trials he appeared to be carefully avoiding eye contact. Prolonged gaze aversion (20 sec) was usually a good indicator that the session might as well end, though a few infants later attempted to elicit the stimulus again.

The foregoing paragraph describes what one can observe using our procedure with any of a variety of modeled actions. With a mouthing pattern similar to the one used in the present study, the first behavior seen will usually be isolated mouth movements. Within a few trials mouth movements will be accompanied by rhythmic self-adapt movements or arm beating, sometimes bursts of vocalization, pulling on the dress, and/or open-and-close movements of the hands. These latter often take the form of clutching or scrabbling against a surface or against the infant's own body. Eventually there will be a convincingly imitative burst of mouth movements, but the other actions will continue on subsequent trials.

DISCUSSION

(1) *Is there systematic accommodation?*

We did not find a standard sequence of imitated features through which infants progressed toward more perfect imitation of the model. Nearly all infants responded quite early with mouth movements not particularly matched to the form of the model. Some, before producing bursts of open-and-close mouth movements, tried bursts of grosser activity such as arm beating or vocalization; and/or they tried opening and closing their fists. Six subjects produced at least one mouth burst containing exactly five beats to match the model, but no infant converged on the number five and stayed there convincingly over successive trials. Only one infant imitated the sound associated with the model, as shown in Table 3.

At a more general level, it was possible to distinguish phases in the typical infant's response over trials: (1) an orienting to the experimenter, stilling of the body, and checking to confirm that his or her eye movements really were sufficient to control the adult's behavior; (2) a series of imitations of single features of the model, beginning with mouth movement; (3) a combination of two or more features, sometimes beginning with sequential combinations before (4) integrating the features into bursts of mouth opening and closing. In short, individual infants appeared systematic in their active imitation of features of the model, though there was no universal sequence with respect to those features.

(2) *Does the development of mouth bursts over many trials correspond to the stages through which immediate imitation seems to progress over many months?*

We shall argue that the phases listed above support our second hypothesis, at least in the sense of being consistent with it. Piaget (1951, 1952) traces the development of schemas such as rhythmic arm and hand movements out of primary circular reactions. He describes their relation to the infant's ability to imitate actions and eventually represent them in covert imitation. The observations by Maratos (1973) of "imitated" head movements are of the earliest kind, primary circular reactions. These imitated movements begin as visual tracking of the adult's face, and as a prolongation of the sensations which result when the adult's head is moving. Even earlier, the newborn links the sight of normal human mouth movements to completely unaccommodated mouth movements of his own. As we said in the introduction, we believe that the common observation of mouth-elicited mouthing in the newborn is due to a reflex. Thus, what happens at 6 months can be understood as the natural extension of a process which begins much earlier and corresponds with Piaget's description of the development of imitation over the first year of life during which, by reciprocal assimilation, features are combined in an accommodated schema. The trials, grouped into more general phases, remind us of the sensory-motor stages through which Piaget's infants progressed (1951). On the first few trials our subjects look like Stage II, in which reflecting an infant's own behavior (mouth movements) back to him can result in an increased rate of the behavior and a kind of turn-taking with the adult. After a few more trials the same subjects look like Stage III or IV, in which schemas from their own repertoires are activated and variations are introduced (rhythmic arm or body or vocalization burst) . . . (open-and-close hands) . . . (mouth movement, plus other rhythmic burst). Eventually when a convincing mouth burst has been achieved by the infant, all that distinguishes his imitation from that of Stage V is the amount of time and effort that has been required to produce it. All the features of our "mouth burst" are available to the 6-month-old through assimilation of schemas he can observe himself enacting, except one. The missing feature, the link between the sight of a moving mouth and the kinesthetic sensations of his own mouth, seems to be present at birth.

Implications for Cognitive Development

The way our subjects progressed through different features of the model is somewhat reminiscent of a stochastic theory which Piaget (1950) once offered to account for the development of conservation and perceptual illusions. To illustrate with our present data, we could say that mouth movements have a very high probability of being elicited by mouth movements, rhythmic bursts have a somewhat lower probability of being elicited by rhythmic bursts, etc. The joint probability of the infant's attending to these several features and imitating them together would initially be very low but would increase as the frequency of imitation of the separate features increased. Such an account is inadequate to deal with our data (and probably inadequate with respect to the later operational accomplishments as well). The separate probabilities of occurrence of each constituent are in fact never independent. The limited attentional capacities of the infant, as well as limited motor control, necessitate separate practicing of constituents until, as Bruner (1973) argues, sufficient attention can be freed for working on other constituents and eventually on their combination. Our subjects imitated separate features; these might then drop out but (far from having been extinguished by the experimenter's nonresponse) later reappeared in sequential combinations. At 6 months the infant's behavior remains a continuum, its fluctuations over trials being a matter of noise in the system, without any qualitative discontinuities or irreversibility. However, the direction of that continuum is from isolated features of the model to means of assimilating those features to one another; this corresponds to the direction of progress in conceptual consciousness, from the periphery of action and object to the center, or coordination of movements (Piaget, 1976); or in Bernstein's (1967) terms from *ist-wert* and *sol-wert* to *delta-wert.* The working out of this basic direction first on the plane of automatic regulation of the infant's own movements – before regulation with objects, before representation, and before conscious conceptualization – is entirely consistent with Piaget's recent theory (1976).

We are not saying the 6-month-old "knows" what he or she is doing. In the first place, to invoke consciousness of this accommodation in the infant would have no explanatory value. If she knows what she is doing in any sense we still have to explain where she gets the relevant information. It is, however, worth comparing the behavior of our subjects with that of considerably older subjects in whom Piaget (1976) has studied "cognizance" of their own actions. Cognizance involves conceptualization, and the child's regulation of his actions with concepts is manifested by discrete changes. What Piaget calls "reflexive abstraction" is actually observable. The child either registers success or halts at points of mismatch between action and concept. This is precisely what we do not see at 6 months. Rather, we are seeing the overt, fluctuating, and often approximate accommodation of a schema, such as later will be refined and internalized. Other evidence for representation, such as deferred imitation, is not seen at 6 months. However, one of the earliest steps toward representation by means of assimilation (e.g., when the infant shows recognition of his grandmother by initiating a particular pat-a-cake game which they have played) does begin some time between 6 and 9 months. If we take as one of the defining criteria of representation the ability to imitate novel acts immediately (Piaget, 1951), which is not seen until some time in the middle of the second year, we can regard the slow accommodation seen in the present study as an early form. In other words, when the child "has" representation we really mean that he has representation*s* and the ability to use them in immediate imitation, in imitating absent models, and in play; but earlier, at 6 months, we already see the active process of re-presentation in the overt accommodation of schemas.

CONCLUSIONS

The recent literature on imitation in the first 2 years of life suggests that it is a matter of a basic ability gradually spreading over more and more complicated tasks (Uzgiris, 1972; Maratos, 1973; McCall, 1975). For example, one can get a large proportion of 10- to 12-month-olds to imitate simple movements of their own body, but one must wait a few weeks for more complex movements they cannot see themselves make. One must wait longer for tasks involving multiple relations among objects than for simple object-directed acts, etc. In general these studies (and the limited way imitation has been investigated in connection with language development) give the impression that the child imitates just those kinds of actions in which he spontaneously engages at any given age.

Without denying that the kinds of behavior which can be imitated expand in number and complexity with the infant's sensory-motor development we would make three further statements: (1) imitation itself develops in speed and efficiency. While the process of accommodation may not vary (always going from the differentiation of parts to the coordination of the whole), its mechanisms make enormous progress from overt representation to cognizance. In addition, the infant's attentional capacity and motor control develop. The developmental course of imitation is to a large extent a matter of the speed and efficiency with which the infant can imitate various behavior. The relative speed and efficiency depends on the manner of accommodation (overt or covert). This is not apparent when we stop our experiment after one or two presentations of the model. (2) Imitation and accommodation depend also upon the building blocks or schemas available to the infant in his repertoire. This is perhaps obvious, but it has a less obvious implication: the limits upon the complexity of behavior imitated by the young infant may be due to the small number of schemas at his disposal rather than to the constraints of complexity itself; or it may be due to both. (3) The study of *immediate* imitation tells us little or nothing about how imitation is being used by the infant or child at a given stage, at the frontier of developing schemas.

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