MIRROR-IMAGE RESPONSES AND THE DEVELOPMENT OF SELF-RECOGNITION DURING THE FIRST TWO YEARS OF LIFE

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE
in
Psychology

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August, 1974

Blacksburg, Virginia

ACKNOWLEDGEMENT

I wish to extend my appreciation to my major advisor, Dr. A. H. Schulman, for his suggestion of the problem and to the other members of my thesis committee for their encouragement, confidence, and patience. Special thanks are extended to Dr. J. A. Sgro for his assistance on statistical matters. In addition, a study such as this one would not have been possible without the understanding and cooperation of the mothers in the University community to whom I am sincerely grateful.

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INTRODUCTION

Different elements of interaction between an individual and his social environment contribute to the development of the self-concept (Cooley, 1902). Mirrors have long been used as a device in the investigation of the self-concept. An atypical social situation is created by the organism's own reflection as a reciprocal social exchange with the reflection is impossible. A child's experience with mirrors may give us some insight into his developing awareness of himself as distinct from others as he learns to recognize what he sees as himself (Dixon, 1957). Verbal indications of self-recognition do not appear until about two years of age with the child's use of his name or self-reference pronouns (Ames, 1952). Even at this time, the child frequently cannot express feelings, desires, and beliefs about himself because too subtle or too complicated a verbal definition is required (Horowitz, 1943). It is for this reason that mirrors are a potential resource in studying the development of the self-concept, or self-recognition. One may easily observe the nonverbal cues of a child reacting to his mirror image.

Mirror Image Studies with Animals

Gallup (1968), in his review of the literature on mirror image stimulation concluded that an animal's own mirror image provides an unusual type of stimulation as it enables the animal to see itself as it is seen by other animals. Gallup stated that many animals are responsive to mirrors, and this responsiveness to the reflected image can be explained in terms of the motivational and social stimulus

properties which have been found to extend across a wide variety of species. Support for this can be found in evidence presented by Zajonc (1965) that the mere presence of other organisms of the same species increases general arousal. Although an organism is instrumental in producing changes in the behavior of the reflected image, most below the phylogenetic level of primates respond as if the image were another animal, thus demonstrating an increase in arousal. This has been shown in studies using male siamese fighting fish (Lissmann, 1932) as well as dogs, cats, and birds (Koffka, 1959).

The second interpretation, taken from Tinbergen (1951), defines a social situation as one in which the responses of one individual serve as stimuli for the responses of another. With a reflecting surface, the animal creates its own social situation as only those responses it makes to its own social stimuli serve as stimuli for further social responding. In reference to primates, Yerkes and Yerkes (1929) found that the mirror image was a useful means of demonstrating social behavior. Yerkes (1927) and Kohler (1927) demonstrated that chimps, gorillas, and orangutans engage in mirror play, yet neither found evidence that these subhuman primates referred their image back to themselves. This has been questioned recently by Gallup (1970), who by putting a spot of red paint on the side of the nose, has shown that chimps are capable of recognizing their image. Feral chimps can be taught to recognize their own mirror images whereas socially deprived chimps and rhesus monkeys seem incapable of such learning.

In addition to social stimulus properties, mirrors have been shown to have reinforcing properties due to their novel source of stimulation.

All movements by the organism are mimicked by the image, allowing for a situation over which the organism has control and in which it is instrumental in producing near maximum stimulus change (Gallup, 1968). This has been demonstrated using siamese fighting fish and fighting cocks (Thompson, 1963 and 1964) as well as preadolescent pigtail and rhesus monkeys (Gallup, 1966) and male squirrel monkeys (MacLean, 1964).

Concerning reinforcement and choice behavior, a preference has been demonstrated in siamese fighting fish (Baenninger, 1966) as well as in goldfish (Gallup and Hess, 1971) to view their mirror images over a conspecific behind glass. With respect to developmental findings, Gallup and McClure (1971) have found that surrogate-reared rhesus monkeys spent more time viewing and interacting with their mirror image than with a conspecific. The opposite was found for feral monkeys. These findings extend the Pratt and Sackett (1967) findings that an animal's own reflection in a mirror may have more attentional value for the social isolate than visual access to a deprived peer. Once again, the opposite was found to be true for feral monkeys. The explanation that is offered by Gallup and McClure is that there is predictability in intraspecific encounters, especially in encounters with comparably reared peers. With mirror image stimulation, the predictability is enhanced. The image never initiates the social encounter, and there is always information with regard to what the "other" will do.

Form Perception in the Human Infant

With human children, the problem of self-identity involves the process of differentiating one's self from the environment and from other persons and forming the concept of "This is me." The common premise of

theorists such as Freud (1949) and Piaget (1954) that the neonate perceives his environment in a diffuse and disorganized manner and only gradually forms sensations into distinct objects has been rejected by most investigators. To date, the prevailing view is that the perception of the infant is qualitatively similar to that of the adult. This implies that various aspects of perceptual functioning are given but that some kind of development takes place (Bond, 1972). The positions taken by perceptual theorists differ with respect to this development.

According to gestalt theory of form perception (e.g., Koffka, 1928), perceptual experience is organized at birth, and the infant is able to perceive form, figures or qualities upon a ground. These primitive elements are not in isolation but are organized into configurations with interacting parts. It is with maturation and learning that more complex configurations are organized, and the perceptual world of the infant grows.

Hebb (1949), in his "building block" notion of the development of form perception, stated that various elements of a stimulus are "picked up" and are gradually integrated into wholes through associative experience. Development is characterized by changes that occur in the linkages and strength of the neural structures.

The explanation offered by Hershenson (1967) is based on the Ames and Silfen (1965) idea that the young infant is captured by stimuli whereas the older infant captures the stimuli by his visual behavior. For Hershenson, development of form perception is viewed as the development of two parallel structures. The first consists of primary elements that gradually interact to form functionally autonomous structures. The

second system is embodied in a shift from obligatory attention to stimuli to greater control over the "attended to" stimuli.

Gibson and Gibson (1955) view perception as the individual's selection, organization, and initial interpretation of sensory impressions. The process of perceptual development, therefore, is one of learning to differentiate distinctive features from the total, undifferentiated visual field. This increased differentiation in perception implies more accuracy and specificity or greater precision in recognizing similaries and differences in physical stimuli. Sophisticated information such as stimuli indicating depth is present at birth, but it is only through experience that the infant learns to use finer details or more cues to differentiate "higher-order" variables (Gibson, 1969). With increased experience and learning and the acquisition of appropriate language labels, the child tends to make finer distinctions among stimuli in his environment as stimili become more distinctive when specific language labels are applied to them. Gibson views the infant, then, not as a passive recipient of information, but as an active seeker.

Form perception for Fantz (1961, 1967) is the complex interplay of innate ability maturation, and learning that take place to mold visual behavior. Acquisition of knowledge can occur without specific changes in response (overt behavior). It may be assumed that information has been taken in through the senses whenever there is a learned change in response tendency, but one is not reducible to the other. Fantz has stated that the importance of visual experience is in the development of the capacity to receive and discriminate stimuli and in the development of the act of attending to a stimulus. He contends that the critical

age for the development of a given visual response is when visual, mental, and motor capacities are ready to be used, and, under normal circumstances, will be used together. If the response is not "imprinted" at the critical age for want of a visual stimulus, development proceeds abnormally, without the visual component.

Kagan (1967b) emphasizes the construction and alteration of internal representation of experience that form a basis for such functions as memory. The newborn's attention will be attracted by a few unique stimulus characteristics, thus forming a bias toward selecting certain kinds of information. This in turn will influence the type of stimuli that are represented. For Kagan, representation is in the form of a schema or internal representation of form. Maximal attention for the infant is elicited by stimuli representing new schemata and by stimuli consisting of small departures from the established schemata.

An all-encompassing view of the development of form perception is not possible as each theory introduces new terms and ideas and emphasizes different aspects of the infant's relationship with his environment. One conclusion that can be made is in reference to the basic visual abilities of the infant. Hershenson (1967) has concluded that there is no evidence to show that the infant does not have the basic visual abilities necessary for form perception.

Bond (1972), in her review of the literature on form perception in the infant, found that the research fell into two main categories, visual scanning patterns and response to pattern characteristics. With respect to the former, Bond concluded that the infant responds selectively to elements of form from birth. Examination of more extensive portions of a

figure through active scanning develop with age. This quantitative change partially depends upon the maturation of the ability to scan with facility in different directions.

Studies concerned with the second category, response to pattern characteristics, investigated areas such as pattern preference, the novelty-familiarity dimension, complexity and contour, and interest in faces. In all studies, assessment of the infant's interest was the visual looking response or visual fixation. Observations by Fantz (1966) have suggested that, if the direction and maintanence of the gaze are related to the visual characteristics of what is being fixated, then it may be assumed that these characteristics can be seen. When the position is varied and the same response is made, a visual preference is defined. Objects come into awareness or are attended to by the infant first in terms of immediate threat or gratification before they become connected or associated to things.

Bond's review of studies concerned with pattern preference clearly indicated that infants from one day to at least six months old prefer to look at patterned rather than plain surfaces. The novelty-familiarity dimension was viewed by Bond as a function of stimulus repetition or the length of time a stimulus is exposed and stated that studies concerned with this component were important from two viewpoints relevant to the present discussion. The first involves the finding of Lewis (1970) that the phenomenon of response decrement to a repeated stimulus may be indicative of an early cognitive process. This interpretation can be made only in cases where satiation due to receptor or effector fatigue can be ruled out. If an infant decreases his response to a stimulus that is

repeated, he must in some way recognize or remember it. Investigators have shown that, in general, habituation to a repeated stimulus occurs in infants and children from two months of age (Fagan, 1970; Fantz, 1966; Lewis and Goldberg, 1969), although it has been shown to occur in a small group of infants from six to 12 weeks of age (McGurk, 1970). Ames (1966) and Fantz (1964) have found greater response decrement with older as compared to younger subjects.

The second source of information in studies using stimulus repetitions concerns the effects of stimulus dimensions. Caron and Caron (1968, 1969) and Ames (1966), using infants from 5.5 to 14 weeks old, demonstrated that the magnitude of response decrement depended on both the age of the subject and the complexity or amount of contour of the stimulus.

Early studies relating infants' responses to visual stimuli to complexity of the patterns used demonstrated that infants generally preferred patterns with the greatest amount of contour (Berlyne, 1958) and that the infant's initial pattern preference changed toward a preference for complexity (Fantz, 1958). The evidence to date points to an age related preference for complexity whether it is defined as the number of elements in the stimulus (Fantz, 1966) or the number of light-dark transitions in a checkboard stimulus (Hershenson, 1964) as older subjects when compared to younger ones demonstrated a preference for more complex stimuli (Brennen, Ames, and Moore, 1966; Thomas, 1965).

Bond, in summarizing the results of complexity studies employing shapes varying in number of turns (angles), has concluded that a developmental shift in preference may possibly be predicted as older children

prefer a larger number of turns while those under nine months of age prefer a relatively large number but not the largest in the series. Fixation time has been shown to be related to the amount of contour, a measure defined as the summation of the lengths of the light-dark transitions horizontally and vertically over the whole pattern (McCall and Kagan, 1967; McCall and Melson, 1970; Salapatek and Kessen, 1966). According to Salapatek and Kessen (1966), visual areas of the cortex are responsive to contour edges in particular spatial orientations. The longer attention to stimuli with contours is the result of a biological characteristic of the central nervous system (CNS). Stimuli that have a high degree of contour and movement will hold the attention of infants two to three months old, and it is for this reason that Hubel and Weisel (1962) have suggested that infants have been found to focus attention on their mothers' eyes.

Investigators of form perception have long been interested in the facial characteristics which elicit interest in the very young and how this interest changes with age. Although Spitz and Wolf (1946) reported that infants less than 20 days old did not smile at a human face, others have shown that infants from birth to one month old will respond (fixate the stimulus) to a live face (Stechler and Latz, 1966) or to a schematic face (Fantz, 1963; Thomas, 1973). Several investigators have failed to demonstrate a preference in neonates for different arrangements of photographic faces (Hershenson, 1965), drawings of faces (Hershenson, Kessen, and Munsinger, 1967) or schematic faces (Fantz, 1966).

While Wolff (1963) reported that, from one to two months of age, smiling is elicited by nodding of and eye-to-eye contact with a human

face, it was also shown that a simple dot or angle pattern (Ahrens, 1954) or a rotated black and white sectored disk (Salzen, 1963) would also elicit smiling at this age. Therefore, it is not possible to conclude that Wolff's subjects were responding to the facial features themselves, but it has been suggested (Ahrens, 1954; Fantz, 1967; Watson, 1966) that infants of two to 4.5 months respond to and prefer certain arrangements of features (i.e., upright or 0 degree faces).

Observations by Fantz (1967) have suggested that infants two to three months old fixate longer on a real schematic face as opposed to a scrambled one, although this finding could not be replicated (Fantz and Nevis, 1967; Koopman and Ames, 1968). It has been demonstrated that infants of four months will show a preference for (Fantz and Nevis, 1967) or will smile more at (Kagan, 1967b) a regular face. Kagan, Henker, Hen-tov, and Lewis (1966) have concluded that, by four months of age, the regular face stands for pleasure because of its association with care and affection from the mother. Further support has been given by studies in which physiological measures were taken on four month old subjects. Fitzgerald (1968) demonstrated that greater pupillary dilation accompanied the presentation of social versus nonsocial stimuli while Kagan et al. (1966) found a large decrease in heart rate with the presentation of a regular face.

Although it has been reported that six month old subjects are able to differentiate between a male and female face (Kagan and Lewis, 1965), two other studies have failed to find differential responding to different facial expressions before seven months of age (Ahrens, 1954; and Wilcox and Clayton, 1968).

The four month old infant, then, can discriminate feature arrangement, although this discrimination may possibly be based on the position of one or more features (Bond, 1972). By eight months of age, the face has become a much firmer schema and is immediately recognized. The frequency of smiling to both the regular and distorted face is equal but reduced (Kagan, 1967a). It would appear then that the general configuration of a face identifies a human being to the young infant whereas, at a later age, a specific person is recognized primarily by more precise perception of his facial pattern. Still later, subtle details of the facial expression tell the child whether the person is happy or sad, friendly or unfriendly (Fantz, 1961; Bower, 1971).

The study of the development of form perception in the infant may be extended to encompass the development of social behavior during the first two years of life. Buhler (1927, 1933), concerned with the age at which an infant realizes the presence of another of the same age, concluded that active seeking of social contact did not occur before six months of age. Infants four or five months old, when placed near each other, often did not become aware of the other's presence. By six months of age, they began to actively look around and attract the attention of the playmate by touching, cooing, and, at times, interfering in his activities. More active physical contact was characteristic of children six to 10 months of age as they began to exchange toys and push or pull their partner.

Observations by Maudry and Nekula (1939) of children six to 25 months old suggested that social behavior occurred in four successive stages. Infants six to eight months old did not differentiate their partner from a toy or play-thing. From nine to 13 months of age, the partner became

an obstacle in the play situation. Although fighting prevailed, special attention to the partner did begin at this stage. A transition period of less fighting and more cooperation was characteristic of the social behavior of children 14 to 18 months old. But it was not until 19 to 25 months of age that the children responded positively to their social contacts, and the partner became a playmate.

The questions of how and when the child learns that "This is me" are still unanswered. Because this is a critical step in the early development and because the infant and young child are not capable of conveying this verbally, nonverbal cues must be observed.

Use of the Mirror in Developmental Scales

It is for this reason that the mirror has been used in developmental scales for almost 45 years. Early attempts were made at gathering information regarding mirror behavior performed by a vast number of children at different age levels (Gesell, 1925). Although this was conscientious effort, the information was of little use in the study of self-recognition.

After studying over 500 children, Gesell and Thompson (1934) believed that children regarded their image as a spurious co-twin as late as five years of life. Shirley (1933) arrived at a similar conclusion.

One of the first investigators to include mirror behavior on a developmental scale (the Merrill-Palmer) without relating it to self-awareness was Stutsman (1931). The child's ability to identify his mirror image was assessed at the second year level, a task satisfactorily completed by 67% of the subjects. Cattell (1940) included mirror behavior on the Developmental and Intelligence Scale at two age levels. The six month old child was expected to reach out and finger his reflection while

the seven month old was given credit for patting and smiling or talking to his reflection.

Mirror Image Studies with Infants

Boulanger-Balleyguier (1964), possibly the first to study the mirror behavior of neonates, found that infants during the first three months of life fixate longer on their mirror image than on moving stimuli, while the reverse was shown for infants of four or five months of age. Self-recognition was reported to be absent over the five successive months.

Papousek and Papousek (1974) employed an elaborate two choice preference design in a pilot study of 11 five month old infants. Each was presented two matching televized images in order to assess the individual factors of the mirror image for the discriminant variables between the images. Papousek and Papousek reported a greater initial preference for eye-to-eye contact in the movie of self than for the TV mirror image but found that interest in the mirror image increased during the course of the experimental manipulation. The interpretation offered by these investigators was that interest in the mirror image emerges from a period of learning from incidental observations of the relation between the infant's movements and those in the mirror image. Reference to self-recognition was never made.

Dixon (1957) observed the mirror behavior of his twin sons and three unrelated singletons from four to 16 months of age. From four to six months, subjects were found to react toward their image as if it were a playmate, but by six or seven months, they attempted to relate the mirror image back to themselves. At nine months, infants began to observe their own hand and arm manipulations while self-admiring or embarrassed (coy)

behavior was shown by 12 months of age. Dixon concluded that true self-recognition took place at this time. Gallup (1971) is in agreement as he found self-recognition to begin at approximately 10 months of age.

Gesell and Ames (1947) observed the mirror behavior of one infant from four to 15 months of age. Social behavior was reported to begin at six months but to decline slightly at eight, at which time the child appeared to relate what he saw to himself as he began to observe his own manipulations. Self-admiring or embarrassed behavior was shown by 12 months of age. Gesell and Ames concluded that their subject showed both interest in the personal (himself and the experimenter) and a growing sense of social awareness but made no reference to self-recognition.

Observations by Amsterdam (1972) of children between the ages of three and 24 months suggested that infants of six to 12 months react to their image as if it were a sociable playmate. Avoidance of and withdrawal from the mirror image was observed by the second year of life, accompanied by self-admiring and embarrassed behavior starting at 14 months and lasting until past 20 months. Self-recognition was reported to have been demonstrated by 65% of the subjects aged 20 to 24 months.

The general purpose of the present work is to study the phenomenon of mirror behavior during the first two years of life. This age interval was selected in view of the results of studies indicating that very young infants are capable of perceiving form as well as those studies indicating that verbal identification of self-recognition is not yet well developed in the two year old child.

The more specific purpose of this work is to relate the existing data on infants' responses to pattern characteristics to the reactions

of young children to their mirror images in order to assess the trend of mirror behavior in the first two years of life and to determine whether there is a relationship between these behaviors and the development of self-recognition.

The use of distorted and occluded mirrors will be employed in this study in light of the findings concerning response to pattern characteristics studies reviewed by Bond (1972). It was suggested in this review that infants of at least six months of age prefer patterned over plain stimuli and that most infants, particularly older ones, prefer complexity (and contour). With respect to the novelty-familiarity component, infants were found to show habituation to the familiar, but it was also stated that habituation depended on age (and experience) and the complexity of the stimulus. Rapid habituation may possibly be shown to the familiar or plain mirror by older infants or by those accustomed to viewing themselves. Pattern preference, complexity, and novelty may be associated with both responses to the plain mirror (by infants not accustomed to viewing themselves) and to the distorted mirror (by older or more experienced subjects). In addition, the finding that infants over four months of age respond to and prefer certain arrangements of features may also differentially influence the response to the familiar or plain mirror.

METHOD

Subjects. A sample of approximately 90 children aged one to 24 months was solicited by mail on a voluntary basis from a middle class population of the local community. All children lived with both parents, 75% of whom were connected in some way with the University. Mothers were requested to dress their children in white or light colored clothing so as not to distract attention from their faces and to bring a favorite toy for their child should he (she) become upset or frightened upon entering the testing room.

A pre-study interview was conducted by telephone one week after the original letter was sent. At that time, such information as the child's exact age, his reactions to other people and degree to which he might cooperate was ascertained.

A post-study interview consisted of a short, one page questionnaire that was answered by the mother upon completion of the trial. Because this study was concerned with perception, any history of visual impairment was recorded. A total of 77 children participated in the study, but three were eliminated due to familial congenital eye problems and two cried vigorously, reducing the sample to 72 subjects of which 39 were males and 33 were females. All children were white with the exception of one American Indian and one East Indian.

Apparatus. The apparatus used for this study consisted of two identical mirrors, 38.1 cm x 30.5 cm, with one cracked and slightly bent to give a somewhat distorted effect. The mirrors were large enough for the average 12 month old child to observe the upper third of this body when standing at the distance of approximately 30.5 cm. Half of each

mirror (divided vertically) was covered with translucent contact paper enabling the subject to observe a blurred image and affording him four different conditions of exposure. The mirrors were placed side by side and held firmly by small metal brackets on a pegboard, 91.4 cm x 91.4 cm, mounted on a wall at floor level. The height of the mirrors was adjusted to the height of the subject who either stood, sat unaided, or was strapped into an infant seat in front of the mirrors. The spatial position of the mirrors was varied systematically. When not in use, the mirrors were covered with a white cloth enabling the experimenter to record the initial response of each subject to the mirrors and all subsequent behaviors. Sony video tape equipment (Portapack model AVC 3400) was used to record all behaviors during the trial. The video camera was held by the experimenter approximately three meters behind the subject and slightly over his head in order to record eye position in the mirrors.

Procedure. All subjects were brought to the testing room by their mothers. The room, 4.15 m x 5.5 m, was painted white and beige and was empty except for a chair and the video equipment which was set on a large desk.

Each subject received one three-minute trial scheduled between the hours of 8:30 AM and 11:30 AM at the mother's convenience. A two-minute adaptation period allowed the child to become accustomed to the experimenter and to the testing room. During that time, the experimenter explained to the mother her role in the study. The mother was then asked to put a spot of rouge on the child's nose, a device which helps

to focus attention on the face and which serves as a point of reference for evaluating self-recognition in the mirrors (Amsterdam, 1972).

At the end of the adaptation period, the mother was instructed to bring her child to the mirrors, have him face them but not stand in front of a particular one. She then moved to one side, away from the apparatus. The position of the mother with respect to her child was varied from subject to subject. She was then asked to remove the cover from the mirrors, at which time the trial began.

It was only when the child lost interest or became restless that the mother was allowed to intervene. She was instructed to ask her child, "Who's that in the mirror?", "Where's baby?", or "Where's (child's name)?" and to point in the direction of the mirrors but not to one in particular as it was important for the child to show his preference. If the child wandered from the apparatus, his mother was to retrieve him. If he cried, the trial was stopped until he was ready to resume observing. If he turned to look at the experimenter and video camera, the mother was asked to turn the child so that he once again faced the mirrors.

It was important for the mother to understand that she do nothing to draw attention to herself in any way. Her role in the study was to keep the child's attention on the mirrors during the three minute video taped trial.

A modification of Amsterdam's (1968, 1972) mirror behavior checklist was used to catergorize the 34 possible behaviors. A brief definition of each behavior is found on the following page. The four "simple" mirror behaviors are listed first, followed by the remaining 30 arranged

in the order of their expected sequential appearance according to Amsterdam.

Plain Mirror (PM) - observes image in plain mirror - scored as PM

Cloudy Plain Mirror (CPM) - observes image in cloudy half of plain mirror - scored as CPM

Distorted Mirror (DM) - observes image in distorted mirror - scored as DM

Cloudy Distorted Mirror (CDM) - observes image in cloudy half of distorted mirror - scored as CDM

No Interest (NI) - does not observe image; focuses on mother or experimenter; plays with frame, clothing, or body; walks away from mirror to explore test room - scored as NI

Social Behavior (SB) - smiles, laughs, coos, talks, kisses, playfully touches image - scored as PMSB, CPMSB, DMSB, and CDMSB

Observes Bodily Manipulations (OBM) - observes own image as subject moves part of it; alternately focuses on image and body as subject moves part of it; focuses on hand on mirror and image of it - scored as PMOBM, CPMOBM, DMOBM, and CDMOBM

Searching Behavior (SrB) - searches for image; reaches into mirror; looks over, under, or behind mirror; looks between frame and mirror - scored as PMSrB, CPMSrB, DMSrB, and CDMSrB

Puzzled Behavior (PB) - appears puzzled or confused; touches experimentally - scored as PMPB, CPMPB, DMPB, and CDMPB

Avoidance Reaction (AR) - cries, hides, withdraws from mirror; avoids image - scored as AR

Admires Image (AI) - glances coyly, blushes, preens, appears to admire, clowns, giggles; appears embarrassed - scored as PMAI, CPMAI, DMAI, and CDMAI

Observes Nose (ON) - behaviors involving subject's observing rouge on nose; moving toward mirror to see nose; focusing eyes downward; pointing, touching, or wiping off rouge from nose - scored as PMON, CPMON, DMON, and CPMON

Recognition (Rec) - says name or "me"; points to self - scores as PMRec, CPMRec, DMRec, and CDMRec

RESULTS

Upon completion of the 72 three-minute trials, the experimenter rated the duration, in seconds, of each behavior for each subject. Ten behaviors were found not to occur and were therefore eliminated. These included CPMOBM (cloudy plain mirror observes bodily manipulations), CDMOBM (cloudy distorted mirror observes bodily manipulations), CPMSrB (cloudy plain mirror searching behavior), CPMAI (cloudy plain mirror admires image), CDMAI (cloudy distorted mirror admires image), CDMON (cloudy distorted mirror observes nose), CPMRec (cloudy plain mirror recognition), DMRec (distorted mirror recognition), CDMRec (cloudy distorted mirror recognition), and CPMPB (cloudy plain mirror puzzled behavior). Seven other behaviors were eliminated as they were exhibited by only one or two subjects - CPMSB (cloudy plain mirror social behavior), CDMSB (cloudy distorted mirror social behavior), DMOBM (distorted mirror observes bodily manipulations), CDMSrB (cloudy distorted mirror searching behavior), DMAI (distorted mirror admires image), CPMON (cloudy plain mirror observes nose), and CDMPB (cloudy distorted mirror puzzled behavior). In addition, six other mirror behaviors were eliminated as analyses on these behaviors were not possible due to the small number of subjects who performed the behaviors at each age level (maximum = 5 subjects). These included CDM (cloudy distorted mirror), PMOBM (plain mirror observes bodily manipulations), PMSrB (plain mirror searching behavior), and DMSrB (distorted mirror searching behavior), PMPB (plain mirror puzzled behavior), and DMON (distorted mirror observes nose).

With the exception of three plain mirror behaviors and five distorted mirror behaviors, all other excluded behaviors involved responding to the cloudy or blurred image. A total of 11 mirror behaviors remain.

Subjects were then divided into four six-month age levels: one to six months, seven to 12 months, 13 to 18 months, and 19 to 24 months of age.

Reliability data were obtained on one-third of the sample, or a total of 24 subjects chosen at random. The age range of these subjects was the same as that of the total sample. Correlations between two observers were calculated for the number of times each behavior occurred and for the duration, in seconds, of each behavior of each of the 24 subjects of the sample. Appendix 1 indicates that reliability coefficients for frequency ranged from .88 to 1.00 with 93% ranging from .90 to 1.00. Response duration reliabilities ranged from .75 to 1.00 with 87% ranging from .90 to 1.00. It was not possible to obtain a coefficient for two behaviors as one observer did not score their occurrence for these 24 subjects; therefore, it would not be possible to conclude that there was agreement on these two measures. The experimenter's ratings were used in all cases of discrepancy.

Initial analyses were done to assess the general kind and amount of activity taking place during the trial. In all analyses, sex was a nonsignificant factor ($p > .05$).

Kind and Amount of Activity

Each infant was scored for the number of seconds he performed each behavior. Table 1 indicates the number as well as the percentage of subjects in each age group who performed the various behaviors.

A significant age effect for NI (no interest) was revealed by an Analysis of Variance, $F=5.84$, $df=3/64$, $p < .01$, and a Duncan's New Multiple Range Test using unequal n's (Winer, 1962, p. 101) found the difference to lie between the first two six-month age groups and the fourth. The frequency of performing the NI behavior for the first two groups was approximately 1.5 times as great as that for the fourth group. It was also found that the pattern of responding for most subjects consisted of a single mirror behavior followed by NI, a chain of one mirror behavior (r=1). Table 2 summarizes the frequency of occurrence of sequences of one or more mirror behaviors followed by NI as a response pattern at each age level. It can be seen that 92.5% of responding of r=1 was characteristic of the youngest subjects while 74% to 80.6% of responding as such was noted for older subjects who, in addition, more frequently performed two or more different mirror behaviors consecutively (r=2, 3, 4, or 5). Sequences of more than five different mirror behaviors terminating with NI were never found.

Table 3 summarizes the mean number of different behaviors performed at each age level: A significant age effect was revealed by an Analysis of Variance on the number of different behaviors (maximum = 11) performed at each of the four six-month age intervals, $F=16.5$, $df=3/64$, $p < .01$. Duncan's test indicated a significant difference between each of the first three age groups and the fourth, the means of these groups increasing with age. In addition, the probability that a behavior observed in one age group and then was observed in the successive age group was 1.00 as can be seen from Table 1. This indicates that there is a progressive continuity of the mirror behaviors shown across age

TABLE 1

NUMBER AND PERCENT OF SUBJECTS SHOWING BEHAVIORS BETWEEN 1 AND 24 MONTHS

Age Level 1	PM	CPM	DM	NI	PMSB	DMSB	DMPB	AR	PMAI	PMON	PMRec
(1 to 6 mos)	12	1	9	12	1						
N = 12	100%	8%	75%	100%	8%						
Age Level 2											
(7 to 12 mos)	20	3	17	20	9	9	4	3			
N = 20	100%	15%	85%	100%	45%	45%	20%	15%			
Age Level 3											
(13 to 18 mos)	18	4	16	19	10	8	7	10	3	2	
N = 19	95%	21%	84%	100%	53%	42%	37%	53%	16%	11%	
Age Level 4	21	10	21	21	5	3	8	12	15	13	11
(19 to 24 mos)	100%	48%	100%	100%	24%	14%	38%	57%	71%	62%	52%
N = 21											

TABLE 2

FREQUENCY OF OCCURRENCE OF SEQUENCES OF 1 OR MORE MIRROR BEHAVIORS FOLLOWED BY NO INTEREST AS A RESPONSE PATTERN AT EACH AGE LEVEL
(r = MIRROR BEHAVIOR CHAIN)

Age Level	No. of Responses	r=1	%	r=2	%	r=3	%	r=4	%	r=5	%
1 (1 to 6 mos)	133	123	92.5	7	5.3	2	1.5	1	.7	0	0
2 (7 to 12 mos)	266	208	78.1	39	14.7	9	3.4	4	1.5	6	2.3
3 (13 to 18 mos)	248	200	80.6	31	12.5	11	4.4	3	1.2	3	1
4 (19 to 24 mos)	281	208	74.0	46	16.4	15	5.3	4	1.5	8	2.8

TABLE 3

MEAN NUMBER OF DIFFERENT BEHAVIORS PERFORMED AT EACH AGE LEVEL

Age Levels	Means
1 (1 to 6 mos)	3.10
2 (7 to 12 mos)	4.95
3 (13 to 18 mos)	6.10
4 (19 to 24 mos)	7.40

levels. The developmental trend is thus the addition of new, more complex mirror behaviors and not the elimination of the earlier, simple behaviors.

An index of activity, consisting of the number of transitions made from one behavior to the next, was determined for each child in order to assess how active subjects were during the three-minute trial. A greater number of transitions would indicate greater activity as a subject would frequently be changing behaviors. Table 4 summarizes the mean number of transitions performed at each age level. An Analysis of Variance revealed a significant age effect for the number of transitions for the four age levels, $F=11.94$, $df=3/64$, $p < .01$. The results of Duncan's test indicated that the mean number of transitions for each of the first three groups differed significantly from that of the fourth group. Also, an Analysis of Variance performed on the total time, in seconds, that each subject engaged in mirror behavior, revealed a nonsignificant age effect, $F=1.88$, $df=3/64$, $p > .05$. The NI (no interest) and AR (avoidance reaction) behaviors were not included in this analysis. Thus, the oldest group was more active than the other groups (i.e., showed more response variability).

Mirror Behaviors Characteristic of Specific Age Groups

Analyses of Variance were performed on PM (plain mirror) and DM (distorted mirror) as only these variables had substantial durations, in seconds, at each age level. Because several of these durations were below 10, a square root transformation ($Y'ij = \sqrt{Yij+.5}$) was used (Myers, 1966, p. 64). No age differences for PM ($F=2.45$, $df=3/64$,

TABLE 4

MEAN NUMBER OF TRANSITIONS PERFORMED AT EACH AGE LEVEL

Age Levels	Means
1 (1 to 6 mos)	23.1
2 (7 to 12 mos)	31.3
3 (13 to 18 mos)	29.8
4 (19 to 24 mos)	34.8

$p > .05$) or DM ($F=1.72$, $df=3/64$, $p > .05$) were found, suggesting that neither of these changes with age.

The χ^2 test was performed on all 11 behaviors in order to assess the occurrence of these behaviors in the first two years of life. Wherever possible, the four six-month age levels were used.

Table 5 summarizes the frequency of occurrence of the plain and distorted mirror behaviors in the four six-month age levels. The χ^2 test reveals no significant age differences for the two mirror behaviors. Once again, this suggests that these behaviors do not change with age. In addition, Table 6 summarizes the frequency of performing both the plain and distorted mirror behaviors by subjects in each of the four age levels. The χ^2 test reveals no significant age differences indicating that one condition of exposure was not preferred over the other.

Table 7 summarizes the number of subjects, grouped at six-month intervals, who performed four specific mirror behaviors. Significant age effects were revealed by the χ^2 test for CPM (cloudy plain mirror), $\chi^2=8.63$, $df=3$, $p < .05$; PMSB (plain mirror social behavior), $\chi^2=8.52$, $df=3$, $p < .05$; DMSB (distorted mirror social behavior), $\chi^2=11.19$, $df=3$, $p < .05$; and AR (avoidance reaction), $\chi^2=17.14$, $df=3$, $p < .001$. Partitioning of the contingency tables (Castellan, 1965) indicated a significant variation between the first three age groups and the fourth for CPM ($\chi^2=8.09$, $df=1$, $p < .01$), between the first two groups for PMSB ($\chi^2= 4.45$, $df=1$, $p < .05$) and DMSB ($\chi^2=7.75$, $df=1$, $p < .01$), and between the third group and the other three for AR ($\chi^2=9.84$, $df=1$, $p < .01$).

TABLE 5

FREQUENCY OF OCCURRENCE OF PLAIN AND DISTORTED MIRROR BEHAVIORS IN THE 4 AGE GROUPS (1 to 6 mos., 7 to 12 mos., 13 to 18 mos., and 19 to 24 mos.)

Age Levels	1 (N=12)	2 (N=20)	3 (N=19)	4 (N=21)	χ^2
Number of Ss who performed PM	12	20	18	21	2.74 (NS)
Number of Ss who performed DM	9	17	16	21	4.74 (NS)

TABLE 6

FREQUENCY OF PERFORMING BOTH PLAIN AND DISTORTED MIRROR BEHAVIORS IN THE 4 AGE GROUPS (1 to 6 mos., 7 to 12 mos., 13 to 18 mos., and 19 to 24 mos.)

Age Levels	1 (N=12)	2 (N=20)	3 (N=19)	4 (N=21)	χ^2
Number of Ss who performed PM	12	20	18	21	.34 (NS)
Number of Ss who performed DM	9	17	16	21	

TABLE 7

FREQUENCY OF OCCURRENCE OF 4 MIRROR BEHAVIORS IN THE 4 AGE GROUPS
(1 to 6 mos., 7 to 12 mos., 13 to 18 mos., and 19 to 24 mos.)

Age Levels	1 (N=12)	2 (N=20)	3 (N=19)	4 (N=21)	p
Number of Ss who performed:					
CPM	1	3	4	10	$<.05$
PMSB	1	9	10	5	$<.05$
DMSB	0	9	8	3	$<.05$
AR	0	3	10	12	$<.001$

The χ^2 test performed on the four six-month age levels did not indicate a significant age effect for four additional mirror behaviors. The subjects were therefore re-grouped into two year age levels. Table 8 summarizes the number of subjects who performed these four additional behaviors at each of the two year age levels. Significantly more subjects in the older age group performed these four behaviors; i.e., reliable age differences were revealed by the χ^2 test for DMPB (distorted mirror puzzled behavior), $\chi^2=4.62$, df=1, $p < .05$; PMAI (plain mirror admires image), $\chi^2=19.64$, df=1, $p < .001$; PMON (plain mirror observes nose), $\chi^2=14.13$, df=1, $p < .001$; and PMRec (plain mirror recognition), $\chi^2=8.59$, df=1, $p < .01$. Although small expected frequencies prevented χ^2 analyses of differences between the four age levels (Siegel, 1956, p. 46), it was found that performance of PMAI and PMON began in the third age level with two or three subjects exhibiting the behaviors. More than half of the subjects in the fourth age level performed PMAI and PMON. PMRec was not shown until the fourth age level when more than half of the subjects exhibited the behavior.

TABLE 8

FREQUENCY OF OCCURRENCE OF 4 MIRROR BEHAVIORS IN THE 2 AGE GROUPS (1 to 12 mos. and 13 to 24 mos.)

Age Levels	1 (N=32)	2 (N=40)	p
Number of Ss who performed:			
DMPB	4	15	$<.05$
PMAI	0	18	$<.001$
PMON	0	15	$<.001$
PMRec	0	11	$<.01$

DISCUSSION

The purpose of this study was to assess the reactions of young children to a variety of mirror images in order to assess the trend of mirror behavior in the first two years of life and to determine whether there was a relationship between these behaviors and the development of self-recognition.

The children participating in this study were to number between 80 and 88, divided into eight three-month age groups with equal numbers of males and females in each. Because it was not possible to obtain subjects through an agency or clinic, the number of available children between the ages of one and 24 months in the local community was limited. Thus, four six-month age levels with an unequal distribution of subjects were used although the eight three-month groups would have provided for a more sensitive measure and therefore, would have been preferred.

Kind and Amount of Activity

Several developmental trends were noted in the kind and amount of activity exhibited by the subjects during the three-minute trial. Younger subjects exhibited fewer mirror behaviors (Table 3), spent more time (in seconds) at each (Table 4), and showed NI more often ($p < .01$) than older subjects who exhibited a larger variety of mirror behaviors (Table 3), spent less time at each, and changed behaviors more frequently by older subjects ($p < .01$). Because the two negative or non-observing behaviors (NI and AR) were performed by the youngest and oldest groups respectively, the total time spent in positive mirror behaviors was approximately equal for the age levels. Most subjects performed the NI

behavior after each mirror behavior, although the younger one exhibited this pattern of one mirror behavior followed by NI (r=1) more frequently than the older ones who were found to perform two or more mirror behaviors (maximum=5) before losing interest in the mirrors (Table 2).

In summary, the mirror behavior repertoire increases with age as the youngest subjects performed only simple mirror behaviors (PM and DM) and frequently showed NI, while the oldest subjects exhibited approximately seven different behaviors and less NI. This suggests that the early mirror behaviors are not lost but act as a foundation upon which later, more complex, behaviors are built.

Mirror Behaviors Characteristic of Specific Age Groups

The number of subjects who performed each mirror behavior (Table 1) was used to determine the occurrence of these behaviors at each of the two-year age levels or, wherever possible, the four six-month age levels. Twenty-three mirror behaviors were eliminated due to the lack of subjects performing these behaviors.

Concerning the simple mirror behaviors, subjects within each age group behaved consistently and a difference between groups was not found for PM and DM. All subjects performed the PM behavior with the exception of one in the third age group, and at least 75% of the subjects in each of the four groups performed the DM behavior. Once again, this suggests that these behaviors do not change with age. CPM was exhibited by more older subjects (19 to 24 months) than those in the first three age groups. It may be assumed that older subjects, being more mobile and more experienced with mirrors, found interest in the blurred image while exploring the testing situation as the cloudy plain mirror was not too

discrepant from the usual, clear image. The cloudy distorted mirror (including most related behaviors) followed the same response pattern as the cloudy plain mirror (Table 1) but was more discrepant from what these subjects were accustomed to as it was a combination of a distorted and blurred image, and was therefore avoided (not preferred) by most subjects and eliminated from analysis.

Because the patterns of occurrence for PMSB and DMSB were similar, it is possible to conclude that social behavior begins in the second or seven to 12 month age group and declines by the fourth, or 19 to 24 month group. One exception was one six month old subject who performed PMSB. Social behavior was thus most evident among the seven to 18 month old infants, a finding which is in agreement with that of Amsterdam (1968) who reports that social behavior begins by six months of age and continues through the beginning of the second year when other behaviors become more evident. Also in agreement are Buhler (1927) and Gesell and Ames (1947) who have stated that social behavior does not occur before six months of age. Only Dixon (1957) reported social behavior to begin at four months.

Second year subjects were found to exhibit DMPB more frequently than the first year subjects. Those in the first year group who did exhibit the behavior were in the seven to 12 month age group while no subjects younger than seven months were found to exhibit DMPB. It is not surprising that, while PMPB was eliminated due to the lack of subjects performing the behavior, a significant number performed DMPB. The presentation of a cracked and distorted mirror to a young child is, in itself, an unusual experience and the puzzled or fearful reaction is understandable. This

suggests that subjects may have responded to the novelty aspect (distorted mirror) instead of to their image because responding to the plain mirror (PMPB) was reported by Amsterdam (1972) to have occurred in 25% of her subjects.

The response pattern of infants in their second year of life was found to be dimorphic as both a negative mirror behavior (AR) and positive ones (PMAI and PMON) were performed by these subjects. It is possible that this is a transitional stage for those subjects who are beginning to experience self-recognition.

AR was performed by over half of the subjects comprising the third and fourth age groups while only a small percentage of the subjects in the second group exhibited this behavior. This finding is in agreement with Amsterdam's (1972) finding that AR begins in the second half of the first year and continues through the second half of the second year when it is most evident. The performance of AR by the older subjects suggests that they are beginning to experience self-recognition as they are relating what they see in the mirror to themselves. It is possible that this is a frightening or uncomfortable stage for children as they avoid viewing themselves in the mirror. Lewis's (1970) explanation of disinterest due to the habituation to a repeated stimulus (viewing themselves) is not a totally satisfactory explanation for the avoidance reaction of children 13 to 24 months of age to their mirror image. The result of habituation may simply be disinterest in viewing the image as represented by NI, and not the fearful withdrawal from or avoidance of the image as AR was defined to be. In summary, self-recognition begins with AR and

is developed in the subsequent mirror behaviors all of which involved responding to the plain mirror.

PMAI and PMON were first shown in the third age group (13 to 18 months) but were most evident among subjects of 19 to 24 months of age. Once again, this agrees with Amsterdam's (1972) finding that subjects in their second year of life admire their image and focus on the spot of rouge on their nose, both of which are signs of recognition.

Recognition of the mirror image occurred among 52% of the subjects in their second year or those 19 to 24 months of age (Table 1). Amsterdam (1968, 1972) reported similar results while both Dixon (1957) and Gallup (1971) stated that recognition occurred within the first year of life. The present finding lends support to Amsterdam.

The consistent agreement of the present study with the work of Amsterdam (1968, 1972) is not surprising as the latter formed the basis for this study. Similar procedures, including putting a spot of rouge on the subjects' nose and using the mirror behavior checklist to guide the observation of specific behaviors, allowed for clear and consistent observations as well as definitive results.

Response to Pattern Characteristics

As stated earlier, the use of distorted and occluded mirrors were introduced in this study in light of the results reported by Bond (1972) concerning infants' responses to pattern characteristics of form. A noticeable result of the present work was that the cloudy mirrors were not preferred by most subjects, suggesting that the more distinctive and detailed image was more interesting and preferred. Evidence to this effect have also been cited by Bruner (1970). The plain and distorted

mirrors presented a more detailed image and were more preferred by most subjects than the cloudy mirrors, determined by the number of subjects who observed their image and who performed related mirror behaviors.

Because infants in all age groups were found to observe their image in both the plain and distorted mirrors and not show a preference for one over the other while the frequency of such observations and the number of related PM and DM behaviors increased with age, it would not be possible to conclude that the pattern preference and complexity associated with the human face are age related. Both mirrors presented a patterned image, a regular face versus one with slightly distorted facial features, and both mirrors presented varying degrees of complexity, defined here as the size and shape of the facial features; yet, neither mirror image was more preferred. This finding supports Fantz's (1961) observation that infants are responsive to general facial characteristics. The results of form perception studies concerning pattern preference and complexity (Bond, 1972) were not truly assessed in this study as subjects were presented with their own face only and not with controlled facial stimuli.

Assessment of the novelty-familiarity dimension and interest in faces indicated that interest in viewing one's own face does not change with age and is not subject to rapid habituation. The infant's face is not familiar in the sense of lacking new interest but is novel as it presents new or renewed interest each time it is observed, whether it is observed in a regular mirror (PM) or an irregular one (DM). The Kagan, Henker, Hen-tov, and Lewis (1966) finding that the four month old child prefers the real face as he associates it with maternal care and affection

was not assessed here; yet, it may be suggested that the one month old infant observes his image for its intrinsic interest and would not necessarily, at this young age, associate it with affection. This would suggest that infants may posses an innate facial schema (Ahrens, 1954).

In summary, interest in viewing one's face did not change with age among the one to 24 month old subjects. All performed the simple behaviors of observing themselves while the older one performed more complex (related) behaviors. Neither the plain nor the distorted mirror exposure was preferred suggesting that the infant observes the general configuration of the face for its intrinsic interest. Specific developmental trends were noted in the kind and amount of activity during the first two years of life along with a sequence of behaviors that culminated in self-recognition. This study would therefore, support the view that infants' perception is qualitatively similar to that of adults.

APPENDIX 1

RELIABILITY COEFFICIENTS ON OCCURRENCE AND DURATION OF MIRROR BEHAVIORS FOR 24 SUBJECTS

Mirror Behaviors	Abbreviations	Occurrence	Duration
Plain Mirror	PM	.92	.99
Cloudy Plain Mirror	CPM	1.00	.95
Distorted Mirror	DM	.98	.99
Cloudy Distorted Mirror	CDM	1.00	.98
No Interest	NI	.88	1.00
Plain Mirror Social Behavior	PMSB	.97	.99
Distorted Mirror Social Behavior	DMSB	.98	.99
Plain Mirror Observes Bodily Manipulations	PMOBM	1.00	.75
Plain Mirror Searching Behavior	PMSrB	1.00	.96
Distorted Mirror Searching Behavior	DMSrB	1.00	1.00
Plain Mirror Puzzled Behavior	PMPB	.94	.99
Distorted Mirror Puzzled Behavior	DMPB	1.00	.99
Avoidance Reaction	AR	----	----
Plain Mirror Admires Image	PMAI	1.00	1.00
Plain Mirror Observes Nose	PMON	1.00	.94
Distorted Mirror Observes Nose	DMON	.94	.86
Plain Mirror Recognition	PMRec	----	----

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MIRROR-IMAGE RESPONSES AND THE DEVELOPMENT OF SELF-RECOGNITION DURING THE FIRST TWO YEARS OF LIFE

by

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(ABSTRACT)

Video tape records were made of seventy-seven infants, ranging in age from one to 24 months, as each was exposed for three minutes to four different levels of mirror distortion. A mirror behavior checklist (Amsterdam 1968, 1972) was used to identify 34 possible behaviors. The range and complexity of mirror related activities increases significantly during the first two years of life, culminating in self-recognition by 52% of the subjects aged 19 to 24 months. All subjects responded equivalently to both the plain and distorted mirror images, suggesting that it is the general configuration of the face that holds intrinsic interest at these age levels. The prevailing view that the infant's perception is qualitatively similar to that of the adult was supported by this study.