A LONGITUDINAL STUDY OF IMITATION IN ONE INFANT THREE TO NINE WEEKS OF AGE

by

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Abstract

Piagetian theory of imitation allows for imitation of head movements by perceptive-motor accommodation, but precludes mouth, tongue and hand imitation in the first weeks of life. Nevertheless, imitation of these latter behaviours has been reported in several recent studies. Controls were often inadequate in these studies however. Some of them used only one observer while others lacked measures of scorer reliability or did not control for activation effects and experimenter bias. Furthermore, although a developmental process was hypothesized, none of these studies continued observation for more than one week. This study was designed as a longitudinal study of early imitation using more controlled conditions.

One male infant was observed and video taped every second day from the age of 19 to 62 days. Four behaviours were modelled each test day: head nodding, mouth opening and closing, tongue protrusion and hand opening and closing. Each presentation was video taped and consisted of a 15 second control interval, a 15 second modelling interval, and a 15 second delay interval. In order to keep the activating effect of a moving model the same in the control interval as in the modelling interval, the experimenter made slight sideways movements of her head in the control interval.

During the delay interval, which was designed to allow for the possibility of delayed imitation, the experimenter remained motionless.

Two observers scored each of the three video taped intervals for frequency of analogous behaviours (behaviours analogous to those modelled) as well as for head turning movements, and vocalizations. In addition, arm and mouth movements were timed. The tapes were first scored independently. Where there was disagreement they were re-scored and consensus was reached. The stability of the consensus scores was determined by replicating the scoring procedure for 24 randomly selected test intervals and comparing these consensus scores obtained in the scoring replication to the initial consensus scores. The percent agreement between the two sets of consensus scores was computed for each response measure. The mean percent agreement was 86%. This procedure which provides an assessment of the stability of consensus scores was not followed in other studies of early imitation.

The results yielded no evidence of imitation of the modelled behaviours in that there were no significant increases in analogous mouth, tongue, hand or head behaviour in the experimental or delay intervals relative to the control intervals. There was, in the control interval however, a significant increase with age in head turning movements similar to those of the experimenter. This is in line with

Piaget's observations that imitation at the second stage consists of replication of movements by perceptive motor accommodation.

In general, the results of the longitudinal study of one infant support Piaget's theory of the development of imitation and do not confirm the findings of imitation in young infants that were obtained in brief observations under less controlled conditions. The methodological insufficiencies of these other studies are discussed and a more adequate procedure for studying the development of imitation in young infants is proposed.

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Table of Contents

List of Tables

List of Figures

A Longitudinal Study of Imitation in One Infant

Three to Nine Weeks of Age

It has been widely demonstrated that imitation is a pervasive phenomenon (Hamburg, 1969: Kawamura, 1959; Chesler, 1970) and that it plays a major role in the development of cognitive skills (Piaget, 1962; Aronfreed, 1969) and socialization skills (Bandura, 1969; Gerwitz and Stingle, 1968) in both human and subhuman species. In human infants, the emergence of imitative behaviour has generally been observed towards the end of the first year of life (Gesell, 1928), and this is in accord with prevailing theory (Piaget, 1962; Guillaume, 1971). However, several recent reports (Gardner and Gardner, 1970; Brazelton and Young, 1964; Zazzo, 1957; Smillie and Coppotelli, 1975; Moore and Meltzoff, 1975) indicate that imitative behaviour may occur as early as the second, sixth or ninth weeks of life. If such findings are confirmed by further evidence, a theoretical modification would be necessary.

Piaget's theory of imitation is the most comprehensive one, and regards the development of imitative behaviour as paralleling general cognitive development. Piaget describes imitation as progressing through several stages. It begins with the preparation for imitation wherein the infant's reflexes are triggered by an analogous external stimulus e.g. the sound of other infants' crying may set off crying behaviour in the subject.

Next, these reflex schemas or patterns of behaviour are expanded by the addition of other related elements or by becoming more selectively associated with a given stimulus, as in the case of imitating specific sounds. The infant begins to reproduce sounds that he himself has emitted when these are repeated to him. A circular process results as the infant perpetuates the sound he initially produced by continuing to vocalize, alternately with a respondent. Also, through the process of accommodation he can while looking at the model reproduce gross behaviour analogous to the model's, such as nodding. In so doing he is continuing the movements that he had to make to follow the model's movement and at the same time is perpetuating the visual image that was presented to him, again in a circular fashion.

By two and a half to three months of age Piaget (1962) observed imitation of nodding and sideways movements of the head. Also reported is the tendency to perpetuate a moving visual image of an object which was moving but has stopped by moving the head. The infant at this stage must be able to differentiate stimuli at a gross level and also be able to perceive that the sensory input from the model is similar to that resulting from his own behaviour. The imitation of known sounds and the imitation of nodding and sideways movements of the head become possible at this stage, although they are performed in a rather sporadic manner.

Piaget's observations of the imitation of sounds at this stage of development have been replicated by others. Uzgiris (1972) studying twelve infants reports imitation of "cooing" sounds by all the infants by three months of age. This imitation of sound in general, rather than of a specific sound, is consistent with Piaget's second stage of imitation. Valentine (1930) observing his own five children again reports imitation of sound making in three of his children before the seventh week of age.

The third of Piaget's stages is characterized by the systematic imitation of sounds belonging to the phonation of the child and movements he has already made and seen. Various hand movements e.g. opening and closing the hand, bringing the hands together, waving goodbye, were noted as being imitated regularly at this stage. At this point the infant recognizes the similarity between his own behaviour and that of the model.

It is only at the fourth stage that Piaget allows for the imitation of movements already made by the child, but which he cannot see himself perform. To accomplish this feat the child must utilize "mobile indices" which are relatively detached from actual perception. For example, a sound may serve as an index to enable the child to assimilate a movement he has seen the model make to a non-visible movement of his own--e.g. smacking the lips, protruding the tongue, etc. Utilizing these indices, the child is able to translate the stimulus from the model into the appropriate modality, and progressively approximate the model's actions. Visual schemas are progressively translated into the tactilo-kinesthetic, and the converse.

The last two stages include the beginnings of imitation of novel auditory and visual models, and the beginnings of representative or symbolic imitation--i.e. the imitation of a model no longer present. This sequence of stages in the development of imitation parallels cognitive development through the sensori-motor period, and as with cognitive development, imitation continues thereafter to expand and to be refined.

Guillaume (1971) also made a longitudinal study of the development of imitation, but presents a somewhat different viewpoint. Guillaume also recognizes the existence of the early reflexive types of imitation but does not include these in his definition of imitation. He states that imitation is not complete until it is accompanied by the awareness that one is imitating, by the notion of one's own resemblance to other beings, and by the knowledge that one's acts are equivalent to those of others. The early appearance of behaviours similar to imitation are said to be a collection of specific instincts, which later develop into habits that are modified by experience and selection. Guillaume asserts that no imitation takes place before an infant reaches about six months of age. Piaget and Guillaume base their theories on longitudinal observations of the development of their own children, Piaget reporting on a sample of three, Guillaume on two. Both began observations at birth and studied the children into late childhood.

In contrast to the above, Gardner and Gardner (1970) studying their own infant over a period of a week observed evidence of what they referred to as "partial imitation" at six weeks of age. They concluded that an infant may exhibit an early primitive ability to assimilate the actions of a model, or alternately, to abstract the modal properties of these actions and reproduce them.

The specific imitative behaviours most frequently noted by the Gardners were those involving the mouth area. These were extending and withdrawing the tongue and opening and closing the mouth. To a lesser extent, they noted imitation of parallel movements of the hand, opening and closing the hand, and extending and withdrawing the forefinger.

In terms of Piagetian theory, the hand movements would be expected at the third stage of imitative development (approximately four to six months of age), presupposing the progression through and assimilation of the two earlier stages. The mouth movements would be expected only at the fourth stage (about six to seven months of age), and then only by progressive approximation utilizing mobile indices. Piagetian theory does not address the issue of the possibility of early intermittent imitation, but rather views imitation as a progressively differentiating developmental phenomenon. In order to assess the stability and developmental progression of such early imitation a longitudinal study is necessary.

Several other studies lend support to the Gardner's findings. Brazelton and Young (1964) observed an infant of nine weeks who was imitating such mouth movements as smacking the lips and yawning. However, they felt that this was exceptional and reflected the "unhealthy" over-dependent relationship between mother and child.

Smillie and Coppotelli (1975) studying twelve infants aged from five to eight and a half weeks report findings of imitation of tongue protrusion, and possibly some evidence of mouth opening and closing imitation. However, methodological deficiencies make interpretation of their findings somewhat difficult. They observed and filmed each infant four minutes on one occasion only. The coders apparently observed the films showing both model and infant with no attempt to block out the model's activity. A consensus procedure was devised after initial scoring yielded low interscorer agreement, but the stability of the consensus scores was not reported.

Moore and Meltzoff (1975) observing each of six two-week old infants only once report differential responding to modelled stimuli. Four stimuli were presented to the infants: lip protrusion, mouth opening, tongue protrusion, and sequential finger movement. They report differential analogous responding to these stimuli, and interpret these findings as support for the notion of imitation in early infancy. They utilized a rather unique scoring procedure, however, in which there is no way of telling exactly what was being scored. In their study naive scorers observed video tapes of the infants without the models and tried to guess which model the infant was "observing" and "trying to imitate" (p. 4). Because they obtained results suggestive of imitation, this study will attempt to replicate their scoring procedure using a part of the data although such scoring is not utilized in the main part of the study.

Zazzo (1957) observing his own son, noted the imitation of tongue protrusion at twenty-five days of age. He states that similar observations were reported for a further twenty infants by his colleagues who were observing their own children and institutional infants. Zazzo, however, attributes these observations to the fact that the infant responds to the stimulus of a moving mouth by a generalized reaction of eyes, lips and tongue. He suggests that the observers are selecting the particular behaviour from a conglomerate of behaviours because of its similarity to the presenting stimulus. These criticisms could be remedied by repeating these observations under conditions promoting more objective scoring in which the scorers would not know which behaviour was being modelled.

If these reported findings of early infant imitation were replicated under conditions of adequate experimental control, this would seriously call into question Piaget's formulations, and lead to speculation about some alternate mechanism of imitation in early infancy.

The purpose of the present study is to replicate and expand upon the Gardners' study (1970), the only one in recent years in which an infant was observed more than once, using a longer developmental period and utilizing more rigorously controlled conditions. The Gardners recorded observations of their infant from age 41 days to 48 days. The present study, in seeking to determine whether developmental trends in imitative behaviours could be discerned, recorded observations from age 19 days to 62 days. Observations were recorded every day for the first week and every second day thereafter.

In the Gardners' study, as well as in other earlier studies (e.g. Piaget, 1962; Brazelton and Young, 1964; Valentine, 1930) infant imitative responses were recorded on the basis of the experimenters's immediate perception of the event. The present study utilized video tape records of the behaviours thus permitting review and reanalysis of observed behaviours, rather than being dependent on immediate judgments.

The Gardners used single observers to score behaviours which, although consistent with prevailing practice prior to that date, allows for no indication of interscorer agreement. The present study utilized two independent scorers and a detailed scoring protocol to promote stability of scores. The scorers reviewed discrepant scores until consensus was reached. A measure of the stability of the scores reached using this consensus procedure was undertaken which is seldom done when consensus procedures are used. Smillie and Coppotelli (1975), for example, used consensus procedure but report no stability measures for their consensus scores.

A rigorous scoring procedure such as this has not been utilized in any preceding study, and it is a thesis of this paper that this represents a great deficiency in previous studies of infant imitation. In later infancy and early childhood when behaviours are more discrete, stability of observations may be easier to obtain. In early infancy, however, when the movements of the infant tend to be continual and apparently random, it is extremely difficult to differentiate discrete motor movements. Stability of observations thus assumes paramount significance.

The Gardners' study utilized a control period in which the experimenter sat motionless in the infant's field of vision. The experimenter only became mobile in the subsequent modelling period. In the present study the experimenter moved in the control as well as the modelling periods so as to equate the level of stimulation in both periods. It was thought that a non-moving image of the experimenter would not be an adequate control in that it would not stimulate the infant as much as the moving image provided in the modelling interval. The simple introduction of movement in the experimental interval might activate the infant and thus increase the probability of him producing a movement analogous to the model's. Only by having a moving image in both control and experimental intervals could equivalent levels of stimulation be presented.

The Gardners only observed infant responses that were concurrent with the model's activity. It has been frequently noted (Piaget, 1963; Brazelton and Young, 1964; Zazzo, 1957; Smillie and Coppotelli, 1975) that an infant begins to imitate after the model has ceased to act. In the present study infant responses were recorded both during the experimental interval concurrent with the modelling and during the delay interval after the modelling when the model was inactive.

In order to determine whether there is a sequential order in the development of infant imitation, the range of behaviours that were modelled and observed in the present study correspond to those occuring in each of Piaget's stages. The observed behaviours were head turning and nodding movements which reflect imiative responses of the second stage, hand opening and closing which would be expected at the third stage, and mouth opening and closing and tongue movement which would be expected only in the fourth stage. The Gardners also observed hand opening and closing, mouth opening and closing and tongue protrusion, but they did not include any behaviours representing the second stage.

In addition to observing discrete behaviours, two measures of more generalized nature were also recorded in this study. Total time per observation interval was noted for mouth and arm movement separately. These measures primarily served as indicators of the general activity level of the infant as did the frequency of vocalization which was also recorded. In addition, an increase in mouth movement time during mouth modelling or arm movement time during hand modelling could suggest an attempt to imitate.

In summary, the purpose of this research, is to investigate the development of early imitation in a longitudinal study which is designed to replicate, under more stringently controlled conditions, the Gardners' study of infant imitation. In so doing one male infant was observed and video taped from age 19 to 62 days. Four behaviours were modelled each test day: head nodding, mouth opening and closing, tongue protrusion, and hand opening and closing. Each presentation consisted of a control interval, experimental interval and delay interval. The infant's behaviour was video taped in all three intervals. Scoring was done from the video tape record by two independent scorers. A consensus procedure was devised for scoring discrepant scores, and by rescoring a sample of data, the stability of the consensus scores was computed.

The data were analyzed by means of analysis of variance. Imitative behaviour would be evidenced by a significant increment in responses analogous to the model's occurring in the experimental or delay intervals relative to the control intervals. A developmental trend would be discerned, if such an increment changed over time.

Predicting from Piagetian theory, only imitation of head movements performed as circular reactions would be expected in the age range of this study. The Gardners' (1970) results would suggest, however, that imitation of all the hand and mouth movements included in their study could be expected as well. The results reported by Moore and Meltzoff, (1975) would support this and in addition would be in agreement with those reported by Smillie and Coppotelli (1975) in suggesting tongue imitation. By studying the development of imitation longitudinally and replicating the Gardners' work with more stringent controls, the present study attempts to delineate more clearly the imitative behaviour of the infant in early infancy.

Method

Subject

The subject was the experimenter's own first-born male infant, who was studied between the ages of 19 and 62 days. He was a full-term baby, delivered by emergency Cesarean section. At birth, he had an Apgar rating of 8, which is considered "good" for this type of delivery (Apgar, 1958). At age ten weeks he was given the Cattell Infant Intelligence Test, and found to be functioning within the normal range. For full test results, see Appendix A.

Apparatus

The infant was placed in a supine position in a "Cuddle Seat", tilted upwards at a 45° angle. The Cuddle Seat was placed on a table 3 ft. (.91m) by 4 ft. (1.22m) in surface dimensions, and 4 ft. (1.22m) in height. A mirror 20 in. (51 cm) by 22 in. (56 cm) was placed on the table behind and slightly to the left of the Cuddle Seat. Two sweep-second Lafayette clock timers (model 20225 ADW) were placed to the right of the Cuddle Seat, one behind the other. The anterior timer was operated by a push-button connection at the experimenter's left hand. The other clock-timer was activated by a lever pushed by the experimenter as she commenced each test session.

A Sony portable videocamera (model AVC 3400) was mounted on a tripod and placed six feet in front of the table. Filming was done over the experimenter's right shoulder as she stood in front of the infant. The view from the camera included the infant in the Cuddle Seat, a reflection of the experimenter in the mirror, and the two clock faces, as diagrammed in Figure 1. The reflection of the experimenter served to clearly identify the behaviour modelled and assisted in locating appropriate tape segments in scoring and re-scoring.

The video tapes were scored using a Sony television monitor with a 19 inch screen. The tapes were played back on a Sony recorder (model AV 3400). The measurements of total arm and mouth movement time were obtained using a digital second timer calibrated in hundredths of seconds. The timer was activated by push-button control.

Procedure

The research was conducted in the infant's bedroom, a setting familiar to him. Observation was started when he was 19 days old, and carried on formally until he was 62 days and informally until he was 83 days old. Test sessions were held every day during the first week, and on alternate days thereafter with one session per day. This schedule was chosen in order to avoid overtiring the infant at any one time while having sessions frequently enough to discern any behavioural change.

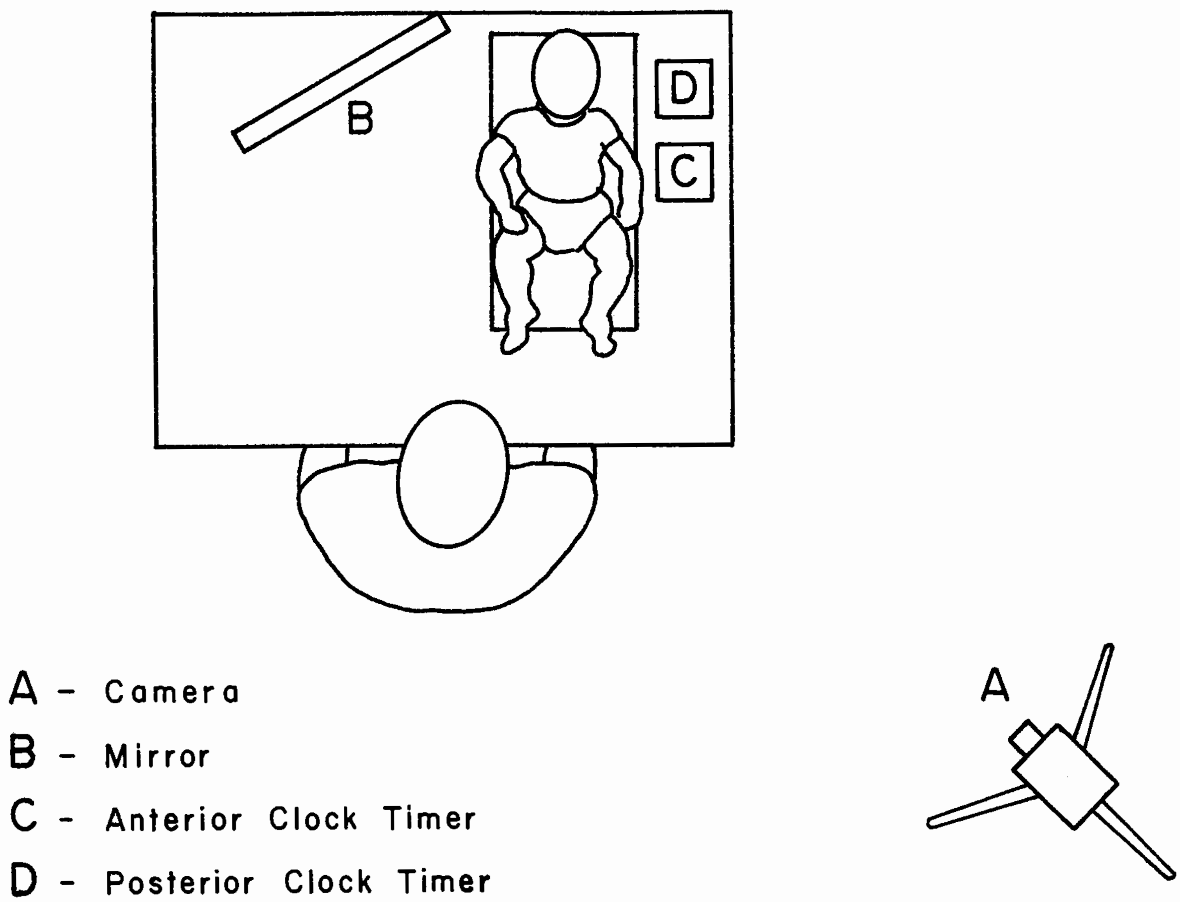

Figure 1. Diagram of testing situation.

The anterior clock, which was operated by a push button at the experimenter's left hand, measured total time that the infant attended. Attending being considered a necessary precondition to imitation, no intervals in which the infant attended less than one half of the interval were scored. If the infant was clearly distracted during testing and not attending, testing was terminated and recommenced when the experimenter resecured his attention. Unmodifiable distraction or distress resulted in termination of testing for the day.

The posterior clock, which was switched on by pushing a lever attached to the clock, was started by the experimenter simultaneously with beginning the test procedure. This clock, which ran continuously, was used to designate the beginning of each 15 second interval. The experimenter used it to regulate her activity, changing it every 15 seconds. Also, in scoring the test intervals, the scorers used the picture of this clock on the video tape to indicate the beginning of each 15 second interval.

Four behaviours were modelled at each session. The presentation of each modelled behaviour was preceeded by a control interval, and followed by a delay interval. Each interval, including the experimental interval in which the behaviour was modelled, was 15 seconds in duration.

Testing was not carried out at any specific time of day but rather when the infant was observed to be alert and not distressed. Alertness was defined as a state in which the infant remained open eyed, orienting to sound or movement, and moderately moving his limbs for at least 15 seconds prior to testing. The lack of distress was ascertained by observations of low to moderate vocalizations, a contented or bland facial expression, and lack of strenuous limb movement. A record was kept of the time of testing in relation to the infant's feeding and sleeping times.

To familiarize the infant with the test situation, he was seated in the Cuddle Seat with the camera running several times prior to the initial test day.

Each testing session commenced with the infant being placed in the Cuddle Seat and the experimenter placing herself immediately in front of him, leaning toward him so that her face was ten inches from his eyes. The experimenter then engaged the infant's attention by speaking softly to him, and if necessary moving his head to a frontal position. With the infant's attention secured, the experimenter switched on the video camera and announced the test day and infant's age. As the experimenter began the first control period, she simultaneously switched on the sweep second clocks. Each testing session thus consisted of a sequence of control, experimental and delay intervals which were repeated four times, once for each modelled behaviour, with no interruptions between sequences.

During the control interval, the experimenter stood in front of the infant with a smiling countenance and with her face about ten inches from his eyes. The experimenter made continuous slight sideways turning movements of her head for the duration of the interval. The control interval was designed to provide a level of stimulation approximately equal to the subsequent experimental interval, but without any discrete, exaggerated movements which the infant could be expected to imitate. The repetition of control periods interspersed with experimental periods also allowed for measurement of changes in activity level during the testing session.

During the delay interval, the experimenter remained in the same position, with a smiling face, but made no motion whatsoever. This period allowed for the observation of delayed imitation.

During the experimental interval, the experimenter remained in the position described above, and modelled the behaviour pre-determined for that interval. Each behaviour was presented six times during the experimental interval. They were presented slowly and methodically in an exaggerated fashion.

Four behaviours were modelled for the first twenty-one testing sessions. One was a slow, exaggerated nodding movement of the head.

Another modelled behaviour was a hand opening and closing movement. The experimenter moved her hand from a closed fist position by slowly extending and flexing the fingers into a wide hand open position. Slowly, the hand again was closed. The hand was presented with the palm facing the infant, and about ten inches from his face. The experimenter's face was slightly more removed during the presentation of this stimulus.

Mouth opening and closing was also modelled. The experimenter moved her mouth from a closed position to a wide open position and closed it again.

In addition, tongue extension and withdrawal was modelled. A maximal protrusion of the experimenter's tongue from a slightly opened mouth was followed by a complete withdrawal and closing of the mouth.

Each of these behaviours were modelled on each of the first twenty-one test days. The order of presenting the behaviours was randomized. Table 1 lists each test day with the order of presentation of modelled behaviours.

The main interest of this study was the imitation of behaviours perceived visually. However, as the infant matured and his vocalization increased, the possibility of vocal imitation became of interest. Therefore, when the

Table 1

Presentation Order of Modelled Behaviours
For Each Test Day and Age

Test Day	Age in Days	Order of Presentation				
		First	Second	Third	Fourth	Fifth
1[d]	19	nodding	mouth[a]	hand[b]	tongue[c]	
2[d]	20	mouth	tongue	nodding	hand	
3[d]	21	hand	mouth	tongue	nodding	
4	22	nodding	hand	tongue	mouth	
5	23	mouth	nodding	hand	tongue	
6	24	nodding	hand	mouth	tongue	
7	25	hand	mouth	nodding	tongue	
8	26	tongue	nodding	hand	mouth	
9	28	tongue[e]	hand[e]	mouth[e]	nodding[e]	
10	30	mouth	nodding	tongue	hand	
11	32	tongue	nodding	hand	mouth	
12	34	hand	mouth	nodding	tongue	
13	36	nodding	mouth	tongue	hand	
14	38	mouth	hand	nodding	mouth	
15	40	tongue	hand	nodding	mouth	
16	42	mouth	nodding	hand	tongue	
17	43	hand	mouth	nodding	tongue	
18	45	nodding	mouth	tongue	hand	
19	47	tongue	nodding	mouth	hand	
20	49	mouth	tongue[f]	nodding	hand	
21	51	nodding	hand	mouth	tongue	
22	53	hand	nodding	mouth	tongue	vocalization
23	55	mouth	hand	tongue	nodding	vocalization
24	56	vocal.	tongue	hand	mouth	nodding
25	58	mouth	tongue	nodding	hand	vocalization
26	60	nodding	vocal.	mouth	tongue	hand
27	62	nodding	mouth	tongue	vocal.	hand[g]

[a]mouth = mouth opening/closing

[b]hand = hand opening/closing

[c]tongue = tongue protrusion

d = entire day not scored

e = hand opening/closing not scored

f = delay interval not scored

g = entire presentation not scored

infant was 53 days old, vocal modelling was added to the behavioural models. Thus five behaviours were modelled from age 53 days to 62 days.

The vocal model was that of a sound observed to be in the infant's repertoire at the time. The vocalization was an "eeh" sound. It was repeated slowly and distinctly six times. If the infant responded by vocalizing, presentation of the modelled vocalization ceased and was resumed upon the infant's termination of sound production. An effort to engage the infant in circular vocalization was thereby made.

In summary, the infant was initially exposed each test day to four behavioral models: head nodding, hand opening and closing, mouth opening and closing, and tongue protrusion. At 53 days of age, a vocal model was added. Presentation of each modelled behaviour was preceeded by a control interval and followed by a delay interval. The modelled behaviours were presented in a random order. At 62 days of age the formal observation protocol was terminated.

About a week later from the age of 71 days to 83 days informal observations were conducted in which only vocal behaviours were modelled. This was done for two reasons. Firstly, the sessions described earlier had to be discontinued as it became impossible to hold the visual attention of the infant for the duration of the testing sessions.

This appeared to be the result of an increase in his visual range and interests at the time. Secondly, in informal interaction with the infant it appeared that he was responding to vocal behaviours quite regularly by vocalizing in return. A description of the vocal models and scoring is presented in Appendix B. This informal procedure did not yield any results of interest regarding imitation and therefore will not be discussed any further in this paper.

Scoring

Response measures were obtained from the video-tape record. The scorers observed the tapes played back on a standard television monitor with a 19 inch screen. The upper right hand corner of the screen was covered with a sheet of heavy paper, 11 in. (28 cm) by 8 in. (20 cm), so that the observers could not see the image of the experimenter in the picture. Each 15 second interval was scored for one behaviour at a time. Scoring of the interval commenced when the posterior clock in the video picture indicated that the interval had begun. Scoring terminated when the clock indicated that 15 seconds had elapsed.

Each interval was scored for the number of times that each of the following behaviours occured: head nodding movements, head turning movements, mouth opening and closing, tongue movement (any movement bringing tongue into view of the observer), hand opening and closing, and vocalization. The measure of head turning movement was introduced to detect whether the model's behaviour in the control interval elicited any imitative behaviour. The vocalization measure was included as a measure of activation. From the age of 53 days to 62 days, the frequency of specific or imitative vocalizations was recorded.

The total time of mouth and arm movement was recorded for each interval in seconds. In scoring each interval for movement time the scorer activated a digital second timer by push-button control whenever movement was discerned. Arm and mouth movement time scores for each interval were obtained separately. Mouth movements were defined as any discernible movement of the mouth or lips, excluding yawning, coughing or sneezing. Arm movements were defined as any discernible motion of the arm, excluding those movements directly associated with a cough or sneeze. Both of these measures were designed to measure general activation level. An increase in mouth movement time concurrent with mouth modelling or arm movement time with hand modelling could also suggest imitation. For a detailed description of the frequency and movement time scoring procedures see Appendix C.

All test intervals were scored independently by two observers. Each observer was trained to use the scoring procedure that had been developed. One full day of training was required to achieve a consistently high level of scorer agreement. While scoring the tapes the observers frequently found it necessary to review an interval several times to reach a satisfactory scoring decision regarding a given behaviour. Also, the observers occasionally found it necessary to clarify the behaviour by slow motion control or stop picture control, and to amplify the vocalizations by volume control.

The two sets of scores for each interval were reviewed for any differences in the absolute values of scores. A difference of one or more in the frequency measure was considered a discrepancy. The tapes of the discrepantly scored intervals were then reviewed by the scorers together. They reviewed their bases for scoring, discussed the criteria for their different scores, separately rescored the interval again and reached consensus on each score. These consensus scores were the response measures used in the following analyses.

Each observer scored each interval twice for arm motion time and twice for mouth movement time and a mean score was obtained for each measure. If the mean scores obtained by the two observers differed by more than one second, the observers reviewed the discrepant interval, and then proceeded to make one further independent measure. These two scores were then averaged, regardless of size difference. The final time score for each interval, referred to as the consensus score, was the average of the scores of the two observers.

In total, 24 test days were scored. The video tapes of the first three test days were not scored because the infant failed to attend to the model for the required half of the modelling interval. For each of the first 18 scored test days, 12 fifteen-second intervals were scored. For each of the following six test days an additional three intervals were scored for vocalizations only. Three test days were not completely scored due to the poor quality or incompleteness of the filming. These days are indicated by footnotes in Table 1. In total, 282 intervals were scored for all measures, and 18 for vocalizations only.

Interscorer Agreement and Stability of Consensus Scores

The stability of the consensus scores was computed mid-way through scoring for the first half of the data, and at the end of scoring for the second half of the data and overall. A total of 24 intervals (9% of total intervals) were rescored, 12 from each half of the data. Three sequential intervals, control, experimental and delay, were rescored for each modelling presentation. The presentations were chosen at random with the restriction that each modelling presentation be represented at least once in each stability computation. The intervals were scored independently by the two scorers, discrepant scores reviewed, and consensus was reached on all scores. The stability measure was the percent agreement between these and the initial consensus scores. This measure was calculated separately for each of the behaviours scored.

Computation of the stability of consensus scores is a practice that is seldom followed but one which is particularly necessary in view of generally low interscorer agreement often obtained prior to instituting consensus procedures. Smillie and Coppottelli (1975), for example, report initial interscorer agreement of approximately 66%. This caused them to institute a consensus procedure, but they do not report how stable it was. In this study, the interscorer agreement over all data prior to consensus was calculated for each response measure. The mean percent agreement was 68%. The interscorer agreement for specific behaviours was 77% for nodding, 53% for hand opening/closing, 58% for mouth opening/closing, 70% for head turning, 77% for vocalizations, and 75% for tongue movement.

The stability measures for the consensus scores were considerably higher. The mean percent agreement for consensus scores for the entire sample was 85%. The over-all percent agreement for consensus scores for specific behaviours ranged from 98% for vocalization to 59% for mouth opening/closing. Table 2 presents the percent agreement for the consensus

Table 2

Percent Agreement for Consensus Scores

Behaviours	First 12 Test Days	Second 12 Test Days	Overall
Head nodding	66%	100%	83%
Head turning	92%	92%	92%
Mouth open/close	75%	42%	59%
Hand open/close	92%	92%	92%
Tongue movement	92%	75%	88%
Vocalization	100%	95%	98%
Mean	86%	83%	85%

scores computed for each behaviour for the first twelve test days, the second twelve and overall. None of the overall consensus scores fell below 80% agreement, except for the mouth opening/closing measure.

Stability of consensus scores for arm and mouth movement time were also computed for the rescored intervals using a Pearson coefficient of correlation. The stability of arm movement time scores is indicated by r=.93 obtained overall the data, by r=.96 obtained for the first half, and by r=.90 for the second half of the data. The stability of the mouth time scores is indicated by r= .79 obtained over all the data, by r=.85 obtained for the first half, and by r=.73 for the second half of the data.

Statistical Analysis

Because the number of behaviours occurring in each interval of each test day were very low (ranging from zero to four except for vocalizations which ranged to eight) and had a modal frequency of zero, it was necessary to sum four consecutive test days together to normalize the distribution and make it amenable to statistical analysis. This was also done for the time measures in order to make the two analyses parallel. The basic datum in the analyses, therefore, is the frequency of behaviour or total time summed over four consecutive test days for a given test interval. Thus, in the analyses to be discussed the factor of "days" refers to these four day sums. A total of six such days were thus computed from the 24 actual test days. These six days were further chronologically divided into three age periods of two days each, which will subsequently be referred to as the first, second and third age periods. Each age period approximates two calendar weeks.

The data were subjected to analyses of variance utilizing a four factor design, in which the "days" factor had two levels and was nested in the factor "age period" which had three levels corresponding to the control, experimental and delay intervals and model which had four levels corresponding to the hand, nodding, mouth and tongue models. A separate analysis was computed for each of the six dependent frequency measures and for the arm and mouth movement time measures. Of primary interest in this study is the two-way interaction of model by interval, and the three way interaction of model by interval by age.

A significant model by interval interaction would suggest imitation provided that the infant showed an increase in behaviour analogous to the model's in the experimental and/or delay intervals relative to the control interval. For example a significant increase in nodding by the infant in the experimental or delay intervals corresponding with a nodding model would suggest imitation. A significant model by interval by age interaction in which analogous responding varied with age would indicate a developmental trend in imitative behaviour.

Results are reported as significant at probability levels of .05 or less, and in some cases interesting trends are reported when the probability levels fall between .05 and .15.

Because the results of a study by Smillie and Coppotelli (1975) suggested that imitation was most likely to occur when the infant was free of symptoms of pressing need states such as hunger, the data were reanalyzed in terms of proximity to feeding. The actual test days in this study were therefore regrouped, irrespective of age, according to the time elapsed since the most recent feeding. Five groupings, consisting of a variable number of test days were thus constructed. Table 3 lists the groupings of test days. Analyses of variance were computed using the five groupings of proximity to feeding as one factor. The other factors were model which had the same four levels and test interval which had the same three levels described earlier. Because of the way the data were grouped, age had to be omitted as a factor. The basic datum of the analysis was the frequency or time measure per interval for each test day at a given level of the proximity to feeding factor. The days were not summed in this case because summing would have precluded the computation of a three-way interaction which was of interest. The result was a 5 x 4 x 3 factorial design. Imitation would again be indicated by a significant model by interval interaction due to increased analogous responding in the experimental

Table 3

Grouping of Test Days According to Proximity to Feeding

Time Since Feeding in Minutes	Number of Test Days
0-30	8
31-90	4
91-120	3
121-150	5
151-210	4

or delay intervals. A model by interval by proximity to feeding interaction of the same nature would indicate that imitation was more likely to occur at a given time in relation to feeding. Analyses were computed for each of the six behavioural frequency measures and for the arm and mouth movement time measures.

To determine whether the order of presentation of the model had any effect on the imitative behaviour of the infant, the data were regrouped according to whether the model was presented in the first, second, third or fourth position on a given test day. The frequency of each model presentation in each position is listed in Appendix G, Table G1. The resultant grouping yielded a 4 x 4 x 3 factorial design, the factors being position with four levels, model with four levels and test interval with three levels. Age was again omitted as a factor because of the nature of the data. The basic datum of the analysis was the frequency or time measure per interval for each position. Again, the days were not summed for the reason described earlier. A significant model by interval interaction due to analogous responding in the experimental or delay intervals would again indicate imitation. A model by interval by position interaction would indicate that imitation was more likely to occur when the model was presented in a certain position on a test day. For example, analogous nodding by the infant might occur only if that model was presented first. Analyses were computed for each of the six frequency measures and arm and mouth movement time measures.

Behaviours in the successive control intervals of each test day were analyzed to determine whether any significant changes in activity level took place as testing progressed. An analysis of variance with three factors, age, days nested in age, and succession was computed for each of the response measures. The basic datum of this analysis was the summed measure over four consecutive test days for a given control interval. A significant main effect of succession would indicate that the infant's activity level changed as testing progressed. An age by succession interaction would indicate that such a change was modified as the infant matured.

Missing data in the analyses, which represented less than 5% of total data, were estimated by averaging the values of the corresponding intervals for the three test days prior and two test days following the missing day.

The vocalization responses to the presentation of a vocal model were not included in any of the analyses because the numbers were small and uninteresting upon inspection. The data are presented in Table E3 in Appendix E.

All of the analyses of variance for the frequency and movement time measures are presented in Appendix D. The raw data are presented in Appendix E.

An Attempt to Replicate Moore and Meltzoff's Scoring Procedure

Moore and Meltzoff (1975) suggest that in coding or categorizing the behaviours of an infant as he observes a model, the experimenter may "build-in" the results he desires to test for. In an attempt to remedy this they utilized a procedure in which six naive observers watched video-tapes of an infant and rank ordered their guesses as to which model the two-week old infant was watching and trying to imitate. Four behaviour models had been presented to their infants, lip protrusion, mouth opening, tongue protrusion, and sequential finger movement, and these were also shown to the observers before they began scoring the video-tapes.

In filming their infants, Moore and Meltzoff used a 15 second modelling interval followed by a 20 second delay interval repeated a maximum of three times in succession for each model presentation. A 70 second rest interval separated the different model presentations. They video taped six two-week old infants and used six observers watching either the infant's face or hands. A distribution of assigned ranks for each behaviour by the observers was computed by summing observations across presentations. The results indicated that the highest ranks were always given to the analogous model and a Friedman analysis of variance indicated that the distribution of ranks varied significantly across the different model presentations.

The present study attempted to replicate this procedure as closely as possible using the video tapes described earlier. Six naive observers were shown video tape segments of six test days beginning when the infant was 22 days old and ending when he was 28 days old. These were the first six test days in this study and were chosen because the infant would then be closest to the age of the infants in the Moore and Meltzoff study. The television screen was partly covered with a heavy piece of cardboard so that no part of the model or her shadow were visible to the observers. The experimental and delay intervals for each of the four models presented each test day were shown for the first four test days. In the last two test days only the nodding, mouth opening/closing and tongue protrusion segments were shown. The hand opening/closing segments were excluded because it was not possible to delete all visual clues, such as a shadow of the model's fingers, from the picture.

The naive observers were instructed to observe the infant on the partially covered television screen and to guess which behaviour the infant was watching and trying to imitate. The model demonstrated the behaviours to which the infant had been exposed as had been done in the Moore and Meltzoff study. The observers were instructed to rank order their guesses for each video segment with respect to the four modelled behaviours giving the rank of four to the most likely, three to the next most likely and so on. The complete instructions given to observers may be found in Appendix F. The ranks for each observer were summed for each model as had been done in the Moore and Meltzoff study. Upon completion of the task the observers were interviewed in an attempt to find out what criteria they had used in making their guesses.

Results

None of the analyses of analogous behaviours indicated that the infant was imitating the behaviours modelled in the experimental interval. His rate of emission of analogous behaviours did not increase significantly in the experimental or delay intervals over the base rate established in the control interval. Nor was there any evidence of change in this pattern as the infant matured. The mean frequency of behaviours analogous to the model's in each test interval and age period are presented for each modelling condition in Table 4. Neither the model by interval nor the model by interval by age interactions, which might have suggested imitation, reached significance in any of the analyses of analogous behaviours.

The analysis of the arm movement time measure also supports this conclusion. There was no significant increment in arm movement time when hand opening/closing was modelled. The mean arm movement time for each test interval and age period when hand opening/closing was modelled is presented in Table 5.

A possible indication of imitation may be revealed, however, in the analysis of mouth movement time. In the third age period, mean mouth movement time increased linearly from the control to the experimental and delay intervals when mouth opening/closing was being modelled.

Table 4

Mean Frequency of Behaviours Analogous to Model's for Each Model, Test Interval and Age Period

		Test Interval		
Model	Age Period	Control	Experimental	Delay
Nodding	1	2.0	1.0	2.5
	2	3.5	1.5	0.5
	3	1.5	1.0	2.0
	Overall	2.3	1.2	1.7
Mouth Opening/ Closing	1	4.0	3.0	2.5
	2	6.0	3.0	4.0
	3	4.5	5.5	6.0
	Overall	4.8	3.8	4.2
Tongue Movement	1	0.0	0.5	0.0
	2	1.5	2.0	1.0
	3	0.5	3.0	1.5
	Overall	0.7	1.8	0.8
Hand Opening/ Closing	1	1.5	0.0	3.0
	2	2.5	1.5	2.0
	3	1.0	0.5	2.0
	Overall	1.7	0.7	2.3

Table 5

Mean Arm Movement Time in Seconds For Each Test Interval and Age Period When Hand Opening/Closing Was Modelled

	Test Interval			
Age Period	Control	Experimental	Delay	Overall
1	17.6	8.6	11.8	12.6
2	12.1	5.6	14.7	10.8
3	19.3	15.9	19.9	18.4
Overall	16.3	10.0	15.5	13.9

This is illustrated in Figure 2 which presents mean mouth movement time as a function of age, model and test interval. The mean values for each point in Figure 2 are listed in Table 6. In the analysis of variance of mouth movement time the model by interval by age interaction approached significance, $\underline{F}(12,18) = 1.83$, $\underline{p}<15$.

A suggestion of imitation is also obtained in the analysis of the head turning data. The slight sideways movements of the experimenter's head in the control intervals were not intended to elicit imitation, but it appears that they may have affected the infant's head turning movement. In the first age period, the infant watched the experimenter intently in the control and experimental intervals, making few head turning movements. In the delay interval when the experimenter was not moving, however, the infant frequently turned his head away from the experimenter. As he matured this response changed. By the third age period, the infant reacted vigorously to the experimenter's head movements in the control period. The reaction was typically one of numerous head turning movements accompanied by smiling and cooing. Qualitatively, these responses were quite different from those seen in the first age period. In the analysis of variance of head turning movement, the age by interval interaction was highly significant, $\underline{F}\ (4,18) = 6.48$, $\underline{p}<.005$. The mean frequency of head turning movement as a function of age and test interval is presented in Table 7 and illustrated in Figure 3.

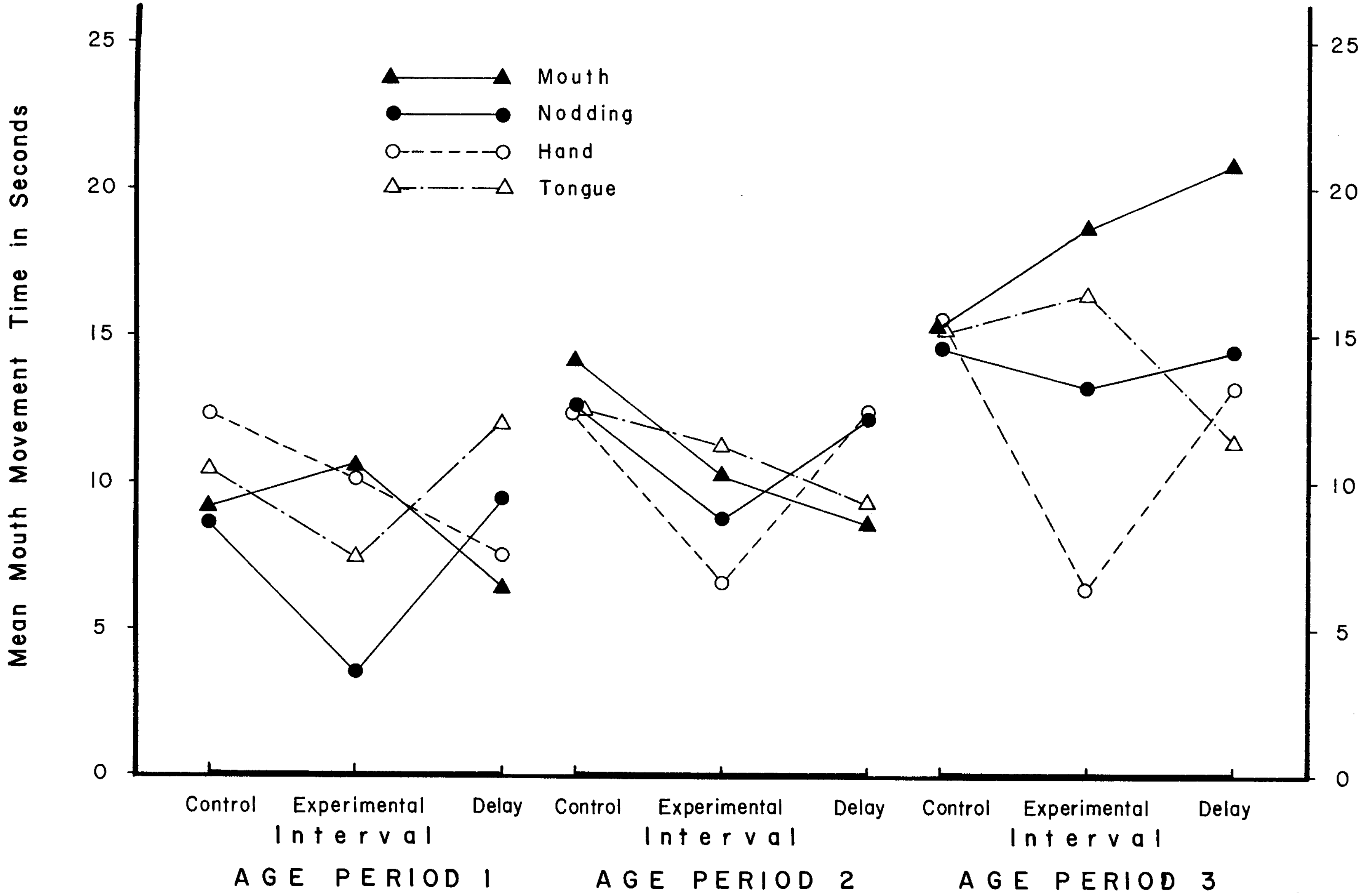

Figure 2. Mean mouth movement time as a function of age, model and test interval.

Table 6

Mean Mouth Movement Time in Seconds as a Function of Age, Model and Test Interval

Age Period	Model	Test Interval: Control	Experimental	Delay	Overall
1	Mouth	9.2	10.5	6.5	8.7
	Nodding	8.8	3.5	9.4	7.2
	Hand	12.3	10.2	7.5	10.0
	Tongue	10.6	7.5	12.0	10.0
2	Mouth	14.1	10.3	8.9	11.1
	Nodding	12.6	8.9	12.2	11.2
	Hand	12.5	6.8	12.2	10.5
	Tongue	12.5	11.2	9.4	11.0
3	Mouth	15.6	18.9	21.0	18.5
	Nodding	14.7	13.1	14.5	14.1
	Hand	15.7	6.5	13.2	11.8
	Tongue	15.2	16.5	11.2	14.3
	Overall	12.8	10.3	11.5	11.5

Table 7

Mean Frequency of Head Turning as a Function of Test Interval and Age

Age Period	Test Interval			Overall
	Control	Experimental	Delay	
1	1.6	2.6	4.9	3.0
2	1.5	0.6	2.9	1.6
3	4.6	1.6	3.5	3.2
Overall	2.5	1.6	3.7	2.6

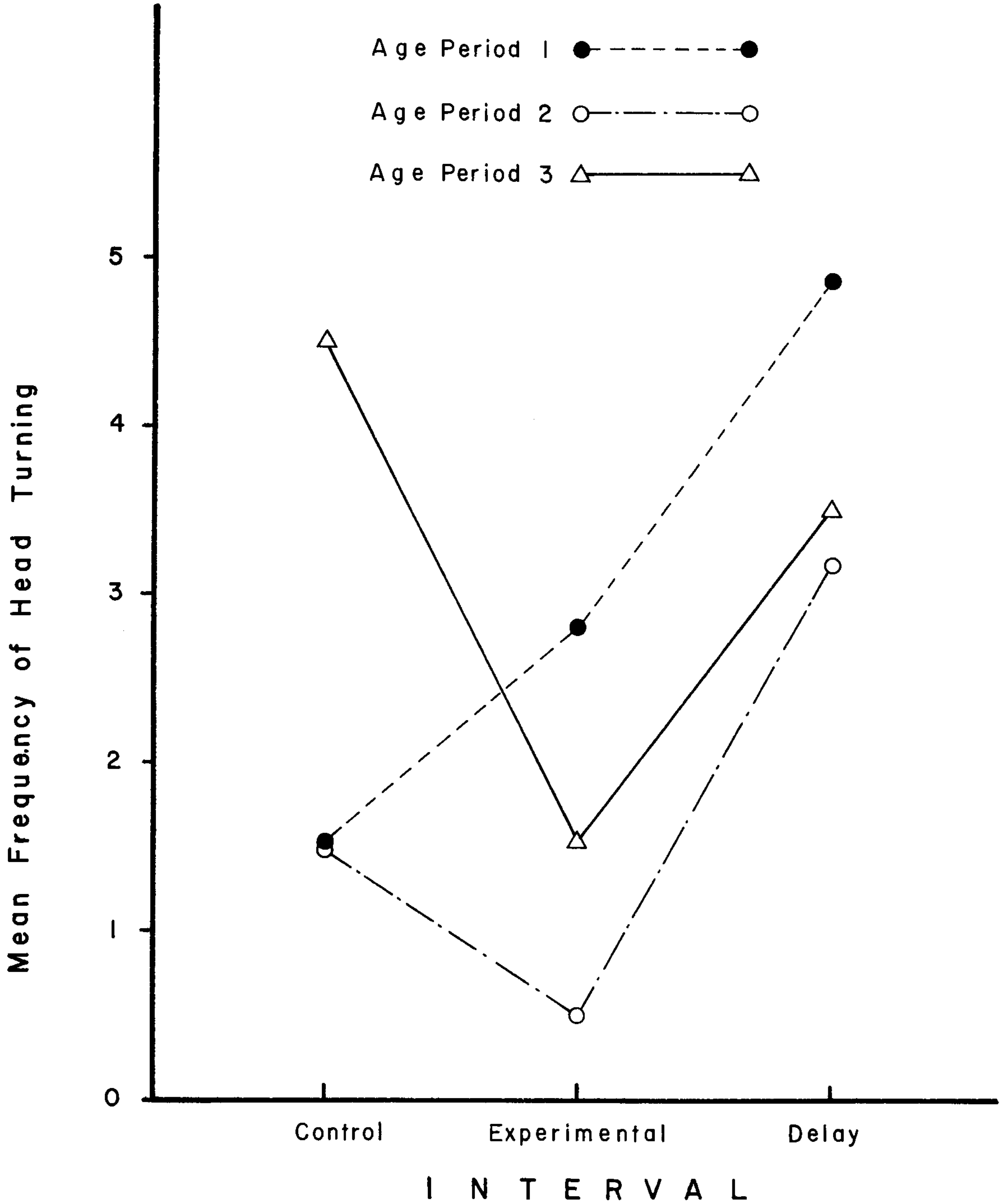

Figure 3. Mean frequency of head turning as a function of age and test interval.

There was no evidence of imitation in the analysis of the data re-grouped according to proximity to feeding. None of the proximity by model by interval interactions reached significance.

Proximity to feeding time did, however, have a significant effect on most of the behavioural measures. A statistically significant main effect of time since feeding was obtained for head nodding, $F(4,228)=5.11$, $p<.001$, mouth opening/closing, $F(4,228) = 2.92$, $p<.05$, tongue movements, $F(4,228) = 5.82$, $p<.001$, vocalization, $F(4,228) = 8.72$, $p<.001$, arm movement time, $F(4,228) = 4.94$, $p<.001$, and mouth movement time, $F(4,228) = 8.56$, $p<.0001$. No significant trend was found for head turning or hand opening/closing. For head nodding, mouth opening/closing and tongue movement the trend was incremental with the frequency of these behaviours increasing as time since feeding increased. For vocalization frequency and to a lesser extent for arm and mouth movement time, the relationship between proximity to feeding and response level appeared to be curvilinear. Somewhat higher levels were evident right after feeding, followed by a decrement, and then an increment in the most distal time periods. These trends are illustrated in Figure 4 for the discrete behaviours and Figure 5 for the movement time measures. Table 8 lists the mean response levels of all measures as a function of proximity to feeding, For head nodding movements, a significant proximity by interval interaction was also

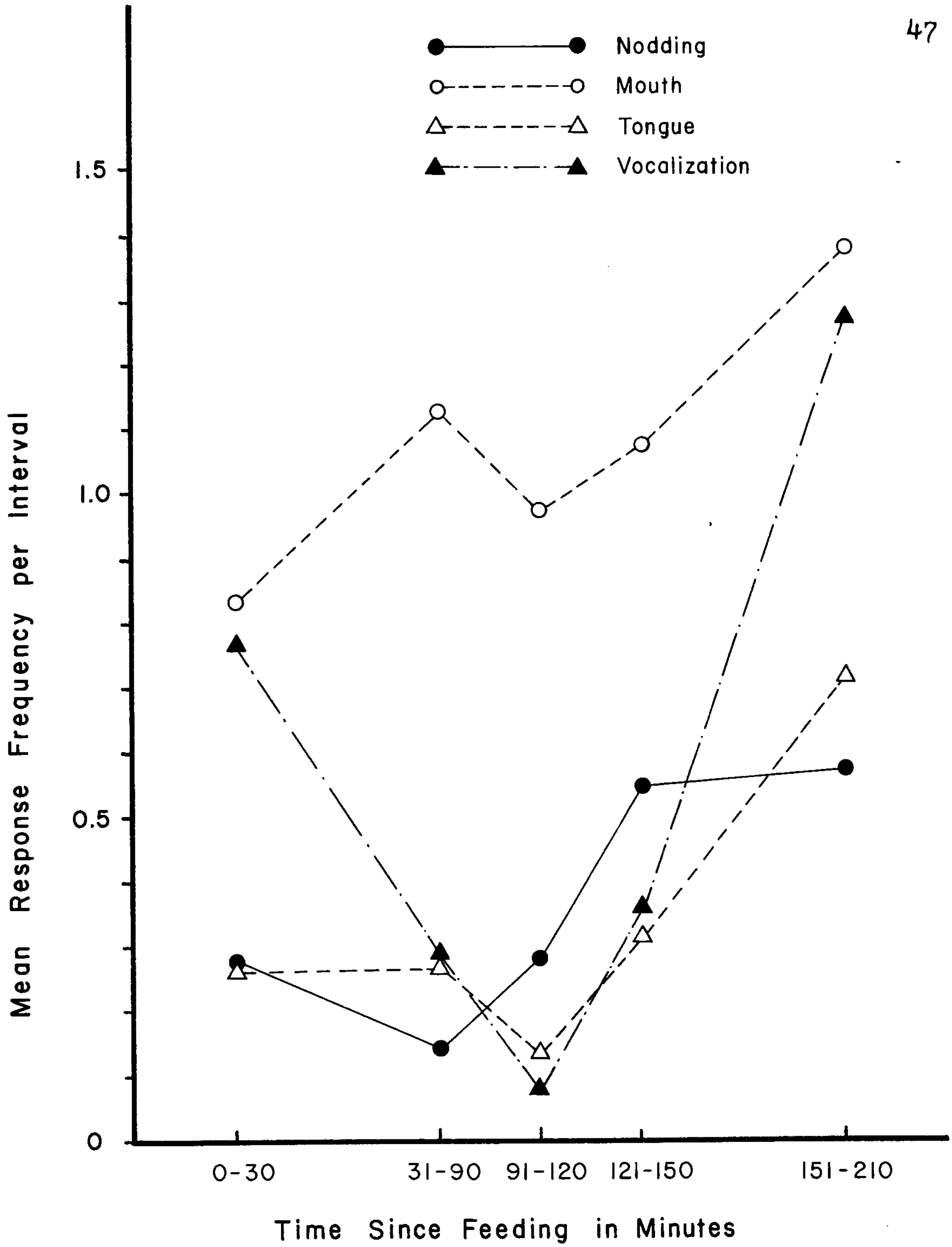

Figure 4. Mean response frequency as a function of proximity to feeding.

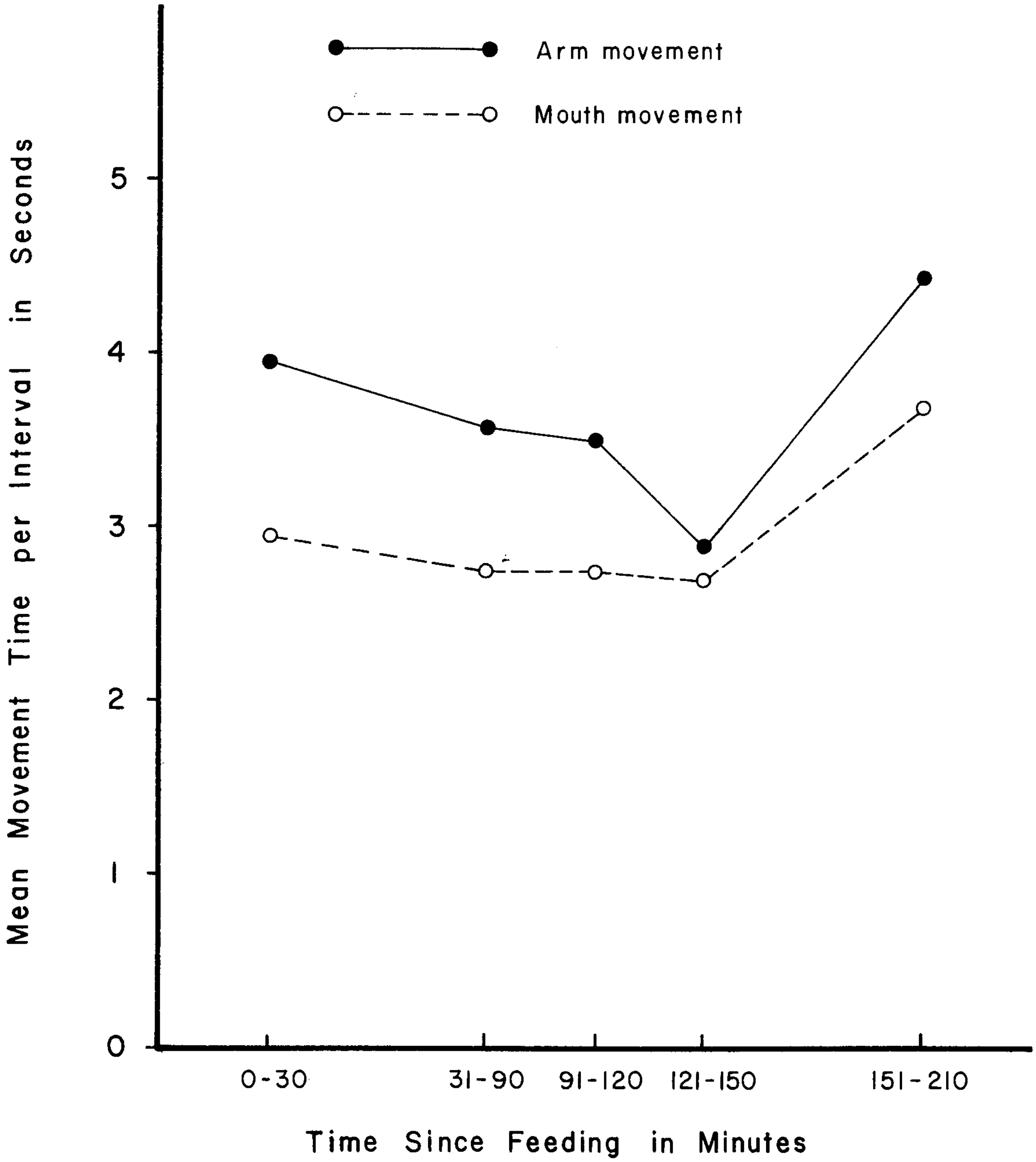

Figure 5. Mean movement time as a function of proximity to feeding.

Table 8

Mean Response Level as a Function of
Proximity to Feeding

Response Level	0-30	31-90	91-120	121-150	150-210
	Time Since Feeding in Minutes				
Frequency					
Head Nodding	0.3	0.2	0.3	0.5	0.6
Mouth Opening/Closing	0.8	1.1	0.9	1.1	1.4
Tongue Movement	0.3	0.3	0.2	0.3	0.7
Vocalization	0.8	0.3	0.1	0.4	1.3
Head Turning	0.8	0.7	0.5	0.5	0.7
Hand Opening/Closing	0.4	0.3	0.4	0.4	0.4
Time in Seconds					
Arm Movement	3.95	3.77	3.50	2.85	4.43
Mouth Movement	2.96	2.53	2.57	2.41	3.97

obtained, $F(6.228) = 1.97$, $p<.05$, suggesting that nodding increased in the experimental interval, when the infant was watching the modelling, only at the time furthest from feeding while it increased earlier in the non-modelling intervals. The mean frequency of head nodding as a function of proximity to feeding and test interval is presented in Table 9.

The analyses of the data regrouped by presentation position indicated that there was no significant increment in analogous behaviour dependent on whether the model was presented first, second, third or fourth on a given test day. Vocalization was the only behaviour which showed any variability according to presentation position. Vocalizations were greatest when tongue protrusion was modelled second and mouth opening/closing fourth. The position by model interaction was significant, $F(6,231) = 3.36$, $p<.01$. The mean frequency of vocalization as a function of position and model is listed in Table 10.

While the overall analyses yielded few significant results indicative of imitation, they did indicate that the experimental procedures had an effect on the infant's behaviour. The main effect of the test interval was found to be statistically significant for a number of measures. A response decrement in the experimental interval followed by a large increase in the delay interval was significant for vocalization, $F(2,18) = 7.72$, $p<.01$ and head turning $F(2,18) = 14.90$, $p<.01$. A significant response decrement

Table 9

Mean Frequency of Head Nodding as a Function of Proximity to Feeding and Test Interval

	Time Since Feeding in Minutes				
Test Interval	0-30	31-90	91-120	121-150	150-210
Control	0.3	0.1	0.2	0.6	0.6
Experimental	0.4	0.1	0.4	0.2	0.9
Delay	0.2	0.2	0.2	0.8	0.4

Table 10

Mean Frequency of Vocalization as a Function of Model and Presentation Position

	Position			
Model	1	2	3	4
Nodding	0.3	0.2	0.5	0.7
Hand Opening/Closing	0.2	0.5	0.4	0.5
Tongue Protrusion	0.6	2.3	0.5	0.5
Mouth Opening/Closing	0.6	0.3	0.5	1.3

in the experimental interval was also found for arm movement time, $\underline{F}(2,18) = 8.61$, $\underline{p}<.01$, and mouth movement time, $\underline{F}(2,18) = 4.52$, $\underline{p}<.05$. A similar trend was observed for mouth opening/closing and hand opening/closing but it was not significant. This trend is illustrated in Figure 6 for the discrete behaviours and Figure 7 for the movement time measures. No such trend was noted for tongue movement and head nodding. The mean response levels as a function of the test interval are listed in Table 11 for all behaviours.

For all of these measures except head turning, the decrement in the experimental interval, however, occurred only when certain behaviours were modelled. Arm movement time and vocalization decreased in the experimental interval in response to the hand opening/closing and nodding models, but increased in response to tongue protrusion and mouth opening/closing models. A similar trend was found in the mouth movement time measures, but the effect was not significant. In the analyses of variance, the model by test interval interaction was significant for arm movement time, $\underline{F}(6,18) = 6.21$, $\underline{p}<.01$ and approached significance for vocalization, $\underline{F}(6,18) = 2.50$, $\underline{p}<.10$. This interaction is illustracted in Figure 8 for arm movement time. The mean response levels as a function of model and test interval are presented in Table 12 for vocalization, and arm and mouth movement time.

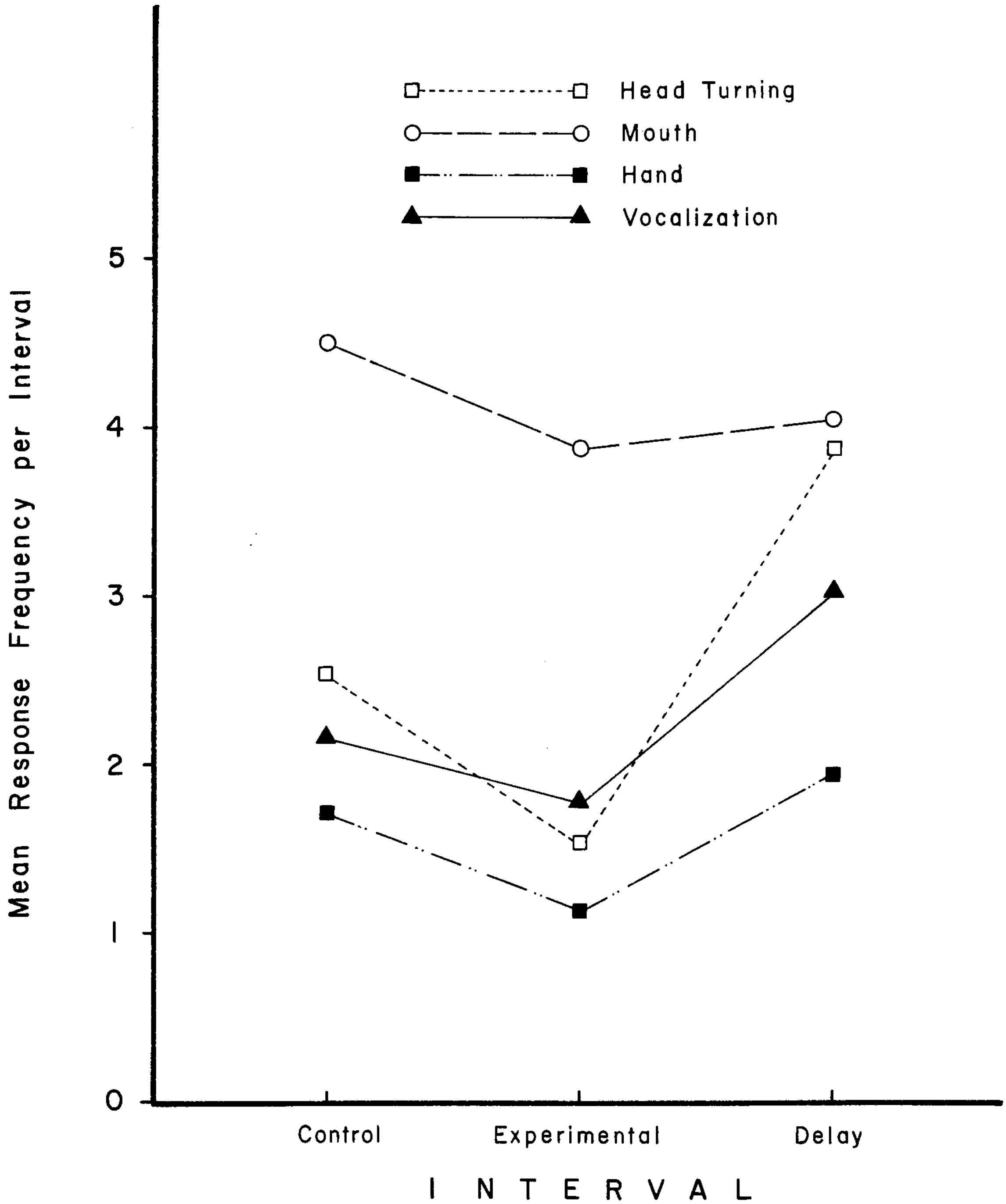

Figure 6. Mean response frequency as a function of test interval.

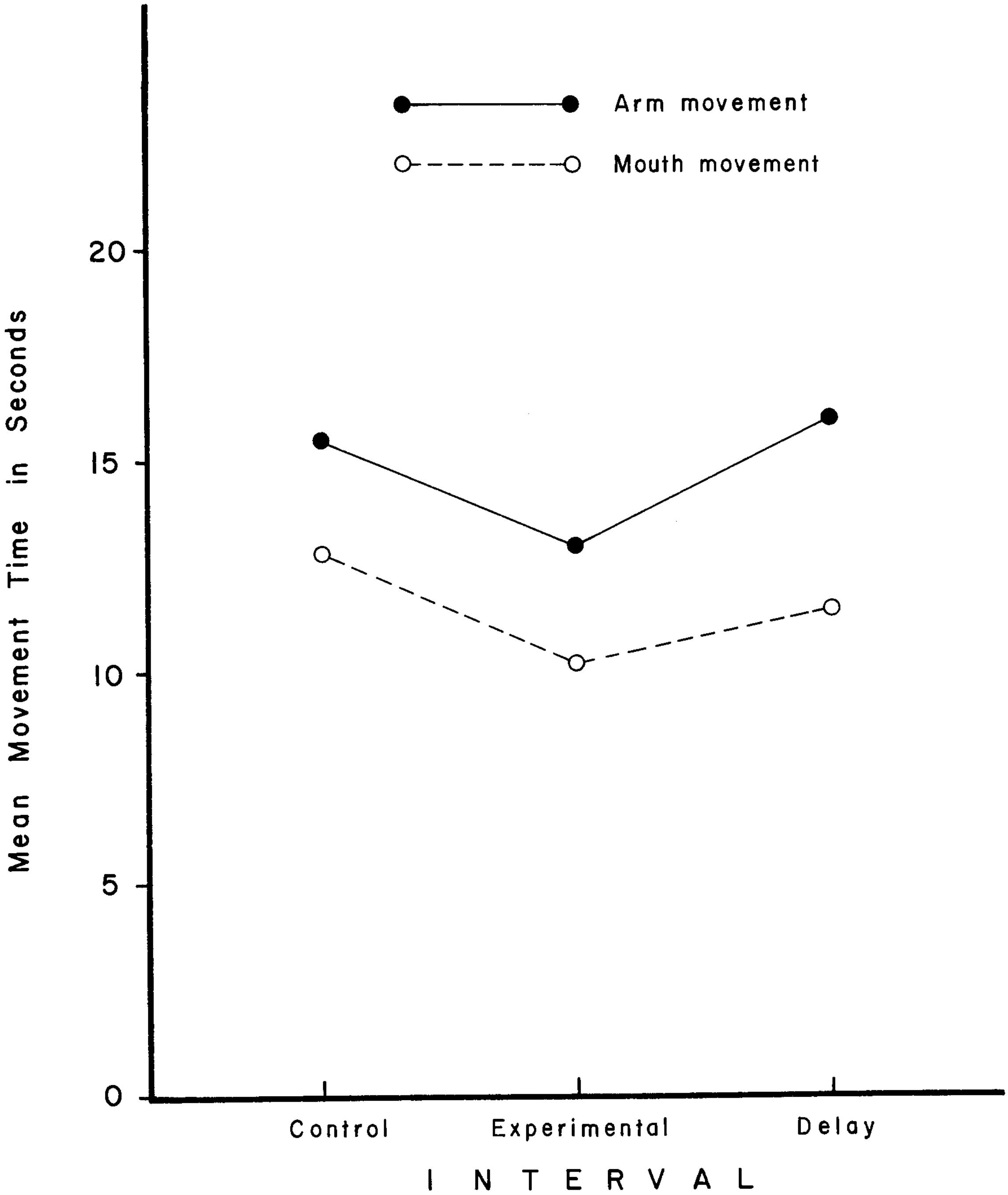

Figure 7. Mean movement time as a function of test interval.

Table 11

Mean Response Level as a Function of Test Interval

Response	Test Interval		
	Control	Experimental	Delay
Frequency			
Vocalization	2.3	1.8	3.1
Head Turning	2.6	1.6	3.8
Mouth Opening/ Closing	4.5	3.9	4.1
Hand Opening/ Closing	1.7	1.3	1.8
Tongue Movement	1.3	1.3	1.5
Head Nodding	1.5	1.6	1.4
Time in Seconds			
Arm Movement	15.5	13.0	16.1
Mouth Movement	12.8	10.4	11.6

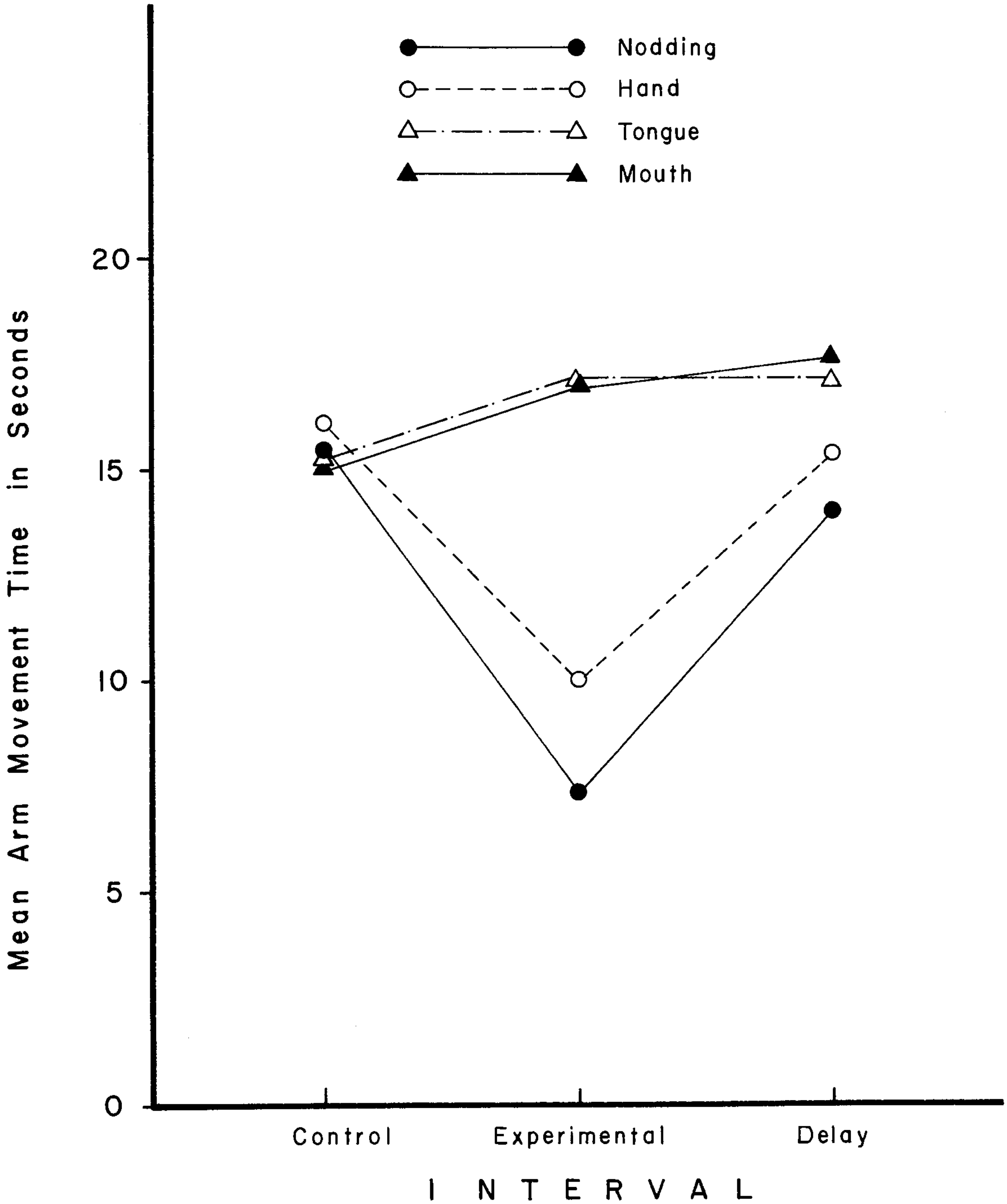

Figure 8. Mean arm movement time as a function of model and test interval.

Table 12

Mean Response Level as a Function of
Model and Test Interval

Response	Model	Test Interval: Control	Experimental	Delay
Frequency				
Vocalization	Nodding	1.5	1.2	2.8
	Hand	2.8	0.5	2.3
	Tongue	2.8	3.2	3.3
	Mouth	1.8	2.3	4.2
Time in Seconds				
Arm Movement	Nodding	15.5	7.5	14.0
	Hand	16.3	10.1	15.5
	Tongue	15.2	17.3	17.1
	Mouth	15.0	17.3	17.6
Mouth Movement	Nodding	12.0	8.5	12.0
	Hand	13.5	7.9	11.0
	Tongue	12.8	11.8	10.9
	Mouth	13.0	13.2	12.2

For both vocalization and mouth movement time the change in response level with model and interval was dependent upon the age of the infant and only showed up clearly in the third age period. In this age period both vocalization and mouth movement time increased linearly across intervals in response to mouth modelling and slightly increased in the experimental interval in response to tongue modelling. A marked decrease in the experimental interval occurred in response to hand modelling and to a lesser extent in response to nodding. In the analyses of variance, the age by model by interval interaction approaches significance for both vocalization, $F(6,18) = 2.11$, $p<.10$ and mouth movement time, $F(6,18) = 1.83$, $p<.15$. These trends are illustrated in Figure 9 for vocalization and Figure 2 for mouth movement time. The corresponding means are located in Table 13 for vocalization and Table 6 for mouth movement time.

A number of behaviours also increased significantly with age. An increment in response level with age was significant for vocalization, $F(2,18) = 110.5$, $p<.001$, tongue movement, $F(2,18) = 9.94$, $p<.01$, head turning, $F(2,18) = 9.74$, $p<.01$, arm movement time, $F(2,18) = 52.09$, $p<.001$, and mouth movement time, $F(2,18) = 23.91$, $p<.001$. Mean response levels as a function of age are listed in Table 14 for all behaviours.

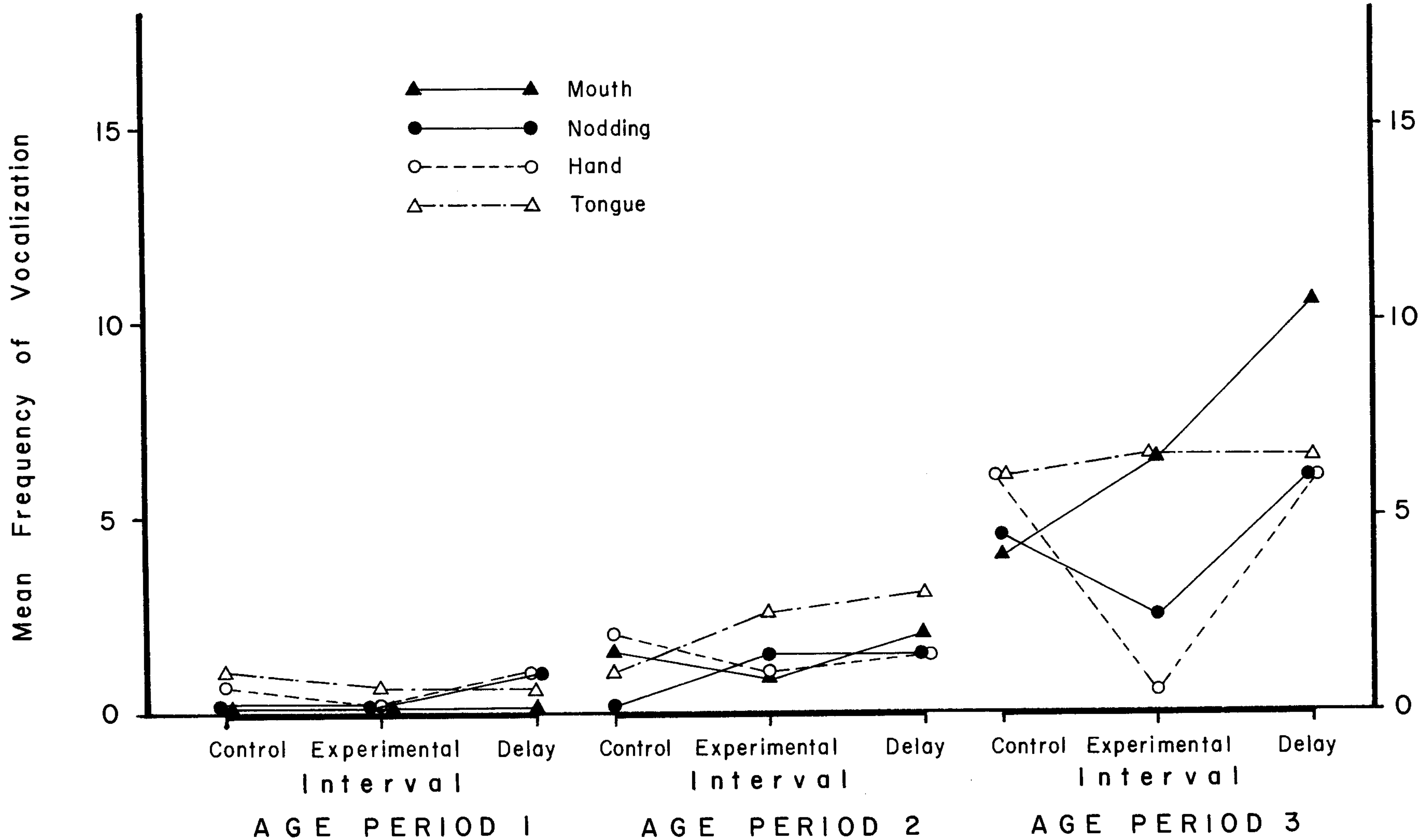

Figure 9. Mean frequency of vocalization as a function of age, model and test interval.

Table 13

Mean Vocalization Frequency as a Function of Age, Model and Test Interval

Age Period	Model	Test Interval: Control	Experimental	Delay	Overall
1	Nodding	0.0	0.0	1.0	.3
	Hand	0.5	0.0	0.0	.2
	Tongue	1.0	0.5	0.5	.7
	Mouth	0.0	0.0	0.0	.0
2	Nodding	0.0	1.5	1.5	1.0
	Hand	2.0	1.0	1.5	1.5
	Tongue	1.5	2.5	3.0	2.3
	Mouth	1.5	0.5	2.0	1.3
3	Nodding	4.5	2.0	6.0	4.2
	Hand	6.0	0.5	5.5	5.5
	Tongue	6.0	6.5	6.5	6.3
	Mouth	4.0	6.5	10.5	7.0
Overall		2.2	1.8	3.2	2.4

Table 14

Mean Response Level as a Function of Age

	Age Period		
Response	1	2	3
Frequency			
Vocalization	0.3	1.5	5.4
Tongue Movement	0.5	1.5	2.1
Head Turning	3.0	1.7	3.3
Head Nodding	1.4	1.7	1.4
Mouth Open/Close	3.7	4.6	4.2
Hand Open/Close	1.5	1.7	1.5
Time in Seconds			
Arm Movement	13.2	12.0	19.4
Mouth Movement	9.0	10.9	14.7

There were no significant effects at all for three of the behaviours: head nodding, mouth opening/closing and hand opening/closing. Tongue movement only varied significantly with age as reported above. All of these behaviours, with the exception of mouth opening/closing, occurred rather infrequently. Mouth opening/closing, which contrarily was the most frequent behaviour, had the lowest stability, however, and this may account for the lack of significant findings. The overall mean response level per interval of all behaviours and time measures are presented in Table 15.

No overall fatigue or activation effect was found in the analyses of successive control intervals within a test session. The main effect of order was found to be significant for only three measures, vocalization, $F(3,9) = 2.84$, $p<.01$, head nodding, $F(3,9) = 5.34$, $p<.05$, and mouth movement time, $F(3,9) = 4.03$, $p<.05$. Mouth movement time declined somewhat as testing progressed, and a parallel non-significant trend was observed in the measure of mouth opening/closing. Vocalizations increased as testing progressed but this increase was only clearly evident in the third age period: the age by order interaction was significant for vocalization, $F(6,9) = 5.13$, $p<.05$. Head nodding also increased somewhat as testing progressed but dropped off sharply in the fourth control interval. Again this was most clearly evident in

Table 15

Overall Mean Response Level Per Interval

Response	Mean
Frequency	
Head Nodding	1.5
Mouth Open/Close	4.2
Hand Open/Close	1.6
Tongue Movement	1.4
Head Turning	2.6
Vocalization	2.4
Movement Time in Seconds	
Arm	14.9
Mouth	11.6

the third age period. The age by order interaction was also significant for nodding, $F(6,9) = 14.1$, $p < .05$. The mean response levels in successive control intervals are listed in Table 16. Table 17 lists the mean response frequency of head nodding and vocalization as a function of age and successive control intervals.

The results of replicating the Moore and Meltzoff (1975) scoring procedure failed to provide any evidence that naive observers could correctly identify which model the infant was observing and trying to imitate. Inspection of the mean ranks of the six observers across the four modelling conditions, as presented in Table 18, and of the summed ranks of each observer for each modelling condition, as listed in Appendix E, Table E4, suggests that the guesses were randomly distributed. In none of the modelling conditions did the observers rank the correct model more highly than the other models.

Upon being interviewed, the observers stated that the criterion they had used in making their rankings had been the amount of movement of a given area of the infant's body. If there had been a great deal of hand activity, for example, hand opening/closing would have been ranked most highly. This criterion led to some fairly consistent but incorrect guessing by the observers. For example, the first model presented was nodding, but it was ranked as hand opening/closing by five of the six observers.

Table 16

Mean Response Levels in Successive Control Intervals

	Successive Control Intervals			
Response	1	2	3	4
Frequency				
Head Nodding	1.7	1.7	2.0	0.5
Vocalization	1.2	2.3	2.5	2.5
Head Turning	3.2	2.2	2.8	2.0
Mouth Open/Close	5.8	5.3	3.7	3.8
Tongue Movement	1.7	1.2	0.8	1.8
Hand Open/Close	1.7	1.7	1.7	1.7
Time in Seconds				
Arm Movement	14.4	16.2	16.6	14.8
Mouth Movement	14.8	14.3	10.4	11.6

Table 17

Mean Response Frequency in Successive Control Intervals as a Function of Age

		Successive Control Intervals			
Response	Age Period	1	2	3	4
	1	1.0	2.5	1.5	0.0
Head Nodding	2	2.5	2.0	1.0	1.0
	3	1.5	0.5	3.5	0.5
	1	0.5	0.5	0.0	0.5
Vocalization	2	1.0	2.5	0.5	1.0
	3	2.0	4.0	7.0	6.0

Table 18

Distribution of Mean Ranks Across Four Modelling Conditions

	Model			
Behaviours Ranked	Nodding	Tongue	Mouth	Hand
Nodding	15	17	16	14
Tongue	13	14	14	14
Mouth	17	17	15	19
Hand	15	12	15	13

Discussion

The present study in which an infant was observed longitudinally under controlled experimental conditions failed to provide clear evidence of imitation in the age period from three to nine weeks. The behaviours modelled for the infant did not affect his emission of analogous behaviours to a significant extent. This finding is in accord with Piagetian theory but is contrary to the results reported by Gardner and Gardner (1970) and others (Moore and Meltzoff, 1975; Smillie and Coppotelli, 1975) which indicate imitation in this age period.

The present data, however, do suggest the possible beginning of imitation in the third age period, from seven to nine weeks. An increase in head turning movement in correspondence with the model was noted during the control interval in this age period. This finding is in line with Piagetian theory which postulates the occurrence of such imitative movements at this time by simple perceptual motor accommodation. Piaget (1962) observed imitation of head turning beginning at the end of the second month which is about the same age at which it was observed in this study. Piaget also noted that imitation of head turning usually preceeded imitation of head nodding and that both of these responses were more readily elicited after the mid-point of the third month.

Imitation of head nodding was not found in this study. However, since testing in this study ceased shortly after the end of the second month, it could be postulated that only head turning accommodation was within the infant's capacity at that time. Also the fact that head turning movement was modelled more frequently than any other behaviour may have increased the likelihood that the infant would imitate it.

Although the actual number of head turning movements made during the control interval in the third age period did not differ significantly from those made during the delay interval in the first age period, there was a qualitative difference in these responses with age. At the earlier age the infant generally responded to the active model with an inactive, intent, smileless inspection and the head turning movements in the delay interval were those of turning away when the model was inactive. By the seventh week, however, the infant was socially responding to the model and engaging in an interaction with her. The head turning movements in the control interval were often slight turning movements corresponding to the model's and were frequently synchronous with her movements. These movements by the infant often appeared to be imitative whereas the earlier ones did not.

The increase in mouth movement time in response to mouth modelling from seven to nine weeks could also be construed as an indication of imitation, but as this increase was evident in the vocalization measure too it more likely indicates social activation. Mouth modelling resulted in increases in both mouth movement time and vocalization in the experimental and delay intervals whereas the modelling of hand opening/closing and nodding resulted in decreases in these measures but in the experimental interval only.

Decreased responding in the experimental interval when hand opening/closing and nodding were being modelled was also found for arm movement time. This measure of activation, however, showed only a very slight increment in response to the mouth opening/closing and tongue protrusion models and this pattern did not change with age.

Since these three measures all show a differential effect of the model they do appear to provide a measure of activation. The large asocial models, hand opening/closing and nodding, had a generally deactivating effect on the infant while he was watching them. The smaller mouth opening/closing model, however, did not have this effect and in fact as the infant grew older resulted in increased vocalization and mouth movement time during modelling and the following delay interval. This suggests that mouth modelling elicited a social response from the infant so that instead of quieting to watch what was going on he vocalized and moved his mouth as though attempting to engage in a social interaction with the model. That arm movement time did not increase along with vocalization and mouth movement time is in line with this reasoning in suggesting that mouth modelling had a specifically social rather than general activating effect.

One other measure, head turning, also showed a decrement in the experimental interval when the model was performing. This decrement, however, did not vary with the model and probably indicates that the infant was less inclined to turn away when the model was active.

The lack of imitation found in this study could be explained in a number of ways. The suggestion by Smillie and Coppotelli (1975) that a lack of imitation may be due to the presence of a pressing need state would not be one of them, however, because in this study the infant was always tested when he was alert, attentive and not fussing. Furthermore, the analysis of the data in relation to proximity to feeding did not reveal any evidence of imitation.

On the other hand, if imitation in early infancy is a transient phenomenon as Gardner and Gardner (1970) suggest, it is possible that this transient period of imitation was missed for the present infant. Just when it could be expected, however, would be difficult to predict from the present literature. It apparently occurred at two weeks of age for Moore and Meltzoff's (1975) six infants, and occurred, re-occurred or persisted until the sixth week for Gardner and Gardner's infant and until the fifth to eighth weeks for Smillie and Coppotelli's (1975) twelve infants. It would seem that the timing of early imitation is difficult to establish and may depend on the procedures followed.

The scoring procedures in these three studies reporting early imitation allow for the possibility of experimenter bias and/or error. Gardner and Gardner used single observers who recorded observations while simultaneously modelling behaviours. Smillie and Coppotelli apparently had their observers watch films of the model-infant interaction. In both cases, the observers were aware of the behaviour being modelled and could well have been predisposed to attend to the corresponding behaviour of the infant. Zazzo (1975) has suggested that observers in such situations are prone to select this behaviour from the conglomerate of behaviours presented by the infant because of its similarity to the presenting model. Informal observation of videotapes of model-infant interaction in this study when the infant was seven weeks old, about the age of Smillie and Coppotelli's infants, frequently led to speculation of imitation. For example, hand opening/closing by the infant which corresponded to presentation of the hand model gave the impression of imitation. In reviewing the hand behaviour with the image of the model blocked off, however, it was apparent that the infant's hand opening/closing was equally frequent in response to the other models.

Not only is it possible that there was experimenter bias in these two studies, but it is also possible that the scoring procedures were not stable. The Gardners report no measures of interscorer agreement stating only that each author kept separate notes. Smillie and Coppotelli report low interscorer agreement on initial scores, which led them to institute consensus procedure, but they report no stability measures for their consensus scores. No clear indication of the stability of the final scoring procedure is thus available for either of these studies.

Moore and Meltzoff's (1975) scoring procedure, which involved viewing the filmed image of the infant only, did result in high interscorer agreement but their procedure also allows for a form of experimenter bias. Moore and Meltzoff asked their observers to guess which model the infant was watching and trying to imitate, but they did not interview the observers to find out what clues they had used in making their guesses. The fact that the present observers using this procedure admitted to using clues that had little to do with actual imitation makes it possible that the Moore and Meltzoff observers were scoring something that had more to do with the infants' watching behaviour than their imitative behaviour.

For example while observing the infant's face, their observers may have obtained some clues from the infant's eyes, such as slight eye movements paralleling the model's movement or a reflection of the model in the infant's eyes, that would enable them to guess with considerable accuracy which model was being performed. Furthermore, as this study had demonstrated, the infant does respond differentially to the models presented and while this does not indicate imitation, it could be used as a clue to the model's activity.

The usefulness of the Moore and Meltzoff procedure was not demonstrated when replicated in the present study. The replication, however, differed in several respects. The infant observed in the present study was three weeks older and was observed across six test days. Moore and Meltzoff observed six infants each on one occasion only. They modelled sequential finger movement and lip protrusion whereas this present study modelled hand opening/closing and nodding in addition to mouth opening/closing and tongue protrusion which were modelled in both studies. Furthermore, the total time that the observers were exposed to each presentation may not have been exactly the same in the present replication as the exact observation time was not reported by Moore and Meltzoff. The filmed images presented by Moore and Meltzoff may also have differed slightly. Their observers apparently watched either the infant's hand or face only and may therefore have been exposed to closer, more detailed images of the infant. Nevertheless, it seems unlikely that these differences would have prevented the present observers from noting imitation if it was as evident as it appeared to be in the Moore and Meltzoff study. It would be necessary to undertake further replication of their procedure in order to establish its usefulness.

Although the results of this developmental study are in accord with the observations of Piaget (1962) and Uzgiris and Hunt (1975) in suggesting that imitation of gestures such as hand opening/closing, mouth opening/closing and tongue protrusion are not possible in early infancy, they are based on observation of only one infant. In order to more conclusively resolve the question of the existence of early imitation, the present study should be replicated with some changes in design. Several infants should be studied longitudinally beginning at two weeks instead of three weeks of age and continuing into the third month so as to cover the age range in which early imitation has been reported.

To fully establish whether transient imitation does occur in early infancy, observations should be carried out at least every other day, as in the present study, to ensure that the phenomenon is not missed. Models representing behaviour possible at each of Piaget's stages should be presented throughout the study as was done in the present study.

The infants' behaviour should be recorded on film or video tape and, as in this study, the observers should be exposed only to the image of the infant when scoring the tapes. The observers should not have any knowledge of the model's activity while observing the infant. Only in this way can the possibility of selective perception by the observer be avoided.

The use of film or video tape is also essential in establishing a stable scoring procedure. The difficulty in scoring the behaviour of very young infants is illustrated by the low interscorer agreement obtained both in the present study and that of Smillie and Coppotelli (1975) and indicates the necessity of having more than one scorer so that stability of scoring can be assessed. When consensus procedures are instituted it is imperative that the stability of the consensus scores be documented as agreement does not insure stability as was found for the mouth opening/closing measure in the present study.

The difficulty in obtaining high stability measures for the mouth opening/closing scores in this study may be the result of maturational changes that take place in mouth activity. Gesell (1928) observed that mouth activity changes from small mouth movements to larger more accentuated mouth openings during the age period of this study. By observing samples of mouth activity at different ages prior to the study, and developing a scoring protocol which took into account the maturational change, the stability of mouth opening/closing scores could possibly be improved. A similar procedure could also be instituted with the other behaviours.

In assessing imitation it would be necessary to control for the changes in activity level demonstrated in this study. The increase in most behaviours with age, corroborating earlier longitudinal studies of development (Gesell, 1928), indicates the need for control intervals to record the changing baseline of behaviours as the infant matures. Unless proximity to feeding were to be kept constant in all test sessions, the present results also indicate that control intervals would be needed to record activity levels that change in relation to feeding.

In an attempt to increase the number of observations of a given behaviour so that data could be analyzed in terms of individual test sessions, rather than the sum of four sessions, the test intervals (control, experimental, and delay) could be somewhat lengthened. They could also be presented more than once for each model. Designs such as these would, however, be limited by the attention span of the infant.

Thus by replicating the present study with the design changes suggested, it would be possible to resolve the question of whether there is a transient form of imitation early in infancy. The present longitudinal study concurs with Piagetian theory and data in suggesting that such imitation does not occur but this conclusion awaits the confirmation of replication.

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Appendix A

Report of psychological assessment of

infant at two months of age.

NAME: Jason Russell
Birth Date: November 14, 1972

Jason Russell was seen on the 23rd of January, 1973 and given the Cattell Infant Intelligence Test. At that time he was 2 months, 9 days old. He is a responsive baby, especially to people, relaxed and often smiling.

Test Findings:

On the test he obtained a Basal Age of 2 months, completing all 5 items at that age level. He also got credit for one item at the 3 month level which was inspecting his fingers, and he got credit for one item at the 4 month level which was following a ball across a table with his eyes. He got no items at the 5 month level, and the test was discontinued. A Mental Age of 2.4 months was obtained. It this is converted to days an I.Q. can be computed; with a Mental Age of 72 days, and a Chronological Age of 69 days, he would get an I.Q. of 104. At this age an I.Q. should be considered a development quotient which may relate to intelligence.

The reliability and validity coefficients of the tests for very young infants are low. For the various tests making up the Cattell Infant Intelligence Test Cattell (1) reports a split-half reliability coefficient which has been corrected by the Spearman-Brown Formula of only +0.56, and she reports a correlation between the test score at 3 months and the Stanford-Binet (FormL) score at 36 months of only +0.10. However the 3 month scores do have some predictive value of use, particularly in cases of low or high scores. Data is cited for ten infants of above-average quotients and for ten infants of below-average quotients, and there are many repeated measures for each infant. This data shows that an infant who earns a high development quotient at 3 months has appreciably better-than-average chances of being rated high at 2 or 3 years. However, a low rating at 3 months appeared to give but little indication as to whether an individual child's future development will be above or below average, although his chances of rating below average are greater than those of an infant who rates average or above at 3 months.

~~P.~~ A. Diewold, M.A.
Psychologist

Reference
(1) Cattell, Psyche - The Measurement of Intelligence of Infants and Young Children, The Psychological Corporation, New York, N.Y. 1940 (Revised 1960)

Appendix B

Vocal Behaviors Modelled

Four different vocalizations were modelled. The mode of presentation was the same as for vocalizations described earlier. One vocal model was an "eeh" sound. The infant had previously made this sound but had subsequently dropped it from his repertoire. The experimenter made this sound six times in a clear and distinct fashion during the 15 second interval. The experimenter's face was about ten inches from the infant as she leaned over him. The experimenter's facial expression was a smile. If the infant vocalized, the modelling would cease for the duration of his vocalization, and be resumed immediately when he terminated.

Another vocal model was an "uguh" sound. This was a sound which the infant was currently making with a relatively high frequency. The mode of presentation was as described above. An "mm" sound was another vocal model. The infant had not yet uttered this sound. The mode of presentation was again the same.

The remaining modelling condition was contingent upon infant initiated vocalization. During this interval any vocalization made by the infant would be repeated by the experimenter. The experimenter would not initiate any vocalizations during this interval. If the infant did not vocalize, the interval would be spent in silence.

The testing situation from age 71 days to 83 days was also changed so that the infant was placed lying in a supine position on a counter about four feet in height. He was accustomed to lying on this counter to be changed, dressed, etc. and often engaged in playful vocal exchange with the experimenter in this situation. One clock timer was placed on the counter directly behind the infant's head, and this was switched on by the experimenter simultaneously with the commencement of the testing session. The camera, mounted on a tripod, was about four feet away. The camera view included the infant's face and upper body, a side view of the experimenter, and the clock behind the infant.

<u>Scoring Vocalizations</u>

Because a preliminary scoring of the tapes revealed no consistent pattern in the infant's vocalization, no attempt was made to score these data in a more rigorous way. It appeared that the infant would favour a specific vocalization on a given day, and that the pattern and nature of his emissions were not altered to any extent by the experimenter's vocalizations. The only observations of any effect of the experimenter were in the infant initiated conditions where the experimenter repeated the sound immediately after the infant had made it. On several occasions it appeared that a circular reaction had been generated. However, although a temporal sequence was obtained--infant, experimenter, infant responding sequentially-- the over-all frequency of vocalizations did not differ from the control intervals. This effect was also confounded by the variability of the experimenter's response. The experimenter's immediate response in the testing situation was later sometimes observed to differ from the infant's emission.

Appendix C

Scoring Instructions

Scoring is to be done from the video tape record played on a standard television screen. The image of the experimenter appearing in the left of the picture is to be covered so that the scorer observes the image of the infant only.

Each 15 second interval is to be scored for six frequency measures and two movement time measures. It may be necessary to observe the interval more than once to determine the correct score for any one variable.

The duration of each 15 second interval is to be determined by the posterior clock in the picture. The scorer must observe this clock while concurrently observing the infant, so that behaviours can be noted in the correct interval. Each test day, the switching on of the clock by the experimenter indicates the beginning of testing, and the beginning of the first 15 second interval. The remainder of the intervals follow consecutively. This sequence may be interrupted if the infant is failing to attend to the experimenter. In such cases, the experimenter will stop the clock and attempt to regain the infant's attention. If his attention is regained, the experimenter will re-set the clock and repeat the interval that was interrupted. Testing will then resume as described. Scoring is to be completed on the repeated interval, not the interrupted interval.

The scores for each test day are to be recorded on a daily data sheet. From test day one to 21, 12 intervals are to be scored. From test day 22 to 27, 15 intervals are to be scored. Each interval is to be scored for the following frequency measures.

Head turning

Score one for each time the infant turns his head side-ways at least 2.5 cm from the midline. Do not score for return to midline. Score total number of movements per interval.

Head nodding

Score one for each clear movement of the head upwards or downwards from the initial position. The head should appear to move at least by one cm. before being scored. The size of the movement can be determined by observing the change in the position of the infant's nose on the television screen. Score the total number of movements per interval. Do not score head movement associated with yawning or sneezing.

Mouth opening/closing

Score one for each definite, pronounced opening of the mouth from a closed or almost closed position. The lips should be separated by a minimum of one cm before a mouth opening is scored. If the mouth is open at the beginning of the interval, score one for each distinct widening movement.

Do not score for closing the mouth. Do not score slight mouthing movements. Do not score yawning or mouth opening associated with sneezing. Score total number of movements per interval.

<u>Tongue movement</u>

Score one for each time the tongue is observed to move forward in the mouth. Do not score mouthing movements. Score total number of movements per interval.

<u>Hand opening/closing</u>

Score one for each time the subject extends his fingers and then withdraws them into a fist. Do not score movements in which only one or two fingers are extended. The hand must be extended and closed in the interval for the movement to be scored. Score total number of movements per interval.

<u>Vocalizations</u>

<u>General</u>. Score one for each separate and discrete vocalization without regard to the specific sound emitted. Do not score yawning noises or hiccups. Score total number of vocalizations per interval.

<u>Specific</u>. This behaviour is only to be scored when vocalization is being modelled. Score one for each vocalization which specifically replicates the sound produced by the model. Score total number of such vocalizations per interval.

Movement Time

Each interval is also to be scored for arm and mouth movement time measures. Each interval is to be scored twice for each of these measures. The scorer is to push a button connected to an electric digital clock timer for the duration of the specified movement in each interval. The two scores for each movement time measure per interval are to be recorded from the clock onto the appropriate column of the daily data sheets.

Mouth. Depress the button at all times that the mouth is moving, with the exception of movement associated with yawning or sneezing. The total movement time per interval is to be recorded.

Arm. Depress the button at all times when one or both of the arms are moving. Do not include movements of the fingers only. Movements associated with yawning or sneezing are not to be scored. The total movement time per interval is to be recorded.

Appendix D

Analyses of Variance

Table D1

Analysis of Variance of Frequency of Head Turning
Movement as a Function of Age
Model and Test Interval

Source	df	MS	F
Age (A)	2	17.76	9.74**
Days nested in Age D(A)[a]	3	10.40	5.70**
Model (B)	3	2.64	1.45
A x B	6	1.12	0.61
D(A) x B	9	1.14	0.63
Interval (I)	2	27.18	14.90***
A x I	4	11.83	6.48**
D(A) x I	6	1.19	0.65
B x I	6	3.36	1.85
A x B x I	12	2.57	1.41
Error	18	1.82	

** $p < .01$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D2

Analysis of Variance of Frequency of Head Nodding Movement as a Function of Age Model and Test Interval

Source	*df*	*MS*	*F*
Age (A)	2	0.89	0.61
Days nested in Age D(A)[a]	3	0.93	0.63
Model (B)	3	0.98	0.67
A x B	6	1.52	1.03
D(A) x B	9	0.97	0.66
Interval (I)	2	0.39	0.26
A x I	4	0.33	0.22
D(A) x I	6	0.93	0.63
B x I	6	2.13	1.45
A x B x I	12	1.65	1.12
Error	18	1.47	

[a]Day indicates a block of four test days.

Table D3

Analysis of Variance of Frequency of Mouth Opening/Closing as a Function of Age, Model and Test Interval

Source	df	MS	F
Age (A)	2	4.60	1.16
Days nested in Age D(A)[a]	3	4.73	1.19
Model (B)	3	1.27	0.32
A x B	6	5.47	1.37
D(A) x B	9	4.59	1.15
Interval (I)	2	2.51	0.63
A x I	4	2.89	0.73
D(A) x I	6	1.57	0.39
B x I	6	1.99	0.50
A x B x I	12	2.48	0.62
Error	18	3.98	

[a]Day indicates a block of four test days.

Table D4

Analysis of Variance of Frequency of Tongue Movement as a Function of Age, Model and Test Interval

Source	*df*	*MS*	*F*
Age (A)	2	16.43	9.94 **
Days nested in Age D(A)[a]	3	15.03	9.09 ***
Model (B)	3	1.28	0.77
A x B	6	2.54	1.54
D(A) x B	9	1.34	0.69
Interval (I)	2	0.35	0.21
A x I	4	3.26	1.97
D(A) x I	6	2.82	1.71
B x I	6	2.24	1.35
A x B x I	12	1.29	0.78
Error	18	1.65	

** $p < .01$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D5

Analysis of Variance of Frequency of Hand Opening/Closing as a Function of Age, Model and Test Interval

Source	df	MS	F
Age (A)	2	0.29	0.22
Days nested in Age D(A)[a]	3	5.36	4.09 *
Model (B)	3	2.61	1.99
A x B	6	1.85	1.41
D (A) x B	9	1.77	1.35
Interval (I)	2	1.62	1.24
A x I	4	0.42	0.32
D(A) x I	6	3.07	2.34
B x I	6	2.18	1.66
A x B x I	12	0.83	0.64
Error	18	1.31	

* $p < .05$

[a]Day indicates a block of four test days.

Table D6

Analysis of Variance of Frequency of Vocalization as a Function of Age, Model and Test Interval

Source	df	MS	F
Age (A)	2	168.39	110.55 ***
Days nested in Age D(A)[a]	3	2.26	1.49
Model (B)	3	7.38	4.85 *
A x B	6	4.26	2.91 *
D(A) x B	9	0.86	0.56
Interval (I)	2	11.76	7.72 **
A x I	4	5.60	3.67 *
D(A) x I	6	3.10	2.03
B x I	6	3.80	2.50
A x B x I	12	3.22	2.11
Error	18	1.52	

* $p < .05$

** $p < .01$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D7

Analysis of Variance of Arm Movement Time as a Function of Age, Model and Test Interval

Source	df	MS	F
Age (A)	2	381.98	52.09 ***
Days nested in Age D(A)[a]	3	27.62	3.77 *
Model (B)	3	79.10	10.79 ***
A x B	6	5.28	0.72
D(A) x B	9	17.53	2.39
Interval (I)	2	63.13	8.61 **
A x I	4	18.16	2.48
D(A) x I	6	9.38	1.28
B x I	6	45.57	6.21 **
A x B x I	12	9.91	1.35
Error	18	7.33	

* $p < .05$

** $p < .01$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D8

Analysis of Variance of Mouth Movement Time as a Function of Age, Model and Test Interval

Source	df	MS	F
Age (A)	2	197.91	23.91 ***
Days nested in Age D(A)[a]	3	3.38	0.41
Model (B)	3	16.07	1.94
A x B	6	20.81	2.51
D(A) x B	9	8.12	0.98
Interval (I)	2	37.42	4.52 *
A x I	4	2.75	0.33
D(A) x I	6	5.61	0.68
B x I	6	14.45	1.75
A x B x I	12	15.15	1.83
Error	18	8.28	

* $p < .05$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D9

Analysis of Variance of Frequency of Head Turning Movement as a Function of Proximity to Feeding, Model and Test Interval

Source	df	MS	F
C (Proximity to Feeding)	4	1.30	1.74
B (Model)	3	0.53	0.72
C x B	12	0.60	0.81
Interval (I)	2	5.96	7.99 ***
C x I	8	0.25	0.34
B x I	6	0.67	0.90
C x B X I	24	0.63	0.84
Error	228	0.75	

*** $p < .001$

Table D 10

Analysis of Variance of Frequency of Head Nodding Movement as a Function of Proximity to Feeding, Model and Test Interval

Source	*df*	*MS*	*F*
C (Proximity to Feeding)	4	2.13	5.11 ***
B (Model)	3	0.29	0.71
C x B	12	0.32	0.77
Interval (I)	2	0.10	0.24
C x I	8	0.82	1.97 *
B x I	6	0.41	0.97
C x B x I	24	0.29	0.69
Error	228	0.42	

* $p < .05$

*** $p < .001$

Table D11

Analysis of Variance of Frequency of Mouth Opening/Closing as a Function of Proximity to Feeding, Model and Test Interval

Source	*df*	*MS*	*F*
C (Proximity to Feeding)	4	2.70	2.92 *
B (Model)	3	0.25	0.27
C x B	12	0.89	0.97
Interval (I)	2	0.90	0.97
C x I	8	0.41	0.44
B x I	6	0.58	0.63
C x B x I	24	0.75	0.81
Error	228	0.92	

* $p < .05$

Table D12

Analysis of Variance of Frequency of Tongue Movement as a Function of Proximity to Feeding, Model and Test Interval

Source	*df*	*MS*	*F*
C (Proximity to Feeding)	4	2.36	5.82 ***
B (Model)	3	0.28	0.69
C x B	12	0.31	0.78
Interval (I)	2	0.08	0.20
C x I	8	0.29	0.71
B x I	6	0.59	1.45
C x B x I	24	0.34	0.83
Error	228	0.40	

*** $p < .001$

Table D13

Analysis of Variance of Frequency of Hand Opening/Closing as a Function of Proximity to Feeding, Model and Test Interval

Source	df	MS	F
C (Proximity to Feeding)	4	0.20	0.67
B (Model)	3	0.50	1.66
C x B	12	0.36	1.18
Interval (I)	2	0.68	2.26
C x I	8	0.31	1.04
B x I	6	0.50	1.64
C x B X I	24	0.25	0.84
Error	228	0.30	

Table D14

Analysis of Variance of Frequency of Vocalization as a Function of Proximity to Feeding, Model and Test Interval

Source	*df*	*MS*	*F*
C (Proximity to Feeding)	4	10.38	8.72 ***
B (Model)	3	1.12	0.94
C x B	12	0.47	0.40
Interval (I)	2	2.92	2.45
C x I	8	0.97	0.81
B x I	6	0.86	0.72
C x B x I	24	0.73	0.62
Error	228	1.19	

*** $p < .001$

Table D15

Analysis of Variance of Arm Movement Time as a Function of Proximity to Feeding, Model and Test Interval

Source	df	MS	F
C (Proximity to Feeding)	4	18.95	4.94 ***
B (Model)	3	15.81	4.12 **
C x B	12	1.67	0.43
Interval (I)	2	13.53	3.52 *
C x I	8	2.62	0.68
B x I	6	10.20	2.66 *
C x B x I	24	2.71	0.71
Error	228	3.84	

* $p < .05$

** $p < .01$

*** $p < .001$

Table D16

Analysis of Variance of Mouth Movement Time as a Function of Proximity to Feeding, Model and Test Interval

Source	df	MS	F
C (Proximity to Feeding)	4	20.19	8.56 ***
B (Model)	3	2.83	1.20
C x B	12	3.24	1.37
Interval (I)	2	8.30	3.52 *
C x I	8	0.89	0.38
B x I	6	3.45	1.46
C x B x I	24	1.71	0.73
Error	228	2.36	

* $p < .05$

*** $p < .001$

Table D17

Analysis of Variance of Frequency of Head Turning as a Function of Model, Test Interval and Position

Source	*df*	*MS*	*F*
Model (B)	3	0.45	0.63
Interval (I)	2	5.10	7.23 ***
B x I	6	0.52	0.74
Position (P)	3	0.25	0.35
P x B	9	0.59	0.83
P x I	6	0.79	1.12
P x I x B	18	0.89	1.26
Error	231	0.71	

*** $p < .001$

Table D18

Analysis of Variance of Frequency of Head Nodding as a Function of Model, Test Interval and Position

Source	df	MS	F
Model (B)	3	0.80	0.18
Interval (I)	2	0.24	0.55
B x I	6	0.53	1.19
Position (P)	3	0.14	0.32
P x B	9	0.58	1.32
P x I	6	0.62	1.39
P x I x B	18	0.36	0.81
Error	231	0.44	

Table D19

Analysis of Variance of Frequency of Mouth Opening/ Closing as a Function of Model, Test Interval and Position

Source	df	MS	F
Model (B)	3	0.25	0.26
Interval (I)	2	0.57	0.59
B x I	6	0.50	0.52
Position (P)	3	0.24	0.25
P x B	9	0.52	0.54
P x I	6	1.01	1.05
P x I x B	18	0.65	0.68
Error	231	0.96	

Table D20

Analysis of Variance of Frequency of Tongue Movement as a Function of Model, Test Interval and Position

Source	df	MS	F
Model (B)	3	0.30	0.69
Interval (I)	2	0.15	0.35
B x I	6	0.50	1.14
Position (P)	3	0.61	1.39
P x B	9	0.59	1.33
P x I	6	0.23	0.53
P x I x B	18	0.22	0.50
Error	231	0.44	

Table D21

Analysis of Variance of Frequency of Hand Opening/
Closing as a Function of Model, Test
Interval and Position

Source	df	MS	F
Model (B)	3	0.78	2.49
Interval (I)	2	0.23	0.74
B x I	6	0.64	2.04
Position (P)	3	0.12	0.37
P x B	9	0.25	0.80
P x I	6	0.37	1.16
P x I x B	18	0.25	0.80
Error	231	0.31	

Table D22

Analysis of Variance of Frequency of Vocalization as a Function of Model, Test Interval and Position

Source	*df*	*MS*	*F*
Model (B)	3	4.86	4.15 **
Interval (I)	2	2.93	2.50
B x I	6	0.72	0.61
Position (P)	3	2.22	1.90
P x B	9	3.94	3.36 **
P x I	6	0.60	0.51
P x I x B	18	0.77	0.66
Error	231	1.17	

** $p < .01$

Table D 23

Analysis of Variance of Arm Movement Time as a Function of Model, Test Interval and Position

Source	df	MS	F
Model (B)	3	20.76	5.50 **
Interval (I)	2	18.94	5.02 **
B x I	6	10.38	2.75 *
Position (P)	3	3.72	0.99
P x B	9	6.87	1.82
P x I	6	2.06	0.55
P x I x B	18	2.30	0.61
Error	231	3.77	

* $p < .05$

** $p < .01$

Table D24

Analysis of Variance of Mouth Movement Time as a Function of Model, Test Interval and Position

Source	*df*	*MS*	*F*
Model (B)	3	5.12	1.91
Interval (I)	2	9.69	3.61 *
B x I	6	3.57	1.33
Position (P)	3	3.65	1.36
P x B	9	3.86	1.44
P x I	6	2.75	1.03
P x I x B	18	0.60	.022
Error	231	2.68	

* $p < .05$

Table D25

Analysis of Variance of Frequency of Head Turning in Successive Control Intervals as a Function of Age

Source	*df*	*MS*	*F*
Age (A)	2	23.0	9.70 **
Days nested in Age D(A)[a]	3	4.37	1.84
Order (E)	3	1.82	0.77
A x E	6	4.32	1.82
Error	9	2.37	

** $p < .01$

[a]Day indicates a block of four test days.

Table D26

Analysis of Variance of Frequency of Head Nodding in Successive Control Intervals as a Function of Age

Source	*df*	*MS*	*F*
Age (A)	2	0.29	0.60
Days nested in Age D(A)[a]	3	1.04	2.14
Order (E)	3	2.60	5.34 *
A x E	6	2.34	4.83 *
Error	9	0.49	

* $p < .05$

[a]Day indicates a block of four test days.

Table D27

Analysis of Variance of Frequency of Mouth Opening/ Closing in Successive Control Intervals as a Function of Age

Source	*df*	*MS*	*F*
Age (A)	2	3.29	0.56
Days nested in Age D(A)[a]	3	1.42	0.24
Order (E)	3	7.00	1.19
A x E	6	2.45	0.42
Error	9	5.86	

[a]Day indicates a block of four test days.

Table D28

Analysis of Variance of Frequency of Tongue Movement in Successive Control Intervals as a Function of Age

Source	df	MS	F
Age (A)	2	5.37	3.25
Days nested in Age D(A)[a]	3	2.54	1.54
Order (E)	3	1.26	0.76
A x E	6	1.43	0.87
Error	9	1.65	

[a]Day indicates a block of four test days.

Table D29

Analysis of Variance of Frequency of Hand Opening/ Closing in Successive Control Intervals as a Function of Age

Source	*df*	*MS*	*F*
Age (A)	2	0.54	0.45
Days nested in Age D(A)[a]	3	1.08	0.91
Order (E)	3	0.0	0.0
A x E	6	3.70	3.10
Error	9	1.20	

[a]Day indicates a block of four test days.

Table D30

Analysis of Variance of Frequency of Vocalization in Successive Control Intervals as a Function of Age

Source	df	MS	F
Age (A)	2	42.9	49.0 ***
Days nested in Age D(A)[a]	3	2.87	3.29
Order (E)	3	2.49	2.84
A x E	6	4.49	5.13 *
Error	9	0.87	

* $p < .05$

*** $p < .001$

[a]Day indicates a block of four test days.

Table D31

Analysis of Variance of Arm Movement Time in Successive Control Intervals as a Function of Age

Source	df	MS	F
Age (A)	2	192.7	15.10 **
Days nested in Age D(A)[a]	3	17.2	1.35
Order (E)	3	6.71	0.53
A x E	6	9.58	0.75
Error	9	12.8	

** $p < .01$

[a]Day indicates a block of four test days.

Table D32

Analysis of Variance of Mouth Movement Time in Successive Control Intervals as a Function of Age

Source	df	MS	F
Age (A)	2	54.4	7.95 **
Days nested in Age D(A)[a]	3	4.26	0.62
Order (E)	3	27.6	4.03 *
A x E	6	8.42	1.23
Error	9	6.85	

** $p < .01$

* $p < .05$

[a]Day indicates a block of four test days.

Appendix E

Raw Data

Table E1

Agreed Upon Response Frequencies

Test Day	Response	Model: Nodding C	E	D	Hand C	E	D	Tongue C	E	D	Mouth C	E	D	Vocalization C	E	D
4	Head turning	0	0	0	0	0	0	0	0	1	0	0	2			
	Head nodding	0	0	0	0	0	0	0	1	0	0	0	0			
	Mouth open/close	2	0	0	1	0	0	0	0	0	1	0	0			
	Tongue Movement	0	0	0	0	0	0	0	0	0	0	0	0			
	Hand open/close	0	1	0	0	0	1	0	0	1	1	0	1			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	0			
5	Head turning	0	1	2	0	1	0	0	3	1	0	0	2			
	Head nodding	1	0	0	0	0	0	0	0	1	0	0	0			
	Mouth open/close	2	1	0	1	0	0	2	1	2	1	1	1			
	Tongue movement	0	0	0	2	0	0	0	0	0	1	0	0			
	Hand open/close	0	0	0	0	0	2	1	0	0	0	0	0			
	Vocalization	0	0	0	0	0	0	0	0	1	0	0	0			
6	Head turning	1	0	2	2	1	2	1	1	0	0	1	0			
	Head nodding	0	2	1	1	1	1	0	1	0	1	1	0			
	Mouth open/close	2	1	2	1	3	1	1	0	0	0	2	1			
	Tongue movement	1	0	0	0	2	1	0	0	0	0	0	0			
	Hand open/close	0	0	1	0	0	2	0	0	1	0	1	1			
	Vocalization	0	0	0	1	0	0	1	0	0	0	0	0			

...Continued

Table E1 (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model: Nodding C	E	D	Hand C	E	D	Tongue C	E	D	Mouth C	E	D	Vocalization C	E	D
7	Head turning	0	0	1	0	1	0	0	0	0	0	0	1			
	Head nodding	0	0	0	0	0	0	0	0	0	0	1	0			
	Mouth open/close	0	0	1	3	1	1	1	1	3	2	0	0			
	Tongue movement	0	0	0	0	0	0	0	0	0	0	0	0			
	Hand open/close	1	0	1	0	0	0	1	0	1	1	1	0			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	0			
8	Head turning	1	0	2	1	1	1	0	0	0	2	2	0			
	Head nodding	0	0	2	0	0	0	0	0	0	0	1	1			
	Mouth open/close	1	0	3	2	2	3	2	3	0	2	2	2			
	Tongue movement	0	0	0	0	0	0	0	1	0	0	1	1			
	Hand open/close	0	0	0	0	0	0	0	1	0	1	1	1			
	Vocalization	0	0	0	0	0	0	0	1	0	0	0	0			
9	Head turning	0	2	1	0	2	3	0	2	4	1	0	4			
	Head nodding	0	0	0	0	0	0	0	0	0	0	0	0			
	Mouth open/close	0	0	1	2	1	1	0	1	0	1	0	0			
	Tongue movement	0	0	0	0	0	0	0	0	0	0	0	0			
	Hand open/close	0	0	0	1	0	0	1	1	0	0	0	0			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	0			

...Continued

Table El (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model														
		Nodding			Hand			Tongue			Mouth			Vocalization		
		C	E	D	C	E	D	C	E	D	C	E	D	C	E	D
10	Head turning	1	0	0	0	1	2	0	0	1	0	0	1			
	Head nodding	1	0	0	0	1	0	1	1	0	0	1	0			
	Mouth open/close	1	0	0	0	2	0	0	0	0	1	0	0			
	Tongue movement	0	0	0	0	0	0	0	0	0	0	0	0			
	Hand open/close	0	0	0	1	0	1	2	1	0	0	1	0			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	0			
11	Head turning	0	0	2	1	1	1	0	1	1	2	0	2			
	Head nodding	2	0	2	1	1	0	2	0	1	0	0	2			
	Mouth open/close	1	0	3	2	2	1	1	0	2	0	1	1			
	Tongue movement	0	0	1	0	0	0	0	0	0	0	0	0			
	Hand open/close	1	0	0	1	0	0	1	1	0	0	0	0			
	Vocalization	0	0	2	0	0	0	1	0	0	0	0	0			
12	Head turning	1	0	1	0	0	0	2	0	0	0	1	1			
	Head nodding	1	0	0	0	0	0	0	1	0	0	0	0			
	Mouth open/close	2	0	0	0	3	1	0	1	2	1	0	0			
	Tongue movement	1	0	0	0	0	1	0	1	0	0	0	0			
	Hand open/close	0	0	0	1	0	0	1	0	0	0	1	1			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	0			

...Continued

Table E1 (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model: Nodding C	E	D	Hand C	E	D	Tongue C	E	D	Mouth C	E	D	Vocalization C	E	D
13	Head turning	1	0	0	0	1	2	0	0	1	0	0	1			
	Head nodding	2	1	0	0	4	1	0	0	0	0	0	0			
	Mouth open/close	2	0	1	4	2	2	0	2	0	1	0	3			
	Tongue movement	0	0	0	2	0	0	0	0	0	0	0	1			
	Hand open/close	2	0	0	0	0	0	0	0	0	0	0	1			
	Vocalization	0	0	0	0	1	0	0	0	0	1	0	0			
14	Head turning	0	1	1	0	0	0	1	1	0	1	0	1			
	Head nodding	1	1	0	0	0	0	0	0	0	0	0	0			
	Mouth open/close	2	3	2	2	1	1	1	2	0	0	0	1			
	Tongue movement	1	1	1	1	1	1	0	2	0	0	0	0			
	Hand open/close	0	0	0	0	1	0	0	0	1	1	0	1			
	Vocalization	0	0	0	1	0	0	0	2	0	0	0	1			
15	Head turning	1	0	0	0	0	4	0	0	0	1	0	0			
	Head nodding	0	0	0	1	0	0	0	1	1	0	0	4			
	Mouth open/close	0	2	2	1	0	0	2	1	2	2	0	1			
	Tongue movement	0	2	2	1	0	0	0	1	0	1	0	1			
	Hand open/close	0	0	0	1	0	1	1	0	1	0	0	0			
	Vocalization	0	2	1	1	0	0	1	1	2	0	0	0			

... Continued

Table El (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model														
		Nodding			Hand			Tongue			Mouth			Vocalization		
		C	E	D	C	E	D	C	E	D	C	E	D	C	E	D
16	Head turning	0	0	0	0	0	2	0	0	0	0	0	0			
	Head nodding	1	0	0	0	1	1	0	0	0	0	0	0			
	Mouth open/close	1	3	0	0	0	1	1	0	0	2	1	1			
	Tongue movement	1	0	0	0	0	1	1	0	0	3	0	0			
	Hand open/close	0	1	1	2	0	1	0	1	0	1	1	1			
	Vocalization	0	0	0	0	0	0	0	0	0	0	0	1			
17	Head turning	0	0	0	2	0	1	0	0	0	1	0	2			
	Head nodding	1	0	0	2	1	0	0	0	1	2	0	1			
	Mouth open/close	2	0	1	1	0	1	1	2	4	1	0	2			
	Tongue movement	0	0	0	0	0	0	0	0	1	0	0	0			
	Hand open/close	0	0	1	0	1	0	1	0	1	0	0	0			
	Vocalization	0	0	0	0	1	0	0	1	2	1	0	0			
18	Head turning	1	0	0	0	0	1	0	0	3	0	0	0			
	Head nodding	1	1	1	1	0	1	0	1	0	0	1	0			
	Mouth open/close	3	2	2	2	0	1	0	2	1	3	2	0			
	Tongue movement	0	0	1	2	0	0	0	0	1	1	0	0			
	Hand open/close	2	1	1	1	0	2	0	1	0	0	0	0			
	Vocalization	0	1	2	2	0	2	1	0	1	1	1	1			

...Continued

Table E1 (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model														
		Nodding			Hand			Tongue			Mouth			Vocalization		
		C	E	D	C	E	D	C	E	D	C	E	D	C	E	D
19	Head turning	0	0	1	0	1	1	0	0	0	0	0	0			
	Head nodding	0	0	0	0	0	2	0	0	0	0	1	1			
	Mouth open/close	1	1	1	0	0	1	3	1	0	2	3	0			
	Tongue movement	0	0	0	0	0	1	2	0	0	0	0	0			
	Hand open/close	1	0	1	0	1	0	0	1	0	0	0	1			
	Vocalization	0	0	0	0	0	1	1	1	1	0	0	1			
20	Head turning	2	0	0	0	0	1	1	1	0	0	2	1			
	Head nodding	1	0	0	1	0	0	0	2	0	1	1	1			
	Mouth open/close	4	1	2	2	0	2	1	3	1	1	1	1			
	Tongue movement	1	2	4	2	0	2	0	1	1	1	1	1			
	Hand open/close	0	0	0	0	0	0	2	0	0	0	0	1			
	Vocalization	1	0	3	2	0	0	2	2	2	1	2	2			
21	Head turning	3	0	0	0	0	1	0	0	0	1	0	0			
	Head nodding	0	0	0	0	0	1	0	0	0	0	0	0			
	Mouth open/close	0	1	1	0	0	0	0	1	1	1	2	1			
	Tongue movement	0	0	1	1	0	0	1	0	2	1	1	1			
	Hand open/close	0	0	0	0	0	0	0	0	0	0	0	0			
	Vocalization	1	0	1	0	0	1	0	1	2	2	1	1			

...Continued

Table E1 (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model: Nodding C	E	D	Hand C	E	D	Tongue C	E	D	Mouth C	E	D	Vocalization	C	E	D
	Head turning	1	0	3	1	0	1	0	1	0	2	0	0				
	Head nodding	0	0	0	0	0	0	0	0	0	0	0	0				
22	Mouth open/close	2	3	1	1	1	1	0	2	1	1	2	1				
	Tongue movement	0	0	0	0	0	1	0	2	0	0	2	2				
	Hand open/close	0	0	0	0	1	0	0	0	0	1	0	0				
	Vocalization	1	1	0	0	0	2	1	1	2	1	1	2	General	0	0	0
														Specific	1	0	1
	Head turning	0	0	1	1	0	1	1	1	1	1	0	1				
	Head nodding	0	0	1	0	2	0	3	0	0	0	1	0				
23	Mouth open/close	0	1	2	2	1	2	1	2	0	2	1	2				
	Tongue movement	0	0	1	1	0	1	0	2	0	1	2	2				
	Hand open/close	0	0	1	1	0	1	0	0	0	0	1	1				
	Vocalization	3	0	3	2	0	4	5	2	0	1	2	8	General	1	0	0
														Specific	0	0	0
	Head turning	2	2	2	3	1	2	2	2	2	0	2	1				
	Head nodding	0	0	1	0	0	0	0	1	0	0	1	0				
24	Mouth open/close	0	0	0	0	1	1	2	1	0	0	1	1				
	Tongue movement	0	0	0	0	0	0	0	0	0	0	0	0				
	Hand open/close	0	0	0	1	0	1	1	1	0	1	1	0				
	Vocalization	1	3	3	3	1	2	2	6	5	2	6	5	General	0	0	1
														Specific	0	1	0

...Continued

Table E1 (Continued)

Agreed Upon Response Frequencies

Test Day	Response	Model															
		Nodding			Hand			Tongue			Mouth			Vocalization			
		C	E	D	C	E	D	C	E	D	C	E	D		C	E	D
25	Head turning	0	0	0	2	0	1	0	0	0	3	1	0				
	Head nodding	1	0	0	0	1	0	1	0	0	0	0	1				
	Mouth open/close	0	2	2	1	0	0	1	1	2	2	2	2				
	Tongue movement	0	0	0	0	1	0	0	0	0	0	2	1				
	Hand open/close	0	0	0	0	0	0	1	1	0	0	1	1				
	Vocalization	2	0	0	1	0	0	0	0	2	1	0	3				
26	Head turning	2	0	1	0	0	1	1	0	1	2	0	1				
	Head nodding	0	0	0	1	0	0	0	0	0	1	1	1				
	Mouth open/close	1	0	0	0	1	1	0	0	0	1	1	2				
	Tongue movement	0	0	0	0	0	0	0	1	0	0	1	1				
	Hand open/close	0	1	1	0	0	1	1	2	1	1	2	1				
	Vocalization	0	0	2	2	0	1	2	1	0	0	1	0	General	2	0	0
														Specific	0	0	0
27	Head turning	2	0	1	2	0	1	0	0	1	2	0	2				
	Head nodding	1	2	2	0	0	0	1	0	0	0	1	0				
	Mouth open/close	2	1	1	0	1	1	1	0	1	1	1	2				
	Tongue movement	1	0	0	0	0	0	0	0	0	0	1	0				
	Hand open/close	0	0	0	0	0	1	1	0	1	0	1	1				
	Vocalization	0	0	0	2	0	1	0	0	0	0	0	0	General	2	0	0
														Specific	0	0	0

Table E2

Agreed Upon Movement Time Measures in Seconds

Test Day	Movement Time Measure	Model											
		Nodding			Hand			Tongue			Mouth		
		C[a]	E[b]	D[c]	C	E	D	C	E	D	C	E	D
4	Arm	3.0	1.8	0.8	1.4	0.0	1.6	1.2	2.4	3.6	3.5	4.9	3.5
	Mouth	2.3	0.0	1.1	1.8	1.1	0.3	0.1	0.4	2.2	1.7	2.8	1.6
5	Arm	2.3	3.0	7.6	4.7	1.4	4.1	3.6	8.1	2.9	2.8	5.5	3.5
	Mouth	3.1	2.2	1.0	2.1	0.5	1.2	4.9	3.6	3.3	2.1	2.9	1.9
6	Arm	1.0	1.2	3.5	2.0	1.9	4.1	4.4	3.4	4.6	5.9	6.7	6.6
	Mouth	4.8	2.1	3.1	3.3	5.2	4.4	2.8	1.6	1.8	3.5	4.6	2.7
7	Arm	1.8	0.9	4.2	6.2	1.0	1.1	2.4	1.6	1.7	2.2	2.7	2.9
	Mouth	0.2	0.0	1.2	3.3	2.8	1.5	1.3	2.7	3.1	2.8	0.9	0.0
8	Arm	3.3	0.0	2.1	7.4	4.3	2.8	1.1	5.7	3.7	6.6	4.4	4.1
	Mouth	3.2	0.0	3.7	3.0	2.4	2.4	4.9	4.1	2.9	3.8	4.1	3.1
9	Arm	4.7	0.7	2.9	5.9	3.2	3.7	2.7	4.7	3.9	4.9	3.5	3.2
	Mouth	0.7	1.0	3.0	4.7	2.6	2.5	3.5	2.2	2.7	2.9	3.5	1.8
10	Arm	6.4	1.4	3.7	4.5	2.1	4.5	3.6	3.6	4.2	3.1	2.7	2.3
	Mouth	2.0	0.2	2.0	2.2	3.0	1.3	0.9	0.5	2.2	1.7	0.6	0.6
11	Arm	3.7	5.4	2.0	3.1	3.3	1.7	3.5	2.7	1.3	1.3	2.6	2.8
	Mouth	1.4	1.5	3.8	4.3	2.9	1.4	2.8	0.0	5.9	0.0	1.7	1.4

....Continued

Table E2 (Continued)

Agreed Upon Movement Time Measures in Seconds

Test Day	Movement Time Measure	Model											
		Nodding			Hand			Tongue			Mouth		
		C	E	D	C	E	D	C	E	D	C	E	D
12	Arm	1.8	0.8	3.6	2.3	2.9	2.8	2.4	2.4	0.7	0.6	3.8	3.1
	Mouth	1.8	1.5	2.1	2.1	3.3	4.9	0.9	1.3	3.0	2.4	1.2	0.7
13	Arm	4.1	1.0	1.2	5.5	1.8	4.9	4.2	4.3	6.1	0.4	2.9	4.3
	Mouth	3.8	0.2	1.7	4.7	3.6	4.1	2.3	3.5	1.5	3.4	2.1	4.2
14	Arm	3.2	2.0	3.2	3.1	1.6	1.1	2.5	2.8	4.7	1.6	3.8	3.2
	Mouth	4.7	3.9	3.8	4.2	3.5	4.8	3.9	4.3	1.9	2.3	1.1	3.0
15	Arm	0.4	0.0	1.0	4.4	0.0	3.9	3.1	6.4	5.0	1.4	2.8	1.1
	Mouth	1.5	4.7	3.5	3.6	0.0	0.0	3.5	2.9	2.7	4.8	2.3	2.0
16	Arm	6.8	3.3	3.7	3.8	1.7	5.0	3.4	4.6	7.5	5.7	6.5	5.4
	Mouth	3.6	2.8	1.2	0.3	1.1	1.0	4.0	1.7	0.2	5.4	3.4	3.0
17	Arm	2.4	1.3	1.7	2.8	0.7	2.3	0.3	3.1	3.5	1.9	2.2	3.1
	Mouth	1.1	0.9	0.9	2.8	1.5	1.4	1.6	2.9	6.3	2.8	1.9	2.1
18	Arm	3.6	3.6	3.8	2.0	1.0	6.6	4.8	6.7	1.7	3.7	5.1	6.3
	Mouth	4.1	2.7	6.6	7.2	0.7	5.2	2.0	3.2	2.1	4.2	4.8	2.0
19	Arm	3.9	0.7	1.2	0.3	1.6	2.8	3.3	3.1	0.5	0.9	3.8	3.6
	Mouth	4.6	1.2	4.6	0.2	0.0	3.0	6.8	2.6	1.2	3.0	3.8	0.9

....Continued

Table E2 (Continued)

Agreed Upon Movement Time Measures in Seconds

Test Day	Movement Time Measure	Model											
		Nodding			Hand			Tongue			Mouth		
		C	E	D	C	E	D	C	E	D	C	E	D
20	Arm	3.7	0.0	4.0	3.1	0.4	5.3	2.7	1.5	3.5	2.7	1.9	4.0
	Mouth	4.3	3.5	4.4	4.4	0.8	3.8	3.1	5.5	2.3	5.4	5.2	5.7
21	Arm	4.2	0.7	4.3	2.1	4.2	3.7	5.9	2.5	4.3	5.4	2.7	0.8
	Mouth	2.6	2.5	3.3	3.6	0.0	2.7	2.8	4.3	2.3	4.0	4.7	4.1
22	Arm	6.0	1.3	4.2	4.1	2.7	6.5	4.0	6.2	5.5	5.7	6.9	4.8
	Mouth	4.3	3.6	4.2	4.3	1.0	3.4	1.1	3.6	3.7	2.8	3.7	3.9
23	Arm	6.6	3.7	7.1	9.3	7.6	6.6	9.4	7.1	7.1	6.9	5.0	9.3
	Mouth	4.8	1.6	3.3	7.7	2.8	6.7	4.9	5.4	2.1	6.7	4.2	7.4
24	Arm	4.7	2.5	4.8	5.2	2.3	2.6	6.5	4.1	5.8	8.2	7.2	8.3
	Mouth	3.6	4.7	1.3	2.1	1.8	1.4	4.8	3.1	2.0	1.4	3.7	3.1
25	Arm	5.3	2.0	3.3	4.0	2.4	1.9	6.6	4.0	6.1	3.5	4.1	5.7
	Mouth	3.8	3.0	5.7	3.3	2.7	3.2	6.0	4.1	5.8	4.4	5.7	6.4
26	Arm	4.7	1.9	2.1	6.6	7.4	8.4	2.7	6.2	7.0	5.4	8.5	6.8
	Mouth	1.7	1.3	3.3	1.9	1.7	2.0	3.7	4.0	1.4	3.5	4.9	6.1
27	Arm	5.5	5.5	8.0	4.3	4.9	4.9	6.4	6.4	7.9	5.7	3.9	7.0
	Mouth	4.3	6.0	3.5	4.2	2.2	3.3	4.0	3.1	2.8	3.1	5.7	5.3

C[a] = control interval
E[b] = experimental interval
D[c] = delay interval

Table E3

Agreed Upon Vocalization Scores in Response to Vocal Modelling

Test Day		Interval: Control	Experimental	Delay
22	General	0	0	0
	Specific	1	0	1
23	General	1	0	0
	Specific	0	0	0
24	General	0	0	1
	Specific	0	1	0
25	General	1	0	0
	Specific	0	0	0
26	General	2	0	0
	Specific	0	0	0
27	General	2	0	0
	Specific	0	0	0

Table E4

Summed Ranks of each Observer for Each Modelling Condition in the Moore and Meltzoff Scoring Replication

		Behaviours Ranked			
Model	Observer	Nodding	Tongue	Mouth	Hand
Nodding[a]	1	13	16	17	14
	2	15	15	18	12
	3	15	12	18	15
	4	16	12	20	12
	5	15	12	17	16
	6	16	10	12	22
	Total	90	77	102	91
Tongue Protrusion[a]	1	15	16	16	13
	2	16	13	15	14
	3	17	14	20	9
	4	17	14	18	11
	5	18	14	19	9
	6	17	15	12	16
	Total	102	86	102	72
Mouth Opening/ Closing[a]	1	18	17	17	8
	2	16	11	13	20
	3	12	19	15	14
	4	15	13	18	14
	5	18	9	15	18
	6	15	15	13	17
	Total	94	84	91	91
Hand Opening/ Closing[b]	1	7	12	13	8
	2	7	11	13	9
	3	12	10	14	4
	4	10	8	10	12
	5	11	7	12	10
	6	9	8	13	10
	Total	56	56	74	53

a = model presented six times

b = model presented four times

Appendix F

Instructions For Scorers in Moore and Meltzoff Replication

You will be observing 22 30-second video-tape segments of an infant. In each segment the infant is observing a model which you will not see. The model is presenting one of these four behaviours which I will now demonstrate:

1. Nodding
2. Tongue protrusion
3. Mouth opening/closing
4. Hand opening/closing

You are to rank order your guesses as to which model the infant was watching and trying to imitate.

Ranks

4 = most likely

3 = more likely

2 = less likely

1 = least likely

Appendix G

Table G1

Frequency of Model Presentation in Each Position

	Position			
Model	First	Second	Third	Fourth
Nodding	7	7	6	3
Hand opening/closing	4	7	5	6
Tongue protrusion	5	3	7	9
Mouth opening/closing	7	6	6	5