INFANTS' DISCRIMINATION OF MOVING AND STATIONARY FORM

KAREN LOUISE HARTLEP
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AND STATIONARY FORM

By

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ABSTRACT

INFANTS' DISCRIMINATION OF MOVING
AND STATIONARY FORM

By

KAREN L. HARTLEP
The present study was designed to investigate the infant's ability to conserve the identity of the features of objects in moving as well as stationary forms. Previous researchers (Bond, 1972) have demonstrated that infants can use a wide variety of physical features to discriminate between stationary objects. Further, several of these studies have shown that it is possible to increase the salience of specific stimulus features through training. However, the infant's ability to discriminate between the features of objects in motion, and to recognize them as being the same as the stable forms is a matter for investigation. Bower (1974) concluded from several related studies that infants about 10-weeks of age do not identify a stationary object as being the same object when it moves. However, his experiments do not rule out the possibility that the infant's failure to demonstrate object permanence is due to a lack of attention to perceptual features of the objects, rather than to a deficit in their concept of the object. The present study demonstrated that 10-week-olds are capable of demonstrating featural discrimination with moving stimuli, if training is given to direct the infant's attention to details useful in differentiating the features of objects in their stationary form.

Two objects, a checkerboard cube and a bull's eye sphere, were simultaneously presented in their stable forms to 24 10-week-old infants. Half of the infants were trained to visually fixate the cube, while the remaining infants
were reinforced for visual fixations to the stable sphere. Following this discrimination training with the two stable objects, the objects were set in motion in a generalization test. Infants were able to maintain the discrimination despite the movement of the objects. They were able to respond to the object that they had been reinforced for fixating in the stable form, despite the motion suggesting some recognition, or conservation, of its identity. Bower's (1974) hypothesis that the infant is unaware that movement is the change in position of an object was not supported. The present study suggests results such as Bower's may be due to the infant's inattention to relevant perceptual details.
Infants' Discrimination of Moving and Stationary Form

What the visual world of the infant must be has been the source of prolonged controversy. Does a newborn see the world as does an adult, with relatively stable objects and events, or is it a mass of evanescent shadows or flashing colors, in William James' words, "buzzing confusion" (James, 1950, p.488)? Is the ability to see a stable world innate, or must it be acquired through experience? Research on this question has resulted in support for both sides. Some aspects of an infant's ability to perceive his/her world, such as the ability to perceive depth, or the rapid approach of a moving object (Ball and Tronick, 1971), are fairly sophisticated even in the newborn. Other abilities, such as the recognition of a particular human face (Haaf and Bell, 1967), seem to develop very slowly with practice. Rather than asking if an infant's ability to perceive is innate or acquired, a more appropriate question may be, what are the relative contributions of each, for any specific perceptual discrimination.

Having rephrased the question, Gibson (1970) has suggested that the perceivable world can be divided into two categories. One can perceive events in space, and one can also perceive objects and their features. Events in space include such things as the perception of depth at a drop-off, motion, occlusion, and the appearance or disappearance of objects. Perception of the features of objects includes the ability to recognize or discriminate one object from another.
on the basis of its unique properties such as color, shape, or size. Perception of events requires a different type of vision than does the perception of objects. Events require ambient vision, the general use of the information inherent in ambient light, such as shadows or texture, without the need to focus the eyes. Objects, on the other hand, require focal vision in which the pupil of the eye must be focused directly on the object to be perceived (Trevarthen, 1968). On the basis of her research, Gibson (1970) suggested that events in space are perceived very early by infants and may be said to be relatively innate. However, perception of the featural characteristics of objects develops much more slowly and appears to require considerable learning.

Within each of these two aspects, event perception and object perception, resides a more fundamental issue of precisely what is perceived. What is the effective stimulus? In the perception of an event in space, such as movement, for example, a number of variables are present that specify motion. An infant may rely on the kinesthetic feedback from his/her own eye-movements rather than other cues to movement, such as occlusion. Harris, Cassel, and Bamborough (1974) investigated the infant's perception of motion using a tracking task. In their first experiment 16 infants in each of two age groups, 10- and 16-weeks, were exposed to two stimulus conditions. In one condition a striped cylinder was made to move across a stationary, newsprint-covered screen. In the second condition both cylinder and screen moved at the same
speed and in the same direction. When the object moved, relative to the screen, the infants exhibited smooth tracking behavior. However, tracking was disrupted when both screen and object moved. To show that relative movement was the important variable and not just movement of the background itself, a second study was done. Thirty-six infants, in three age groups, 14-, 21-, and 27-weeks, served as subjects. Each infant saw the same two stimulus conditions as the infants in the first study, plus one new condition. The object and its background screen were moved together at the same speed, but in opposite directions. Infants exposed to this new condition were able to track the object smoothly. Relative motion appeared to be necessary for smooth tracking, indicating infants, at all ages tested, were sensitive to the perceptual cue of successive occlusion of a visual field, specifying a moving object. The experimenters could then label the effective stimulus in this situation, the most salient aspect for the infant's accurate perception of the event. Similarly, in the perception of objects, certain aspects of them may be more salient, more attention-grabbing than others. The infant may notice size, for example, but not color. Size would then be the effective stimulus.

The purpose of the present study will be to examine these two aspects, the perception of events and the perception of objects, as they relate to the infant's ability to perceive and conserve the identity of an object. One criterion of the ability to perceive and conserve the identity
of an object is the ability to recognize the same object in a variety of situations. The degree to which an infant can demonstrate such recognition should indicate which aspects of the situation are most salient for him/her in perceiving his/her world. What role experience may play in determining the salience of these aspects is also a central concern of the present study.

The review of the literature relevant to the present investigation will consist of two parts. First will be several studies concerned with the infant's perception of stable objects. Second, a more complete review of research on infant perception of objects in motion. Throughout both parts special attention will be given to the use of a learning variable for exploring perceptual discrimination.

Fantz (1961) reported some of his experiments on form perception in infants. An apparatus was constructed with a crib inside a "looking chamber" of uniform color and illumination. Attached to the ceiling of the chamber were pairs of test objects that could be exposed to view for brief periods. An experimenter could look through a peephole in the ceiling of the chamber and observe the image reflected in the pupils of the eyes of the infant below, and thereby determine which of the two test stimuli the infant was observing. If the infant consistently preferred one stimulus over another it was assumed that he/she was able to differentiate a difference in form.
In the first experiment (Fantz, 1968), infants of 15 weeks of age were tested at weekly intervals. A group of stimuli were randomly presented including horizontal stripes and a bull's eye design, a checkerboard pattern of plain square, a cross and a circle, and two different triangles. Results indicated that the infants consistently spent looking at various pairs of stimuli. The infants showed the strongest differential for the horizontal stripes and the bull's eye design, the checkerboard and the square. The triangles did not arouse differential interest. Precisely what was meant by complexity was not defined, but it was concluded that, generally, the more complex the visual, the more attention it received. This indicated that the infant was at least capable of perceiving more than light and dark.

Another experiment (Fantz, Ordy, and others, 1969) was conducted to investigate the infant's acuity. First, he/she differentiate the details of patterns. A series of test stimuli were presented. Each pair consisted of a black and white striped pattern and a gray square of the same brightness. The stripes varied in width in order to test one pattern to the next. Since the earlier study showed that infants prefer patterns to plain stimuli, the width of striped pattern that was consistently preferred the gray was a measure of acuity. The preference level of this acuity study indicated that even infants of 16 weeks of age were able to see a $\frac{1}{8}$ inch stripe one inch away.
of an object is the ability to recognize the same object in a variety of situations. The degree to which an infant can demonstrate such recognition should indicate which aspects of the situation are most salient for him/her in perceiving his/her world. What role experience may play in determining the salience of these aspects is also a central concern of the present study.

The review of the literature relevant to the present investigation will consist of two parts. First will be several studies concerned with the infant's perception of stable objects. Secondly, will follow a more complete review of research on infants' perception of objects in motion. Throughout both sections attention will be given to the use of a learning versus a preference paradigm for exploring perceptual discrimination.

**STABLE OBJECTS**

Fantz (1961) reviewed a series of his experiments on form perception in infants. An apparatus was constructed with a crib inside a "looking chamber" of uniform color and illumination. Attached to the ceiling of the chamber were pairs of test objects that could be exposed to view for brief periods. An experimenter could look through a peephole in the ceiling of the chamber and observe the image reflected in the pupils of the eyes of the infant below, and thereby determine which of the two test stimuli the infant was observing. If the infant consistently preferred one stimulus over another it was assumed that he/she was able to differentiate a difference in form.
In the first experiment (Fantz, 1958) infants of 1 to 15 weeks of age were tested at weekly intervals. Four pairs of stimuli were randomly presented including horizontal stripes and a bull's eye design, a checkerboard and two sizes of plain square, a cross and a circle, and two identical triangles. Results indicated that the amount of time an infant spent looking at various pairs of stimuli differed sharply. The infants showed the strongest differential preferences for the horizontal stripes and the bull's eye, followed by the checkerboard and the square. The cross, circle, and two triangles did not arouse differential interest. Without defining precisely what was meant by complexity, Fantz (1958) concluded that, generally, the more complex the pattern, the more attention it received. This indicated that the infant was at least capable of perceiving more than just blobs of light and dark.

Another experiment (Fantz, Ordy, and Udelf, 1962) was conducted to investigate the infant's acuity. How well could he/she differentiate the details of patterns? Several pairs of test stimuli were presented. Each pair consisted of a black and white striped pattern and a gray square of equal brightness. The stripes varied in width in graded steps from one pattern to the next. Since the earlier study had shown that infants prefer patterns to plain stimuli, the finest width of striped pattern that was consistently preferred over the gray was a measure of acuity. The preference data from this acuity study indicated that even infants of less than 4 weeks of age were able to see a 1/8 inch stripe when 10 inches away.
In two other experiments Fantz (1965) examined preferences in terms of what Fantz called "primitive meaning". First, three flat, pink objects the size and shape of a head were presented. On one was painted a stylized face. A second had a "face" with all the same features of the first, but in a scrambled order. The remaining stimulus was painted solid black at one end to cover an area equal to that of the faces on the other two stimuli. Infants across all ages preferred the "real" face to the scrambled face, and largely ignored the control pattern. In the other experiment, the infants were shown to prefer solid spheres to flat circles. The fact that the infant could discriminate flat from solid, 3-dimensional figures, indicates that he/she is capable of depth perception to some degree. That he/she prefers a face to a stimulus with the same features arranged in a scrambled order indicates that the face has some meaning for the infant, and indicates he/she may recognize it as a human face.

Fantz (1963) also investigated the "attention grabbing" effects of color on an infant's perception. Six flat disks, six inches across, were used as stimuli. Three were patterned, a bull's eye, a face, and a patch of newsprint, and three were plain but brightly colored, red, fluorescent yellow, and white. They were presented one at a time against a blue background, and length of the infant's first glance was timed. The face was the most interesting or attention-grabbing, followed by the newsprint and the bull's eye. The three colors trailed far behind and were never the first choice of any infant.
This series of studies indicates that an infant can perceive form. His/her acuity is not as good as that of an adult, but it is, nevertheless, sufficient to insure that he/she is seeing more than evanescent shadows and blurs of meaningless color. He/she prefers complex patterns to plain homogeneous surfaces, regardless of color, solids to two-dimensional surfaces, and faces to any other stimulus tested. As an explanation for these preferences Fantz pointed out the infant is basing his/her perception on cues most likely to remain stable. Color and brightness, for example, change with illumination, outline changes with point of view, but pattern, the texture and arrangement of details, can be relied on to be the same under diverse conditions. At any rate, Fantz (1970) has shown that infants can both resolve and discriminate as well as differentially attend to the visual pattern, or featural characteristics of stationary objects.

There is evidence that lack of a preference in Fantz's results does not necessarily indicate an inability, on the part of the infant, to discriminate. It may be that the child perceives the difference, but has an equal liking for both patterns, staring equally long at both. In such cases an operant discrimination technique might prove useful in separating lack of preference from inability to discriminate.

Using infants 7 to 12 weeks of age, in a Fantz-like preference test, McKenzie and Day (1971) demonstrated the infants had no preference for horizontal versus vertical striped patterns. The orientation of the stripe made no
difference in the length of the infant's visual fixation to either pattern. The experimenters then used an operant technique to teach the infants to respond with a left head turn to one of the striped patterns, and a right turn in the presence of the other pattern. Infants were able to learn this discrimination, indicating an ability to perceive the orientation of the stripes, despite a lack of preference for the horizontal or the vertical. Fantz's (1961) technique can be used to show what an infant prefers to fixate. An operant discrimination technique can shed further light on this same perceptual problem by demonstrating what the infant is capable of seeing.

A second operant procedure that has provided unique information for perceptual researchers is that of generalization. If a subject is trained to respond in a particular stimulus situation, his/her response should, theoretically, "generalize" to other stimulus situations. That is, it will tend to occur in other situations besides the original training environment. Situations the infant perceives as being most like the original training situation should elicit more responding, greater generalization, than those the infant perceives as being very different from the original. The experimenter may systematically change the original stimulus along various dimensions and, by observing the infant's response rates to each change, determine which dimensions are the more salient, or noticable for the infant.
Bower (1964) used the operant technique of generalization to investigate size constancy and the perception of distance in infants between the ages of 2 and 20 weeks. The infant was placed in a padded infant seat and trained to make a head turning response. A head movement of a few degrees to the right or left was sufficient to close a micro-switch embedded in the padding of the seat. Reinforcement consisted of a brief exposure to a smiling adult experimenter, in a variation of the "peek-a-boo" game often played with very young infants. This reinforcer was shown to be capable of maintaining the response rate of infants as young as two weeks for as many as 400 responses without apparent fatigue (Bower, 1966b). In the first experiment the infants were trained to make this response on a variable-ratio 5 schedule of reinforcement, only in the presence of a white stimulus cube that was 12 inches on a side and placed 3 feet from the child's eyes. After an hour of such training the perceptual abilities of the infants were tested using a generalization procedure in extinction. Three new stimuli were introduced, a 12 inch cube placed 9 feet away, a 36 inch cube placed 9 feet away, and a 36 inch cube placed 3 feet away. The originally conditioned stimulus and these three new stimuli were presented to the infant for four 30-second periods, in a counterbalanced order, and the number of responses the infant made to each was recorded.

It was assumed that the conditioned stimulus would elicit the most responses, but the number of responses made
to the other three stimuli would reflect the degree of similarity the infant perceived between each of them and the original conditioned stimulus. If the infant had neither size constancy nor the ability to perceive distance, then the 36 inch cube 9 feet away should have appeared most like the conditioned stimulus because they both projected the same size retinal image. If the infant could perceive distance, but did not have size constancy, he/she should have responded more to the 36 inch cube placed 3 feet away. If the infant had size constancy but could not perceive distance, then the 12 inch cube placed 9 feet away should have elicited more responding. Finally, if the infant could perceive distance and had size constancy as well, it was predicted that he/she would respond about equally as often to the 12 inch cube placed 9 feet away, and to the 36 inch cube 3 feet away, whereas the 36 inch cube 9 feet away would elicit the fewest responses. Results indicated an average of 102.7 responses to the conditioned stimulus, 66.03 responses on the average to the 12 inch cube placed 9 feet away, 54.1 responses to the 36 inch cube placed 3 feet away, and an average of 22.93 responses to the 36 inch cube placed 9 feet away. The infant does not appear to rely only on retinal image, but seems to utilize real distance and real size in his/her perception of objects.

A second experiment (Bower, 1965) was designed to discover what particular cues the infants were using to judge size and distance. Three possibilities were examined; 1) binocular parallax - the fact that the infant receives a
slightly different view from each eye, 2) motion parallax - the possibility that the infant, by moving his/her head, can pick up slightly different views of an object, and 3) pictorial cues - such as shadows, perspective, coloring, etc. Three groups of infants ages 2 to 20 weeks were tested. One group wore a patch over one eye so that they could not register binocular parallax. A second group, instead of viewing real stimuli, were shown projected slides. These had pictorial cues but lacked both binocular parallax and motion parallax. A third group wore special stereoscopic goggles and viewed stereograms of the various stimuli. This group could utilize binocular parallax and pictorial cues but lacked motion parallax. The training procedure, stimuli, and test procedures were similar to those used in the earlier experiment by Bower (1964).

Results for the group with the eye patch were similar to those of the unrestricted infants in the first experiment (Bower, 1964). The conditioned stimulus, a 30 cm. cube placed 1 m. away elicited an average of 101 responses, a 30 cm. cube 3 m. away, and a 90 cm. cube 1 m. away elicited an average of 60 and 53 responses, respectively, and a 90 cm. cube 3 m. away elicited an average of only 22 responses. The group viewing the slides responded quite differently, however. For this group the conditioned stimulus elicited 96 responses on the average, the 30 cm. cube 3 m. away and the 90 cm. cube 1 m. away elicited an average of 52 and 44 responses, respectively, and the 90 cm. cube 3 m. away elicited an average of 96 responses.
With only pictoral cues, the responses of this group seemed to be determined solely by the projected size of the cubes on the retina. The pictoral cues were not utilized and may not have been detected. The infants wearing the goggles preventing the use of motion parallax differed from the unrestricted infants also. Their responses suggested some size constancy, but less than was shown by the unrestricted infants or by the infants wearing the eye patch. The conditioned stimulus elicited an average of 94 responses, the 30 cm. cube at 3 m. and the 90 cm. cube at 1 m. elicited an average of 44 and 40 responses, respectively, and the 90 cm. cube at 3 m. elicited an average of 32 responses. Thus, according to these results, it appears that motion parallax is the most effective cue to the infant's perception of stable objects at a distance, and for his/her ability to maintain size constancy. Binocular parallax is second in importance in this task. However, pictoral cues do not appear to be utilized by the infant.

This same operant technique was applied by Bower (1966a) in a second series of experiments on shape constancy and slant perception in infants. In these experiments infants were between 50 and 60 days old, and the conditioned stimulus was a wooden rectangle 25 X 50 cm. placed 2 m. away from the infant's eyes, and turned 45° from the frontoparallel plane. The three test stimuli were: 1) the same rectangle placed on the frontoparallel plane, at right angles to the infant's line of sight, 2 m. away, 2) a trapezoid in the frontoparallel
plane that projected the same retinal image as the conditioned stimulus, and 3) a trapezoid placed at a 45° angle to the frontoparallel plane. If the infant could perceive shape constancy it was predicted that stimulus 1), the rectangle, would elicit more responses than the trapezoids in either position. If, on the other hand, retinal shape alone determines the similarity of the test stimulus to the conditioned stimulus, then stimulus 2), the trapezoid in the frontoparallel plane, should be preferred over the rectangle in the frontoparallel plane or the trapezoid at 45°. Results indicated that, while the conditioned stimulus elicited an average of 51 responses, the rectangle in the frontoparallel plane elicited an average of 45.13 responses, and the trapezoids in the frontoparallel plane and at 45° received 28.50 and 26 responses, respectively. Obviously, infants were responding to real shape and not to retinal shape. Moreover, the difference in the average number of responses made to the conditioned stimulus and the average number of responses made to the same rectangle in the frontoparallel plane was not statistically significant. The infants did not appear to be discriminating between orientations of the same object.

Accordingly, a second experiment was designed to see if the infant was capable of differentiating orientation as a cue. Three groups of 50 to 60 day old infants were trained, each with a different set of stimuli. For one group the conditioned stimulus was a rectangle turned 5° from the parallel position. The three test stimuli were the same rectangle
turned 15°, 30°, and 45°. Projective shape and orientation varied, but real shape was held constant. A second group had a trapezoid in the parallel plane as its conditioned stimulus. This trapezoid's retinal image was the same as that projected by the rectangle in the 5° position used as the conditioned stimulus in the first group. The three test stimuli for the second group were trapezoids in the parallel plane that projected retinal images equivalent to those of the three rectangular test stimuli of the first group. Thus, for the second group, real shape and projective shape varied, but orientation was held constant. For a third group the rectangles used with the first group were hidden by a screen with a viewing hole cut into it. The body of each rectangle could be seen, but not its edges. Thus, real shape and projective shape remained constant and orientation alone varied.

Results indicated poorest discrimination among infants in the first group, who tended to respond to all four test stimuli alike, ignoring the orientation differences of the rectangles. Group 2, with the trapezoids, and Group 3, with the partially hidden rectangles, showed very clear discriminations, however, indicating that the infants were capable of utilizing both real shape (and therefore projective shape) and orientation as cues. The poorer performance of the infants in Group 1 is an indication that real shape is a much more salient, or dominant, perceptual cue than either orientation or projective shape. This result is in keeping with the
findings of McKenzie and Day (1971). Their study indicated infants in a Fantz (1961) preference task stared equally long at horizontal striped patterns as they did at vertically striped patterns. Yet these same infants were able to learn an operant discrimination with these two striped patterns. The implication is that, while capable of perceiving orientation, infants are not particularly sensitive to it as a cue.

Using the same operant paradigm, a third and final series of experiments (Bower, 1967a) was conducted to study the Gestaltist principle of completion in infants. In this study 50 to 60 day old infants were conditioned to respond to a black wire triangle with a black iron bar placed across it. Four test stimuli were then presented in the generalization test; 1) a black wire triangle without the bar, 2) a pentagon with a diamond shape at the top, 3) a trapezoid with a small triangle above it, and 4) a wire triangle with a blank space, or gap in it. Each of these four stimuli could have conceivably been constructed from the original conditioned stimulus without the bar across it. However, if the infant were using the principle of completion of a "best form", Gestalt theory would predict that the plain wire triangle, test stimulus 1, would be perceived by the infant as being most similar to the original conditioned stimulus.

Results showed that the infants responded an average of 42 times to the completed wire triangle, stimulus 1. The remaining three test stimuli received an average of 18.25,
16. Assuming none of the infants had had training with triangles previously, Bower concluded the results were due to an innate perceptual organization principle of completion rather than to learning or experience. While one might question this assumption about the infant's experience, the fact remains that infants were capable of making some fine feature differentiations in this study.

In a second experiment infants were presented with projected slides of these same stimuli rather than the triangular objects themselves. Results indicated no particular preferences of the infant for any of the four test stimuli. Again, as in the size and distance experiments, the infants failed to make use of retinal or pictoral cues. Performances instead appeared to depend on cues such as motion or binocular parallax.

In summary, these three sets of studies indicate a number of relevant findings as to what the infant is capable of perceiving as well as what he/she actually seems to utilize (Bower, 1966b). He/she can perceive both size and distance, principally by using motion parallax, but also by utilizing binocular parallax to a degree. He/she does not seem to make use of pictoral cues inherent in the retinal image in his/her perception of size or distance. He/she is able to perceive slant or orientation differences in objects when real shape as well as projective shape is held constant. He/she is also able to perceive real shape and projective
shape when orientation is constant. Yet, he/she is not able to maintain real shape constancy and orientation discrimination at the same time. Real shape becomes the more salient cue. Finally, the infant shows the organizing principle of completion, but only with three dimensional figures, indicating again his/her failure to utilize pictoral cues, at least in his/her perception of the stationary stimuli tested.

Bower (1967b) attempted to determine whether or not infants could maintain existence constancy over various kinds of transformations. An object can be made to appear and disappear in a number of ways, some of which, for adults, signify that the object is still there, while others indicate it has been annihilated. An apparatus was constructed to perform various illusory appearances and disappearances of objects. It consisted of an L-shaped alleyway, both arms of which were identical in color and illumination. The infant was placed so as to view only one of the alley's arms through a half-silvered mirror. The remaining arm could be seen reflected in the mirror, but only when it was illuminated. In addition, a screen of the same material as the alleyway could be dragged across the entrance to either alley arm to hide any objects within.

Twenty infants, ages 49 to 55 days, were trained to make a non-nutritive sucking response on a special pacifier-recorder. Their reinforcement consisted of a 15-second tape recording of a female voice addressing the infant. The infant was then placed in front of the alleyway so as to view
a red and white sphere within one alley arm. The remaining alley arm was not illuminated and thus could not be seen. The infant was trained to make a sucking response only to the sight of this sphere, after which the reinforcement was discontinued and the sphere made to disappear in one of four ways: 1) local, gradual, non-perspective change - the illumination in the original alley was gradually dimmed while that of the second arm was gradually brightened so that it was seen in the mirror. The sphere appeared to dissolve from view; 2) local, sudden, non-perspective change - this resembled the change described in 1), except that the illumination changes in the two alley arms were sudden, the sphere appeared to implode, 3) local, gradual, perspective change - the screen was dragged slowly across the alley until it filled the alley and hid the sphere completely, and 4) local, sudden, perspective change - as in 2), the illumination in the two alley arms was suddenly changed, but, in addition, a screen was already in place filling the second alley arm. A fifth group of infants was left with the sphere as it had appeared in their training sessions. When reinforcement was discontinued this group was allowed to extinguish normally.

Results indicated that the only conditions which elicited any sucking responses were 3), using the slowly moving screen, and 5), the control condition. To Bower this indicated that in gradual, local, perspective changes the infant still believes the object exists and therefore continues responding. However, sudden or non-perspective
effect found for either block or sex, and simple effects tests shed no further light on the interaction obtained. The effect is marginal at best. The lack of an interaction of blocks X sex X groups (F(3,60) = .6651, p = .58024) indicates this result in no way influences the interpretation of the main effect for groups.

In summary, the results of the discrimination testing with stable objects indicated infants were able to respond differentially to the two stationary forms. This result was consistent with the predictions made by Bower's hypothesis and by the hypothesis of the present study. Results of the analysis with data from day 7 indicated infants were able to exhibit discriminative responding when the forms were in motion. This result contradicts the predictions of the study, but supports the hypothesis of the present study. Infants, if trained to attend to relevant featural differences, can indicate recognition of the features of objects that are in motion. Failure to demonstrate recognition of moving objects in Bower's studies may be due to inattention on the infant's part, rather than to a deficit in his concept of the object and its ability to move.

Having shown that recognition of the features of moving forms is possible for 10-week-olds, the various parameters influencing this ability can be investigated. For example, at some point the speed of the movement must affect discriminability. At some point movement must be so
changes meant that the object was no longer there, and thus elicited no further responding.

A replication of this experiment was performed (Bower, 1967b) using heartrate or startle, as a response measure rather than rate of sucking. The assumption was that if changes that are sudden or non-perspective violate the infant's expectations of how an object should act, he/she should show his/her surprize in a change in heartrate. Results, however, showed no particular effects on heartrate for any of the changes. Sucking rate, on the other hand, showed a decrement, but only during gradual, perspective changes. If sucking rate decrement was a measure of surprize, then infants in this study were surprized by gradual, perspective changes, and not by sudden, non-perspective changes such as implosions. These results did not fit well with those of the previous study. Bower hypothesized that the sucking decrement might be due, not to surprize, but to anticipation, on the infant's part. That is, Bower hypothesized that the infant believed the object would reappear, and was waiting for it.

Accordingly, 12 infants from the impermanence conditions of the second experiment received further training. The gradual, perspective change of dragging a screen slowly in front of the sphere was modified. Instead of stopping when it filled the alley, it moved on to re-reveall the sphere. Two total-sphere occlusion intervals of 5 seconds or 15 seconds were also used. These intervals were determined on
the basis of data from the previous study which showed that once the screen had filled the alley and stopped, no infant had resumed sucking before 7 seconds had elapsed, and no infant had taken longer than 11 seconds to resume sucking. It was reasoned that when the stimulus appeared after only 5 seconds infants who were anticipating its reappearance would then begin sucking. With the longer interval it was hypothesized that the infants would either have given up hope or forgotten the sphere by the end of 15 seconds, and would therefore show startle at its reappearance. This hypothesis was confirmed. The reappearance of the sphere after only 5 seconds facilitated the resumption of sucking, while its reappearance after 15 seconds caused a response decrement. This method thus provided an indication of existence constancy in infants, as well as a way of measuring its duration.

Another way of possibly measuring memory in the infant is through the use of the operant method of delayed feedback, or displacement. Varying the temporal and/or spacial intervals between a required operant response and its reinforcer, or between one response and another, may allow the experimenter to measure the infant's ability to conserve a contingency over time and/or space. An example of this technique is that of Millar (1972). With 4 to 8 month old infants, Millar measured hand-pulling behavior by attaching two cords to two switches, and pinning each cord to the infant's sleeves. The infant was then placed before a panel of colored lights which could be lighted in a visual display.
by the experimenter as a reinforcer. For some infants reinforcement followed a hand-pulling response immediately (zero-delay). Other groups of infants received a reinforcement after a 1, 2, or 3 second delay following their response.

Results showed infants with a 3-second delay between response and reinforcement failed to conserve the contingency, and responded the same as infants receiving non-contingent stimulation. One-second and 2-second delay groups learned the contingency, but not as quickly or as well as infants with zero delay. Two seconds appeared to be the cutoff point for learning in this situation. Memory for the existence of an object may be longer than memory necessary to conserve a contingent relationship.

In a fourth experiment Bower (1967b) exposed 24 infants, ages 44 to 50 days, to a series of gradual, perspective changes. The occlusion intervals were again either 5 or 15 seconds, but, in addition, the speed at which the screen moved across the alley was also varied. The disappearance rates were 25, 50, and 75 cm. per second. In addition, the instantaneous disappearance condition from the first experiment was used. The illumination in the two alley arms was suddenly changed, so that at one moment the infant was viewing the object in one alley, and in the next moment could see only the second alleyway with a screen already in place across it. Results again indicated that reappearance of the object after only 5 seconds facilitated the resumption of sucking, while its reappearance after 15 seconds
caused a response decrement. The novel finding, however, was the effect of the different disappearance rates. The instantaneous disappearance brought a decrement, as was expected, but so did the 75 cm. rate. For these infants the 75 cm. per second rate could not be discriminated from an instantaneous disappearance. Possibly their visual systems have a low temporal resolution. Things that move or disappear too quickly elicit non-existence constancy responses. At any rate, infants exhibited existence constancy in a number of situations. Objects in their environment do appear to have some permanence for infants.

Whether or not these objects also have the properties of solidarity for infants was the subject of a further series of experiments (Bower, 1971). It may be possible for the infant to exhibit existence constancy without expecting an object to have tactile properties. That objects have solid, tactile qualities may have to be learned through experience in handling them, apart from merely seeing them.

A shadow casting device was used to project the image of an object on a screen. The infant was placed on the other side of the screen, and fitted with special goggles. The result was a very realistic stereoscopic view of the object. It appeared very real and tangible, at least to the experimenter, on the infant's side of the screen, and within his/her reach, yet it was an illusion. The infant who attempted to grasp the object would find only empty air.
Infants between 16 and 24 weeks of age were randomly presented with the real object or with the illusion, and their reactions were recorded (Bower, Broughton, and Moore, 1970). Surprize was defined by observers in terms of facial expression and crying behavior. Also, the number of times the infant attempted to grasp the object was recorded. No infant showed surprize when his/her hand touched the real object. Every infant, however, showed marked surprize when he/she failed to touch the illusory object. In other words, the infants appeared to have expected the illusory object to have tactile consequences, and were surprized when it did not. If the infant learns that objects have tactile consequences, therefore, he/she must do so sometime before the age of 16 weeks.

Infants of less than 16 weeks often do not have the eye-hand coordination to make a directed attempt to grasp an object. Therefore, the above design had to be modified for use with younger subjects. It is at this point in Bower's research that he began to make use of moving objects as stimuli. Since it is the thesis of the present study that motion, in and of itself, may add a critical variable to the infant's ability to perceive an object, it will be best to summarize the information collected to date on what the infant can perceive of stable objects, before going on to those in motion.

In general, the infant's world is not the confusion that William James (1950) suggested. Fantz's (1961) findings
indicate the infant sees much more of the details of objects than was previously suggested. Up to a point, the infant is attracted by complex patterns such as checkerboards or newsprint, rather than simpler plain surfaces. Color does not appear to be the dominant, attention-grabbing, variable it was once thought to be, since the infant preferred patterned stimuli over simple colored stimuli. That he/she can discriminate solids from two-dimensional stimuli indicates some ability to perceive depth. That he/she prefers real faces to similar forms with scrambled features indicates that he/she not only perceives the featural details of the stimulus, but also that it has some meaning for him/her. Finally, that he/she can differentiate a 1/8 inch width of stripe is an indication that, while he/she lacks the acuity of an adult, his/her visual capacity is sufficient to allow him/her to perceive a wealth of featural detail in his/her world.

The use of an operant discrimination technique by McKenzie and Day (1971) in conjunction with Fantz's visual preference method, indicated what the infant prefers to look at, can be separated from what he/she is capable of perceiving. Though infants looked equally long at striped patterns in either horizontal or vertical orientation in Fantz's procedure, McKenzie and Day (1971) were able to teach infants an operant discrimination based on orientation. Other featural details which do not show differential fixation times with the Fantz procedure, such as color, may also be shown to be discriminable with this operant approach. Bower's (1964, 1965, 1966b, 1967a,
1967b) research provides a slightly different focus. Rather than specific stimulus attributes his studies begin with the assumption that the infant is seeing objects in his world, and concentrate on trying to determine how sophisticated the infant's concept of an object really is. He has demonstrated that infants are capable of size constancy, and therefore can perceive distance. What is more, to do this they seem to rely on motion parallax, primarily, but are also able to use binocular parallax. They did not use the pictoral cues inherent in the retinal image. This is interesting if only because Fantz (1961) and McKenzie and Day (1971) have shown clearly that infants are capable of perceiving these features. Though they are able to see the pictoral cues, they do not use them to judge size or distance. Other cues are more salient. In investigating shape constancy and slant perception in infants, Bower (1966a) found a similar result. The infant tended to respond on the basis of real shape rather than retinal, or projective shape, though he/she was capable of using projective shape as a cue in other situations. Also, though the infant was capable of perceiving differences in slant, or orientation, he/she tended to ignore such information when real shape remained constant. Real shape, apparently, was the more dominant cue. Indications are that what the infant is capable of perceiving and what he/she actually uses to determine his/her response may be two different things. He/she does not appear to use all the information available. This suggests the need for further
research on variables influencing selective attention, or weighting, given to cues for such perceptual discriminations.

In addition to being able to see an object, Bower (1967b) and Bower, Broughton, and Moore (1970), indicate that the infant believes they have some permanence even when out of sight, and have solidarity as well. He/she will anticipate the reappearance of an object that has undergone a gradual, local perspective change, and expects it to have tactile properties. This anticipation response for the reappearance of an object seems to be dependent on the length of time the object remains occluded. More than a few seconds out of sight seems to result in "out of sight, out of mind" behavior. Thus Bower's (1967b) method may lead to information about memory in the infant. An operant technique using delayed feedback, or displacement, may also prove useful in this respect. Varying the spacial or temporal delay between response and reinforcement may indicate the effect of these variables on the infant's ability to conserve a contingency (Millar, 1972).

In relation to Gibson's (1970) hypothesis that the perceivable world could be divided into two categories, events in space, and objects, and that space perception develops more quickly, the literature reviewed so far seems to support this notion. The infant uses binocular or motion parallax over featural cues, indicating that they are more salient for him/her. His/her perceptual acuity is not that of the adult by any means. Yet, that he/she can perceive
the features of objects is also evident, and it may be possible to increase the salience of pictorial cues for the infant through training. Operant techniques may be particularly useful in this respect. In addition to the discrimination, generalization, and delayed feedback techniques already discussed, two additional methods may prove of interest to researchers in infant information processing.

The first is that of conjugate reinforcement, in which the infant's response rate is directly related to the rate, or amount, of reinforcement he/she receives. Rovee and Rovee (1969), for example, attached the infant's foot to a mobile via a string and observed the number of foot movements that occurred. For these 9- to 12-week old infants, foot-kicking was essentially reinforced by the visual display of the moving mobile. An equal number of control subjects were observed. The experimenters moved their mobile non-contingently. Results showed a significant difference in the number of kicks made for the two groups. Foot kicks in the conjugate reinforcement group became so rapid that observers could not keep up with them through the 15-minute session. Responding in the non-contingent group did not increase over the 15-minutes.

Perhaps, the more rewarding the contingent stimulation is for the infant, the more he/she will respond to obtain it. By varying the kind of feedback the infant receives, colored lights, music, etc., the experimenter may be able to determine what the infant prefers by way of reinforcement. The
The method may be sensitive enough for the experimenter to determine if the infant is able to notice changes along various dimensions in his/her reinforcer, and reflect this sensitivity in his/her response rate. For example, one might vary color, size, or complexity of the Rovee and Rovee (1969) mobile to see if it affects the infant's performance.

The fifth possible operant technique is that of satiation, or habituation. Redundancy of a reinforcing event can be varied with groups of infants over equal periods of time. Caron, Caron, and Caldwell (1971) trained infants 3 1/2 months old to make a 20° head turn response. Various colored slides were presented contingent upon each turn as reinforcement. Some infants saw the same slide over and over, however, while others saw more than one slide. Results indicated that infants with less redundancy, or slide repetition, responded more than did infants who saw the same slide over and over. The greater the variety of reinforcing slides, the greater was the rate of response. Adapting this to information processing, an experimenter could obtain a measure of the infant's interest, or value, for each reinforcer by his/her differential rates of responding. A less interesting reinforcer should satiate more quickly than a more interesting, or stimulating, reinforcer. The experimenter may be able to determine the infant's preferred stimulus dimensions in this way. In addition, once the infant habituated to a particular reinforcer, the experimenter might change the reinforcer along some dimension. If the
dimension were salient for the infant, his/her rate of responding should show recovery to some extent. All of these operant procedures could, potentially, yield unique information to the question of what the infant can perceive in objects.

MOVING OBJECTS

Gibson (1970) categorized the perceivable world into the perception of objects, and the perception of events in space. While the first part of the literature review reported a number of studies related to the perception of stationary objects, the second part will be more related to the perception of events in space. Of particular interest are those studies investigating the effect of motion on the infant's perception of objects.

Bower, Broughton, and Moore (1970) tested younger infants in order to see if a transitional period of object perception could be found, a period when the infant could see an object, but did not seem to expect it to have solid properties. Preliminary studies with 40 two-week-old infants indicated that objects moving rapidly toward their faces did not elicit a defensive reaction of any kind, not even a blink. However, these first 40 subjects had been tested while lying on their backs in a prone position, and appeared to be half-asleep. Infants of the same age held in an upright, or semi-upright position, showed completely different reactions. Clearly defensive reactions of with-
drawing the head, and putting the hands in front of the face, and crying, were made in response to the rapidly approaching objects. What is more, these reactions occurred only to approaching objects, not to retreating objects. It appears that even by the second week of life the infant expects a seen object to have tactile consequences. On the basis of such findings Bower argued that the infant did not have to learn that the objects had solidarity by gradually learning to coordinate touch and vision. It is evident that the infant perceives the direction of movement and perhaps some of the characteristics of the object itself. Also, it seems to be of some importance to note the position of the infant when the effect of the stimulus upon him/her is being measured.

The infant's reaction to impending collision was also studied by Ball and Tronick (1971). Three groups of eight infants, ages 2 to 5, 5 to 8, and 8 to 11 weeks, were tested to see if any transitional age effects could be determined. Each infant was seated before a screen, behind which was a shadow casting device. The virtual image of a 5 X 5 X 5 cm. cube, moving toward the infant's face at 12 cm. per second could be produced. The object appeared to follow a path that would lead to collision with the infant, or a miss path. It could also be made to appear flat, or two-dimensional, rather than solid.

A second group of seven infants, ages 3 to 6 weeks, was exposed to a real 30 X 30 X 30 cm. cube which approached
31. their faces at 17 cm. per second on a direct hit or a miss path. Their reactions to the real object were essentially the same as those of the infants viewing the virtual images, so the experimenters assumed the shadow casting device was effective in producing a realistic object.

Results were recorded with a T.V. camera and a microphone, and, in general, confirmed those of Bower, Broughton, and Moore (1970). Descriptively, infants reacted very differently to objects on collision paths than they did to objects on miss paths. During direct hits, infants gave a full avoidance response of raising their arms and pulling their heads back, looking toward the ceiling, and stiffening of the body. On miss paths, the infant slowly turned head and eyes along the object's trajectory, a tracking response. Arms were raised but there was no pulling back of the head or stiffening of the body.

Neither age nor its interaction with hit or miss pathway was found to have an effect. Nor was there any effect or interaction for flat versus solid objects. Earlier research has shown infants are sensitive to dimensionality and prefer three-dimensional solids to two-dimensional, flat objects (Fantz, 1961). However, when collision is involved whether the object is flat or solid does not seem to matter. Overall, the results support those of Bower, Broughton, and Moore (1970). Infants even as young as 2 to 5 weeks appear to be aware of the tactile properties of objects. Ball and Tronick's (1971) research also demonstrates that infants are
sensitive to the trajectory an object will follow. They can judge, or predict, whether an object is on a collision or a miss path, and react appropriately, indicating a rather sophisticated tracking ability.

Bower, Broughton, and Moore (1971) extended the earlier work with existence constancy in infants (Bower, 1967b), in a second series of studies. Instead of dragging a screen at various speeds in front of a stationary object as Bower (1967b) had done, the screen was made stationary and the object, itself, was moved from side to side behind it. It was reasoned that an infant observing a moving object go behind a screen, if he/she believed the object had permanence, should anticipate its reappearance by looking to the other side of the screen. If on the other hand, he/she does not conserve the permanence of the object, he/she should not anticipate its reappearance. His/her gaze should stop at the point where the object disappeared.

Eight-week old infants were placed 1 meter away from a screen. A stimulus moved along a track to the screen and went behind it. Two cameras located behind the screen and aligned with the infant's face, recorded to which side of the screen the infant directed his/her gaze. Results indicated that in every case the infant's gaze was directed to the opposite side of the screen. This result was interpreted as indicating anticipation of the reappearance of the object.

A study on existence constancy and the development of the object concept in young infants was also done by Nelson
(1971). A toy train set was used as a stimulus. The train followed an oval track in full view of the infant, with the exception of one section of track occluded by a tunnel. The tunnel was 27 inches in length. The experimenter was interested in seeing if the infant would stop his/her gaze at the tunnel entrance where the train disappeared, or whether the infant would anticipate the train's reappearance by looking to the tunnel's exit. Forty infants, about 5 months of age, were tested.

Two identical trains were positioned out of the infant's view, one at either end of the tunnel. Train A moved out of the tunnel into view, traveled around the track, reentered the tunnel, and stopped. Meanwhile, train B moved inside the tunnel to take up the initial position of train A. Train B then appeared in place of train A, at the time train A would have traversed the tunnel, given its speed of occlusion. This procedure eliminated the sound of train A's movement within the tunnel as a cue for the infant's tracking behavior. Although the Nelson (1971) apparatus permitted systematic control over time from entrance to exit of the tunnel, this variable was not explored. After a number of trials, train A was made to reverse direction within the tunnel and reappear at the tunnel entrance. The tracking situation was then reversed. "Anticipation" was defined as any eye movement toward the tunnel exit following train A's occlusion, and prior to train B's appearance. Results showed that infants tended to look at the point of train A's dis-
appearance during the first few trials. However, each succeeding trial showed the infant's gaze moving more toward the tunnel exit. Infants were also able to spot the train as it emerged from the tunnel more quickly over trials. Reversal of the train's direction disrupted the anticipatory responses. Infants did not appear to have learned a general rule to search for the train at the opposite end of the tunnel. Instead, they again began by stopping at the point of disappearance and gradually "anticipated" over trials.

There are two aspects of Nelson (1971) that may explain the differences between this study and that of Bower, Broughton, and Moore (1971). The first of these is the length of Nelson's (1971) tunnel, compared to that of Bower et al's (1971) screen, and their relationships to the speeds of the objects. Bower, Broughton, and Moore (1971) used a screen 15 cm. long, and an object that moved at 10 cm. per second. Thus, the object should have been occluded by the screen for about 1.5 seconds, given its speed of occlusion. Nelson's (1971) tunnel was approximately 68.58 cm., yet he states the object took only 1.86 seconds to traverse the tunnel. Nelson's (1971) object must have been moving at a greater rate of speed than was the object used by Bower, Broughton, and Moore (1971). Greater speed may affect the infant's ability to resolve the features of the object, making it more likely that he/she would track the movement alone. Speed also might affect the infant's ability to control his/her head and eye movements. He/she may have more trouble stopping at the point
where the movement ends. Bower et al.'s (1971) results are more likely to be attributed to anticipation on the part of the infant because the object was moving more slowly.

A second possible factor is the use of a screen versus a tunnel. Bower (1974) points out the infant may learn the idea of occlusion before he/she learns the idea of inclusion. That is, the infant may more easily grasp the fact that one object can go behind another, than he/she can comprehend the idea of one object inside of another. That two objects may occupy the same space may develop more slowly, in which case the infant should show less of a tendency to anticipate.

There was a possibility that the results of Bower, Broughton, and Moore (1971) and Nelson (1971) were due, not to anticipation, but to the inability of the infant to arrest his/her head movement, or to a slow reaction time. A second experiment of Bower, Broughton, and Moore (1971), was designed to test this possibility. An object moved along a track and stopped just before it reached the screen, in full view of the infant. It was reasoned that if the infant could not arrest his/her head movement, he/she would track past the stationary object and look to the other side of the screen. If, on the other hand, the infant's response in the earlier study had been due to anticipation, his/her gaze would halt with the object before the screen. Results showed all the infants tracked past the object to the other side of the screen, indicating an inability to arrest head movement. This finding seemed incompatible with earlier studies (Bower,
using moving screens and stationary objects to indicate the infant's anticipation of the reappearance of objects. In those studies Bower assumed that the decrement in rate of sucking when a screen was dragged slowly in front of the stationary object was due to anticipation of the object's reappearance. The infant had some belief as to the continued existence of an object hidden from his/her view. If this assumption was correct, then its converse should also have held true. The infant should have shown anticipation of the reappearance of a moving object behind a stationary screen. However, what appeared to be anticipation in Bower, Broughton, and Moore (1971) and Nelson (1971) was, instead, shown to be due, seemingly, to an inability to arrest head movement.

Accordingly, Bower and Patterson (1973) designed a study using an object moving in a circular trajectory. This object was stopped periodically, and the direction of the infant's gaze was recorded. Results indicated that infants continued to track past the stationary object, but their line of gaze continued to follow the circular trajectory. Bower and Patterson (1973) assumed that if the tracking behavior had been the result of an inability to arrest head movement, the infant's gaze would have gone off at a tangent to the circular path. Also, analysis of the film data indicated that the infants had fixated the now stationary object for about 1/2 second before resuming to track. In other words the infant seemed to be physically able to
arrest his/her gaze, but continued to track the path the object would have followed had it been moving. Bower and Patterson (1973) suggested the infant noticed the stationary object, but was not able to recognize it as the moving object he/she had been tracking. Consequently, after stopping briefly, he/she resumed his/her tracking behavior, looking for the moving object. Though this conclusion may be correct, the data is not conclusive. A 1/2 second pause seems to be strong evidence that the infant could stop his/her gaze, yet this pause must be compared with the rest of his/her tracking behavior before any conclusion can be drawn as to its significance. The infant, for example, may track in spurts with many 1/2 second stops. Normative data is needed to determine whether or not such a pause is worthy of note. Also the assumption that the infant's gaze would go off at a tangent to the rotary path may not be warranted. An infant with a slow reaction time might be slow in inhibiting his/her movement, regardless of the specific pattern involved. Thus a slow reaction time, resulting in an inability to arrest eye movement in time to prevent tracking past the stationary object, regardless of the trajectory of the object, may still be a viable explanation. Bower and Patterson (1973) did show, however, that the infant's resumption of tracking when the object had stopped was not dependent on the presence of a screen. The tracking occurred even when the object remained in full view throughout its cycle of movement.

To examine the extent to which the infant attends to
featural cues of moving objects, Bower, Broughton, and Moore (1971) presented infants with four situations. In the first, an object moved along a track, disappeared behind a screen, re-emerged on the other side, and went on for a short distance before reversing the cycle. The infant had two cues that the object was the same throughout. First, its features remained the same, and secondly, its movement in relation to the screen was continuous and plausible. In the second condition, the object moved along a track and went behind a screen, but at the time when it should have re-emerged, given its speed before disappearance, a new object differing in size, shape, and color emerged in its place. In this condition the features were a cue to the infant that there were in fact two objects involved, whereas the motion cue indicated only one. A third situation had an object move along a track and disappear behind the screen, but an identical object was made to emerge on the other side of the screen too soon for it to have been the original object, given its speed of occlusion. In this case the featural information indicated only one object was present, but the motion cues indicated two. Finally, in the fourth situation condition three was repeated, but, instead of an identical object appearing too soon, an object differing in size, shape, and color emerged. In this last condition both the featural cues and the motion cues indicated that two objects were involved. Infants of less than 16 weeks followed the object of situation 1 with no signs of being disturbed. In situation 2 when a different
object emerged from behind the screen they again continued to track it with no apparent signs of disturbance. However, in situations 3 and 4 when the objects emerged sooner than expected, the infants refused to look any further, and did not continue to track. Thus infants less than 16 weeks of age were apparently not affected by feature differences, but were affected by motion changes. Bower (1971) suggested they were responding, not to moving objects, but to movement, and, conversely, not to stationary objects, but to places. He suggested that it is only older infants, above 16 weeks, who have learned to identify objects by their features, and that infants under 16 weeks must learn that objects can move from place to place along pathways of movement. If this hypothesis of Bower's (1971) is correct, then younger infants see an object as a new thing as soon as it is moved to a different location. Thus he/she must cope with many objects when really there is only one. Converging operations are needed here, however, to buttress this idea. That the infants in Bower, Broughton, and Moore (1971) were affected by changes in movement and not by changes in featural details of the objects does not necessarily mean infants are incapable of attending to featural information. Bower et al. (1971) may have merely demonstrated the salience of movement as a cue. Movement may dominate attention. The infant may have "refused" to track objects that appeared too quickly from behind the screen because he/she realized it could not have been the same object that he/she had been tracking prior to the screen, i.e. he/she
may have been waiting for the original which was still behind the screen. He/she may also have failed to track the object that appeared too soon because his/her eye movements were matched to the original object and he/she was too slow to follow the movement of the new object on the other side of the screen. In other words, he/she missed it at the outset and never "caught up" to it. Further studies are needed if Bower wants to eliminate these explanations.

In a tracking task, somewhat analogous to that of Bower, Broughton, and Moore (1971), Nelson (1974) was able to confirm their results with older infants. Twenty-eight infants 6 to 8 months of age were able to anticipate the reappearance of an object that they had seen occluded by a screen. They also seemed to be sensitive to a change in featural detail of the objects. Each child was exposed to a Bower-like tracking task in which one object moved along a measured path in full view, disappeared behind a screen, and re-emerged on the other side. Four trials served as a baseline measure of anticipatory responses, 12 trials served as learning trials. Two four-trial generalization tests followed the learning trials. In the first test the object was made to travel faster and along a longer path than in previous trials for half the infants. For the other half the object moved more slowly and went a shorter distance than on earlier trials. Results indicated that changes in speed and distance traveled by the object did not affect the infant's tracking behavior. The number of anticipatory responses was not significantly different from those of the previous learning trials.
In the second generalization test a novel object was used. The speed at which it moved and the length of its trajectory were the same as that of the original object. Results showed that, while the number of anticipations shown was significantly more than that shown in the pre-test trials, it was significantly fewer than the number shown in the learning trials with the original object. Infants thus exhibited a generalization effect, yet also indicated an awareness of the change of objects. Nelson's (1974) objects were different on a number of dimensions. One was a toy truck (6 x 12 x 12 inches), while the other was a man, 68 inches tall. His screen was 54 inches wide and 78 inches tall, and was placed only 3 feet from the infant. Thus his whole set-up is a giant version of Bower et al. (1971). By increasing the scale of the stimulus display, Nelson (1974) may have maximized the featural cues for his infants. Unfortunately, he did not test infants under 16 weeks of age. His results merely confirm Bower, Broughton, and Moore's (1971) findings with older infants. They shed little light on Bower's (1971) hypothesis about the younger infant's conception of place and movement.

To follow up the hypothesis that the infant does not realize that objects can move from place to place, Bower (1971) designed a study to show that infants looked for an object in the place where it had been stationary after seeing it move to a new location. The infant was seated before a toy train, stationary on a track. After 10 seconds the train moved to the left and stopped in a new position, where it remained for another 10 seconds, before returning to its original position.
This cycle was repeated 10 times, after which the train moved to an entirely new position to the right. Bower reasoned that if the infant was tracking one object he/she should have no difficulty following it to its new location. However, if the infant saw the stationary object as being something different from the moving object, he/she may have learned the rule "when the object at A disappears, an object appears to the left at B". Thus when the train moves to the right this infant should fail to follow it, but, instead, should look to the old position to the left. Results, in fact, indicated that all of the 3-month old infants tested made this error and looked to the left instead of tracking the object to the right. Bower (1971) concluded that the infant had failed to recognize the object when it was in a different place. He/she had not been tracking the object as one object changing positions, but had instead learned a contingency between two objects, one at point A and another at point B. Again, though Bower's hypothesis may be the correct one, there are other possible interpretations of the results. The infant may not be able to recognize a moving object as being the same one that was stationary, or he/she may recognize it as the same, but may have adopted a more economical way of following it. He/she may have begun by following it as it moved from point A to point B but over 10 trials had learned the contingency, "the object always goes to B". Therefore, rather than track it as it moved, he/she observed it begin to move, then switched his/her attention to the new spot where it had stopped on the
previous 10 trials. This possibility is analogous to the set effects, or learning to learn phenomenon discussed by Harlow (1949).

Bower (1971) assumed the infant failed to recognize the object once it had moved to a different place. His hypothesis was that infants of this age have not yet learned to coordinate movement with object displacement. They do not see movement as the change in position of an object, but tend to connect an object with a particular place. If it appears in another setting it is regarded as a new object. Though set effects are a viable alternative explanation for his results, in this case, his conclusion is particularly interesting in light of earlier research. The work of Fantz (1961), and Bower (1966b) indicated that infants were capable of differentiating a number of featural characteristics of objects such as size, shape, and pattern complexity. Yet, according to Bower (1971) and Bower, Broughton, and Moore (1971), they do not seem to utilize these features in their recognition of moving objects.

Bower (1971) further tested his hypothesis that infants tie objects to place, by placing infants of varying ages in a situation with multiple mirrors. In some cases the infant was presented with two or three images of his/her mother. In other cases the infant saw his/her mother with one or two strangers. Infants of less than 20 weeks responded with smiles and coos to the multiple mother situation, smiling at each image in turn. In the mother plus strangers condition these same infants responded happily to their mothers and tended to
ignore the strangers. Thus the infant was capable of distinguishing his/her mother's features from others', but recognized her as one of many identical mothers. Older infants responded much as the younger ones in the mother plus strangers condition, but became upset at the sight of multiple mothers. Unlike the younger infants, they have learned they have only one mother, and that mother can be in only one place at a time.

This conclusion is an interesting one. The infant may, indeed, be unaware that objects can move from place to place and therefore perceives an overpopulated world, so to speak, full of several copies of everything, including his/her mother. On the other hand, the evidence is far from conclusive. The infant may well be aware that movement is the result of the change in position of an object. His/her failure to stop tracking when the object stops may be due to a failure to recognize it, due to an inability to resolve its features when it is in motion. Another possibility may be that he/she fails to stop tracking because of an inability to inhibit a particular pattern of movement due to a slow reaction time. The reaction to multiple mothers may be due to an age and experience factor in the infant's ability to interact socially, and not with his/her failure to realize he/she has but one mother. There is a need to replicate this study with a multiple stranger condition as a control. Perhaps multiple images of the same stranger would be upsetting to younger infants when multiple mothers were not. Finally, it appears fairly safe to assume the infant has not learned merely that a contingency
exists between two movements on either side of a screen, since the same behavior occurs when the screen is not present (Bower and Patterson, 1973), though this could not be ruled out as an explanation for the results of Bower (1971) or Bower, Broughton, and Moore (1971).

Summarizing, it has been demonstrated (Fantz, 1961; Bower, 1966b; Bond, 1972) that infants are capable of differentiating many of the features of stable objects. They have shown very clear preferences based on such factors as pattern complexity and solidarity. They prefer realistic schematic faces to faces with scrambled features, and can recognize their mother's face and differentiate her from strangers (Bower, 1971). Yet, a change appears to occur when the object is moving. If a moving object that he/she is tracking suddenly stops, the infant will track past it as though he/she did not recognize it as the same object. Bower and Patterson (1973) systematically eliminated contingency learning as a possible explanation. Instead they hypothesized the infant had not yet learned just what movement was. He/she tracked movement as an entity in and of itself, without realizing that it was due to the change in position of an object. He/she did not stop because he/she did not realize that an object could be the terminus of a movement. Objects were still tied to specific stimulus arrays for the infant, so that the same object in a different place represented, for him/her a new object.

While Bower's hypothesis may be correct, there are
other possibilities for explaining his data which have not yet been tested. That the infant sees movement as something more than visual stimulation is indicated by Bower's own research (Bower, Broughton, and Moore, 1970) on the reactions of infants to rapidly approaching objects. The evidence clearly indicated they expected the moving stimulus to have tactile properties, which, in turn, implies they were aware of the fact that they were observing an object. The infant may fail to stop tracking an object that has stopped, not because he/she is tracking mere movement, but because he/she has failed to sufficiently differentiate the stimulus features. Gibson (1970) has hypothesized that events in space develop, perceptually, much more quickly than does the perception of objects. It is possible that motion makes it more difficult for the infant to accurately resolve the features. Or, perhaps motion, being a more salient cue, dominates the infant's attention. He/she tracks past the stationary stimulus because he/she does not recognize it. Indeed, it does not look the same. Finally, the infant may fail to stop tracking an object that has stopped because he/she has a slow reaction time. Regardless of the pattern of movement, whether linear or rotary, he/she continues along the path of movement the object previously followed. In this case his/her failure to stop is independent of his/her recognition of the object, or his/her ability to perceive its features while it is in motion.

It was the purpose of the present study to examine three hypotheses; 1) Bower's idea of an incomplete object
concept, 2) the possibility of the failure to perceive featural information, and 3) the possibility of a slow reaction time, as they relate to the infant's ability to perceive objects in motion. The operant techniques reviewed, briefly, at the conclusion of the stable object section of the literature review, are also applicable to the study of the infant's perception of featural details of moving objects. In examining the infant's ability to perceive the features of moving objects, the present study combined an operant discrimination task with a generalization test in extinction. With the operant techniques, the experimenter hoped to demonstrate what the infant is capable of perceiving, rather than merely that to which the infant may typically attend.

The present experiment was in two phases. During the first phase 10-week-old infants were taught to discriminate between two stationary objects. If the infant was able to learn such a discrimination, he/she must be capable of attending to featural differences between the two objects. The ability to discriminate should indicate whether or not the infant is, at least, capable of perceiving the features of the stationary objects presented.

The purpose of the second phase of the experiment was to see if the infant can recognize the features of the objects in a moving form. The stationary stimuli of the earlier discrimination task were presented to the infants in a moving form as a generalization test. If the infant can respond differentially to the two moving stimuli, it should indicate some recognition of their similarity to the
stationary stimuli. If the infant does not maintain a discrimination it may be true that he/she is unable to differentiate the features of moving objects.

If the infant learns the discrimination in the first phase of the experiment, but fails to generalize his/her response to the same stimuli in moving form in the second phase, it should indicate that Bower's hypothesis has some validity. Though capable of differentiating features of stationary objects, the infant is not aware the same object can assume two forms, moving and stationary. On the other hand, if the infant can learn the discrimination and also generalize his/her response to the same stimuli in moving form, it is an indication that the infant's object concept is more complete than what Bower has suggested. The infant can perceive features of stationary stimuli and he/she does realize that they can move and assume another form. Finally, by avoiding the necessity of having the stimuli stop suddenly or go behind screens, this study also eliminated the possibility of slow reaction time effecting the results.
METHOD

Subjects. Subjects were 24 infants, ranging in age from 59 to 82 days, with a mean age of 71 days, at the completion of the experiment. Half of the subjects were male, half were female. Five additional infants were seen, but their data were not included in the final analyses. Two of these children, one male and one female, failed to complete the training procedure, one because of illness, the other because of a conflict with parents' schedules. The remaining three children, all males, were excluded because they cried during at least two consecutive trials during the generalization test, and failed to complete the required 16 trials.

Apparatus and Stimuli. The display apparatus consisted of two large plywood screens about 4 x 4 feet square, which stood upright on the floor. One was designed as the background upon which two stationary stimulus objects were presented, while on the other, objects in moving as well as stationary form were presented. Figure 1 presents a line drawing of the equipment.

To display the stationary objects, two dowels, 4 inches in length, were attached to the front of the screens, 10 inches from either side, and 13 inches from the tops of the screens. The two dowels were separated by 28 inches. Stimulus objects had holes 4 inches deep so as to fit over the dowels.

For moving stimuli, a motor-driven pulley system was attached to the back of one of the screens so as to be hidden
Figure 1. The displayed apparatus for presentation of both moving and stationary objects.
from the infant's view. Two shafts protruded from this motor-pulley arrangement, through holes in the plywood, to the infant's side of the screen. They were located 21 inches from the top of the screen. One was 10 inches from the left side, and the other was 10 inches from the right side of the screen. The spot where these shafts connected with the screen was directly below the dowels described for stationary objects. The shafts measured approximately 14 inches in the infant's side of the screen, and were bent in an L-shape to allow 10 inches of shaft to move parallel with the screen, while 4 inches at the end served as a dowel to attach the stimuli. Once the motor-pulley system was turned on, objects attached to the ends of the shafts followed two separate counter-clockwise circular paths, 20 inches in diameter. They moved at a speed of approximately 5 cm. per second. This was about half as fast as that used in the tracking task of Bower, Broughton and Moore (1971).

Two 3/4 inch peepholes were located on each stimulus screen to allow two observers to observe the infant from behind the stimulus display. On the screen used only for stationary object presentation, these peepholes were located beneath each of the 4-inch dowels, 21 inches from the top of the screen, and 10 inches from either side. On the screen which presented either stationary or moving objects, the two peepholes were located 16 inches from either side of the screen and 21 inches from its top.
Test stimuli consisted of a checkerboard cube, 6 inches on a side, and a bull's eye sphere, 6 inches in diameter. The checkerboard cube was colored black and white and contained 64 squares (8 x 8). Each of these 64 squares was 3/4 inch on a side. The bull's eye sphere was also colored black and white, but with concentric circles 3/4 inch in width. The child's view of the screen was blocked during stimulus changes with a piece of white paper held in front of his/her face. Additional equipment included a Lafayette timer and a 4-channel event recorder which were behind the screen out of the infant's line of sight.

Procedure. The infant was seated in an infant seat so as to face the stimulus display which was about two feet away. The commercial infant seat was arranged to hold the infant upright at an angle of about 45°.

Days 1-4: Shaping.

Discrimination training was carried out with the stationary objects. The experimenter designated one of the stimulus objects as a stimulus for reinforcement, and one as a stimulus for non-reward, for each infant. Half of the subjects had the cube as the reinforced object, and the sphere as the non-reinforced object. For the other half of the subjects, the reverse was true. This was included as a factor in the design to take into account any initial differential preferences an infant might have for the two stimuli.
The experimenter was positioned behind the screen designed for the presentation of stationary objects only, and observed the infant through the peephole beneath the object chosen as the reinforced stimulus. The experimenter administered a reinforcement whenever she observed that the infant had visually fixated the reinforced object. Fixations to the non-reinforced stimulus went unrewarded.

Though the definition of reinforcement varied from child to child, in general it consisted of a "peek-a-boo" from the experimenter with the presentation of a toy and words of praise such as "good baby" or "hi baby". The experimenter appeared at the mid-point at the top of the screen and addressed the infant briefly and showed the infant a toy. Then the experimenter again dropped out of sight behind the screen and returned to the peephole, or reversed the positions of the two objects, and then disappeared from view. To control for left or right position preferences the experimenter changed the side on which each object appeared at least once every 4 or 5 minutes. This interval was not precisely timed, but was merely estimated by the experimenter, and varied with the infant's performance during shaping.

Days 1 to 4 were used to teach the infant to discriminate the reinforced from the non-reinforced stimulus by visually fixating the reinforced object for 6 seconds to earn a reinforcement. A record was kept of the number of reinforcements given per session by having a mother record the number of times the experimenter gave the infant a "peek-a-boo". The 6-second interval was measured with a Lafayette timer.
Days 5-6: Discrete Trials.

Stimulus presentation on days 5 and 6 followed a discrete trials procedure. The experimenter observed the infant's visual fixations through the peephole, and timed the fixations to either object with a Lafayette timer. If the infant observed either stimulus for 6 consecutive seconds it signaled the end of that trial. If the reinforced object was the object that was first fixated for 6 seconds, the experimenter administered a reinforcement peek-a-boo, or toy. If the non-reinforced stimulus was fixated for 6 seconds, the trial ended without reward. At the end of a trial the experimenter signaled the infant's parent, who then blocked the infant's view of the screen with a piece of white paper until the next trial was ready to begin. Between trials the experimenter systematically varied the sides on which the two objects appeared. Each fixation of 6 seconds was recorded directly onto the order of slide presentation sheets in terms of side (left or right) and object chosen (sphere or cube). All infants received the same order of presentation.

A discrimination ratio was then determined for each side of the screen (left or right) on each of the two days of recording, for each child, with the following formula:

\[
\text{Cube DR} = \frac{\text{Cube} - \text{Sphere}}{\text{Cube} + \text{Sphere}}
\]

For each day, the number of trials in which the cube was presented to the right of the screen was tallied. The number
of trials in which the cube appeared on the left was also
determined, and a discrimination ratio computed for each of
these two situations. The number of times the infant fixated
the sphere for 6 seconds was subtracted from the number of
times he/she chose to fixate the cube, in each side position.
These differences were then divided by the total number of
trials the infant experienced with each cube position in that
day's session. A positive ratio indicated the infant chose
to fixate the cube more than the sphere. A negative score
meant that the infant fixated the sphere more than the cube.
A score of zero resulted if the infant showed no preference
and fixated both objects equally as often. The design of the
experiment for determining whether the discrimination of the
stationary forms had been acquired is represented in Figure
2. A four-way Analysis of Variance (ANOVA) with two repeated
measures was calculated on this data. The two non-repeated
measures factors were the reinforcement group to which the
infant belonged (cube-reinforced or sphere-reinforced) and
the sex of the infant (male or female). The two repeated mea-
sures factors were the position of the objects on the display
(cube-left or cube-right), and the day of testing (day 5 or
day 6). The between-subjects Groups effect should be significant
if training effected discriminability and preference for the
stimuli.
Figure 2. The design of the experiment for determining whether or not the infant has acquired a discrimination of the features of the stationary objects by the 5th and 6th day of training.
Day 7: Generalization Test in Extinction.

The display screen equipped for both stationary and moving stimulus presentations was used for this part of the study. For the first 5 minutes the stimulus situation was the same as that of days 5 and 6. A discrete trials procedure was followed with the two stimuli in stationary forms. The experimenter reinforced 6-second fixations to the reinforced object. One addition was that of a second observer, placed behind the screen with the experimenter. Each observed the infant through a peephole and recorded left and right 6-second fixations per trial, with the experimenter controlling the Lafayette timer. The observer was naive as to the reinforcement group the infant belonged. He was also uninformed as to which object appeared on the left versus the right of the display.

Following this warm-up, the parent blocked the infant's view of the screen and extinction began. The experimenter no longer reinforced the infant for visual fixations. The two stimulus objects were placed on the shafts of the motor-pulley apparatus and started in motion before the infant could view the screen. The infant viewed the objects moving for 20 seconds. Observing through the screen's peepholes, the experimenter and the observer measured the length of visual fixations to the right or left, using a four-channel event recorder. Each observer had two push-buttons, one for left fixations, one for right. At the end of 20 seconds the parent
ended the trial by blocking the infant's view of the screen at a signal from the experimenter. The experimenter then changed the position or the motion of the objects for the next trial. During moving object trials the observer was aware of the position of the particular object on the display. However, he remained naive as to the reinforcement group to which the infant belonged.

The infant saw each of four stimulus arrangements at least four times, for a total of 16 trials. The four stimulus arrangements are summarized in Table 1. The first and second 20-second trials following the warm-up period were always with moving objects. For the third and fourth trials, the objects were always in a stationary form. This represented the first block of trials. Three more blocks of two stationary and two moving trials were then presented to each subject, for a total of 16 trials. The order of moving and stationary trials was varied across the four blocks. Specifically, four orders of presentation of the four stimulus arrangements were used. These orders are presented in Table 2. To evaluate the effect of presentation on responding, three infants from each group received one of the four orders.

The experimenter computed a difference score of the amount of time the infant spent observing the cube minus the amount of time devoted to the sphere for each 20-second trial. If the infant observed the cube more than the sphere the score was positive. If the infant fixated the sphere more than the
Table 1. Four stimulus arrangements were used to display moving and stationary objects during the generalization test on Day 7.

<table>
<thead>
<tr>
<th>Moving</th>
<th>Side of Display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
</tr>
<tr>
<td>Arrangement 1</td>
<td>Cube</td>
</tr>
<tr>
<td>Arrangement 2</td>
<td>Sphere</td>
</tr>
<tr>
<td>Arrangement 3</td>
<td>Cube</td>
</tr>
<tr>
<td>Arrangement 4</td>
<td>Sphere</td>
</tr>
</tbody>
</table>

< Moving

<table>
<thead>
<tr>
<th>Stationary</th>
<th>Side of Display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
</tr>
<tr>
<td>Arrangement 1</td>
<td>Cube</td>
</tr>
<tr>
<td>Arrangement 2</td>
<td>Sphere</td>
</tr>
<tr>
<td>Arrangement 3</td>
<td>Cube</td>
</tr>
<tr>
<td>Arrangement 4</td>
<td>Sphere</td>
</tr>
</tbody>
</table>
Table 2. Four orders of the four stimulus arrangements (Table 1) were used in presenting objects in moving and stationary form during the generalization test on Day 7. Trials 1 and 2 of each block of 4 trials were always with objects in motion. Trials 3 and 4 were always with stationary objects. Side of the display on which a specific object appeared was varied per trial.

<table>
<thead>
<tr>
<th>Order</th>
<th>Stimulus Arrangements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2</td>
<td>2 1 4 3</td>
</tr>
<tr>
<td>3</td>
<td>1 2 4 3</td>
</tr>
<tr>
<td>4</td>
<td>2 1 3 4</td>
</tr>
</tbody>
</table>
cube, the score was negative. If there was no preference shown for either object, the difference score was zero.

The design of the experiment for day 7 is represented in Figure 3. A five-way ANOVA with three repeated measures factors was computed on the difference scores. The non-repeated measures factors were the stimulus object that was reinforced (cube or sphere), and the order of presentation of stimuli. The repeated measures factors were motion (moving or stationary), side of the display on which the objects appeared (cube-left or cube-right), and blocks (the number of times the first four trials were repeated). Significant differences between groups on the stationary, but not on the moving trials would support Bower's position, while significantly longer fixation to the reinforced object on both stationary and moving trials would support the experimenters' hypothesis.
Figure 3. The design of the experiment for determining if the infant is able to discriminate the features of the objects in moving as well as stationary forms, in a generalization test on Day 7.
RESULTS

Discrete Trials Procedure - Discrimination Training Days 5 and 6

The mean cube discrimination ratios obtained from the fifth and sixth days of discrimination training with stationary objects are presented in Table 3. Positive numbers indicate a greater proportion of trials devoted to staring at the cube, while negative numbers reflect a preference for the sphere. These ratios were analyzed in a 4-way Analysis of Variance (ANOVA), with two repeated measures. The non-repeated measures factors were reinforcement group (cube or sphere) and sex (male or female). The repeated measures factors were day of testing (day 5 or day 6) and side of the display on which the objects were displayed (cube-left or cube-right). Table 4 is a summary of the results of this analysis. A main effect for the reinforcement group factor indicated that, overall, the cube group fixated the cube on significantly more trials than did the sphere group, ($F(1,20) = 15.0914$, $p = .00121$). However, this main effect statement must be qualified in light of three significant interaction effects, group X sex ($F(1,20) = 4.7936$, $p = .03849$), group X days ($F(1,20) = 4.6817$, $p = .04057$), and group X days X side ($F(1,20) = 5.7260$, $p = .02523$).

Figure 4 represents the main effect for groups and the interaction of group with sex of the subject. Overall, cube discrimination ratios for infants in the cube-reinforced group were significantly larger than ratios for infants in
Table 3. A table of mean discrimination ratios from the fifth and sixth days of discrimination training with stationary objects.

<table>
<thead>
<tr>
<th></th>
<th>Day 5</th>
<th>Day 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cube Left</td>
<td>Cube Right</td>
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<tr>
<td>Cube Group</td>
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<td></td>
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<tr>
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<td>.6650</td>
<td>.2667</td>
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<tr>
<td>Females</td>
<td>.2250</td>
<td>-.1300</td>
</tr>
<tr>
<td>Sphere Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
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<td>.4767</td>
</tr>
<tr>
<td>Females</td>
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<td>.1950</td>
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</table>
Table 4. The summary table of the 4-way ANOVA from days 5 and 6 of discrimination training with stationary objects.

<table>
<thead>
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<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
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<th>p</th>
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<td>1.1008</td>
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<td>.03849</td>
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<td>.0924</td>
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<td>1.2015</td>
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<td>.8778</td>
<td>1.2872</td>
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<tr>
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</table>
Figure 4. A comparison of males and females in the cube-reinforced group with the males and females in the sphere-reinforced group using the mean cube discrimination ratios from days 5 and 6 of training with stationary objects.
the sphere-reinforced group. Cube-reinforced infants fixated the cube on more trials than did sphere-reinforced infants. A preference for the cube was more clearly demonstrated by the cube-reinforced infants than was the sphere preference shown by the sphere group as a whole. The ratios suggest that the cube as a stimulus object may have enjoyed an initial preference over the sphere.

Cube-reinforced males had high positive ratios indicating a preference for the cube. Sphere-reinforced males had negative ratios indicating a preference for the sphere. Females in the two groups, however, did not follow this same pattern. While females in the cube-reinforced group had positive ratios, their scores were not as large as males in the same group, indicating their preference for the cube was not as strong. Females in the sphere-reinforced group also had positive ratios, though the scores were close to zero. Females in the sphere-reinforced group demonstrated a slight preference for the cube. Simple effects tests on this group X sex interaction are presented in Table 5. A large portion of variability in the cube discrimination ratios existed between reinforcement groups for the males, $F(1,20) = 73.805$, $p < .001$. The cube discrimination ratios were significantly different for females in the cube group versus females in the sphere group, $F(1,20) = 5.750$, $p < .05$, however, the variation accountable due to reinforcement group for females was only about eight percent of the variation accountable due to reinforcement group for males. For both males and females, the
Table 5. A summary table of the tests of simple effects for the group X sex interaction obtained in the discrimination of stationary objects data of days 5 and 6.

<table>
<thead>
<tr>
<th>Source</th>
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<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
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<td>73.805*</td>
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<tr>
<td>groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS At females</td>
<td>1</td>
<td>1.3201</td>
<td>1.3201</td>
<td>5.750**</td>
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<tr>
<td>groups</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SS error</td>
<td>20</td>
<td>4.5928</td>
<td>.2296</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .001$

** $p < .05$
cube-reinforced group had higher positive cube discrimination ratios than did the sphere-reinforced group.

A simple, simple effects test on the interaction of groups X days X side is summarized in Table 6. The cube discrimination ratios for the cube-reinforced group were significantly larger than those for sphere-reinforced infants in all conditions of day of testing and side of display except one. On day 5 when the cube was presented on the right, the two groups did not significantly differ in their responses, $F(1,80) = 1.292, p > .05$. When the cube was presented on the left side of the display on day 5, and when it was presented on the left or the right on day 6, the two groups showed significant differential responding, $F(1,80) = 8.440, p < .01$, $F(1,80) = 4.967, p < .01$, and $F(1,80) = 6.078, p < .01$, respectively.

Thus, the analysis of the data of days 5 and 6 indicated that cube-reinforced children gave a larger proportion of fixations to the cube than did sphere-reinforced children. This result, however, was more pronounced for males than for females. While evidence of discriminative responding on day 5 was not complete, on day 6, the last day of training, there was a greater proportion of fixations to the cube stimulus by the cube-reinforced children, regardless of the side of the display on which the cube was presented.
Table 6. A summary table of tests of simple, simple effects the group X day X side interaction obtained for the discrimination of stationary objects data of days 5 and 6.

<table>
<thead>
<tr>
<th>Source</th>
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<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
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<td>SSgroups at day 5, cube-left</td>
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<td>2.802</td>
<td>2.802</td>
<td>8.440*</td>
</tr>
<tr>
<td>SSgroups at day 5, cube-right</td>
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<td>.429</td>
<td>.429</td>
<td>1.292</td>
</tr>
<tr>
<td>SSgroups at day 6, cube-left</td>
<td>1</td>
<td>1.649</td>
<td>1.649</td>
<td>4.967*</td>
</tr>
<tr>
<td>SSgroups at day 6, cube-right</td>
<td>1</td>
<td>2.018</td>
<td>2.018</td>
<td>6.078*</td>
</tr>
<tr>
<td>SSError</td>
<td>80</td>
<td>26.578</td>
<td>.332</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01
Day 7 - Warm-up and Generalization Test.

The discrete trials procedure used to test the infant's ability to discriminate between the features of the two objects in their stationary forms on days 5 and 6, was repeated during the brief warm-up period on day 7. However, a second observer was present to make independent judgments of the infant's responses. Percent of agreement scores were calculated between the judgements of the two observers for each infant. For cube-reinforced infants the two observers agreed on 97% of their observations. For sphere-reinforced children the observers agreed 100% of the time. Overall, the two sets of judgements matched about 98% of the time.

Two observers also made independent judgements of the infants' visual fixations during the generalization test. Inter-observer reliability correlation coefficients for these judgements ranged from \( r = .815 \) to \( r = 1.000 \) with a median of \( r = .976 \). The judgements of the two observers were then averaged, and the cube-minus-sphere difference scores were computed from these averaged judgements.

A five-way ANOVA with three repeated measures was computed on the cube-minus-sphere difference scores. Table 7 is a summary table of the mean difference scores used in this analysis. Non-repeated measures factors were reinforcement group (cube or sphere) and order of stimulus presentation. Repeated measures factors were blocks of trials, motion of the objects (moving or stationary), and side of the display on which the objects were presented (cube-left
Table 7. A summary table of mean cube-minus-sphere difference scores obtained in the generalization test with moving and stationary objects on day 7.

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
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</thead>
<tbody>
<tr>
<td>Moving</td>
<td>Stationary</td>
<td>Moving</td>
<td>Stationary</td>
</tr>
<tr>
<td>Cube Left</td>
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</tr>
<tr>
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<td>2.4</td>
<td>-6.3</td>
</tr>
<tr>
<td>Order 2</td>
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<td>-2.4</td>
<td>-4.5</td>
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<tr>
<td>Cube Group</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Order 3</td>
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<td>16.8</td>
</tr>
<tr>
<td>Order 4</td>
<td>5.8</td>
<td>-3.8</td>
<td>12.5</td>
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</table>

<table>
<thead>
<tr>
<th>Order 1</th>
<th>Order 2</th>
<th>Order 3</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sphere Group</td>
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<td></td>
</tr>
<tr>
<td>Order 1</td>
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</tr>
<tr>
<td>Order 2</td>
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<tr>
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<td>.9</td>
<td>-9.7</td>
<td>7.0</td>
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</table>
or cube-right). Sex was not included as a factor in the major analysis of the day 7 data since both males and females demonstrated appropriate discriminative responding on the training test of days 5 and 6. A separate ANOVA, to be briefly summarized later, evaluated the effect of sex apart from the major analysis. The results of the major analysis are summarized in Table 8. A main effect for the reinforcement group factor indicated that, overall, the two groups were responding differentially to the features of the two objects. The cube-reinforced group spent more time looking at the cube than did the infants reinforced for fixating the sphere, $F(1,16) = 8.4412, p = .01005$. The main effect for the motion factor, $F(1,16) = 9.2055, p = .00780$, indicated that, overall, the infants responded differently when the objects were moving than when the objects were stationary. For both groups stationary objects had higher difference scores than did moving objects. The group X motion interaction effect predicted from Bower's position was not significant, $F(1,16) = .0261, p = .86792$.

Figure 5 represents the main effects for reinforcement group and motion. Overall, the cube-reinforced group's cube-minus-sphere difference scores were significantly larger than the difference scores for the sphere-reinforced group. Difference scores were significantly larger for objects in stationary form than for moving objects. The significant and large effect for the group factor along with the lack of any significant group X motion interaction effect indicated
Table 8. The summary table of the five-way ANOVA from day 7 of the generalization test with moving as well as stationary objects.

<table>
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<tr>
<th>Source</th>
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Table 8 - Continued

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</table>
Figure 5. A comparison between the cube- and sphere-reinforced groups on the mean cube-minus-sphere difference scores for day 7, with both moving and stationary objects.
not only that infants in the cube-reinforced group looked at the cube more than did infants in the sphere-reinforced group, but also that this effect was obtained regardless of whether the objects were moving or stationary. In addition, the significant and large effect for the motion factor indicates that for both groups, the stationary objects resulted in higher cube-minus-sphere difference scores than did the presentation of the moving objects.

A simple effects test on the interaction of motion X order of presentation is summarized in Table 9. With orders 1 and 2 the scores of moving objects did not differ significantly from those obtained with the objects in stationary form, $F(1,16) = .069, p > .05,$ and $F(1,16) = .967, p > .05,$ respectively. However, significant differences were obtained between moving and stationary forms when orders 3 and 4 were used, $F(1,16) = 8.167, p < .01,$ and $F(1,16) = 10.548, p < .01,$ respectively. The main effect for motion is only true for two of the four orders of presentation of stimulus objects. Table 10 presents a summary table of means for the analysis of the motion X order interaction effect. The greater attention to the cube in the stationary than in the moving form appears to be restricted to infants run in orders 3 and 4, but not in orders 1 and 2. The groups effect, however, was reliable, independent of order and motion combinations.

The effect of sex of the infant on responding was evaluated with a second five-way ANOVA with three repeated measures. Non-repeated measures in this analysis were rein-
Table 9. A summary table of tests of simple effects on the motion X order interaction obtained from the generalization test data on day 7, with moving as well as stationary objects.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
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<td>40.43</td>
<td>.069</td>
</tr>
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<td>44.14</td>
<td>.076</td>
</tr>
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<td>477.04</td>
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</tr>
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<td>16</td>
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</tbody>
</table>

\*p < .01
Table 10. A summary table of mean cube-minus-sphere difference scores used in the analysis of the simple effects of the motion X order interaction effect from day 7.

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<td>3</td>
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<td>6.5917</td>
</tr>
<tr>
<td>4</td>
<td>-1.1583</td>
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</tbody>
</table>
forcement group (cube or sphere) and sex of the infant (male or female). Repeated measures factors were blocks of trials, motion (moving or stationary), and side of the display on which the objects were presented (cube-left or cube-right). As in the earlier ANOVA with order as a factor, the main effect for group, and the main effect for motion were again significant and large. The only new effect found was the block X sex interaction, $F(3,60) = 2.7677$, $p = .04849$. The interaction of sex X group on day 7 failed to reach significance, $F(1,20) = .2706$, $p = .61419$. Table 11 is a summary of the simple effects tests on the block X sex interaction. None of the simple effects tests reached significance. There were no significant main effects for either the blocks or the sex factors. The block X sex interaction effect seems to be due to a tendency on the part of males to fixate the cube more than females on blocks 3 and 4 of testing. The failure to obtain significance in the tests of simple effects is due, primarily, to the low variance associated with the main effects of sex, $F(1,20) = .2112$, $p = .65485$, and blocks, $F(3,60) = .1737$, $p = .91339$.

Finally, the average cube-minus-sphere difference score for each infant on all moving and on all stationary trials for day 7 was obtained. A correlation between the moving and the stationary scores would be expected if infants with a strong preference for one object in stationary form were able to maintain this preference when the objects were set in motion. For the infants in the cube-reinforced group,
Table 11. A summary table of tests of simple effects on the block X sex interaction obtained from an analysis of the data of day 7.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS sex at Block 1</td>
<td>1</td>
<td>54.45</td>
<td>54.45</td>
<td>.400</td>
</tr>
<tr>
<td>SS sex at Block 2</td>
<td>1</td>
<td>66.17</td>
<td>66.17</td>
<td>.486</td>
</tr>
<tr>
<td>SS sex at Block 3</td>
<td>1</td>
<td>293.99</td>
<td>293.99</td>
<td>2.16</td>
</tr>
<tr>
<td>SS sex at Block 4</td>
<td>1</td>
<td>231.88</td>
<td>231.88</td>
<td>1.70</td>
</tr>
<tr>
<td>SS error</td>
<td>80</td>
<td>10887.90</td>
<td>136.10</td>
<td></td>
</tr>
<tr>
<td>SS blocks at Males</td>
<td>3</td>
<td>369.51</td>
<td>123.17</td>
<td>1.78</td>
</tr>
<tr>
<td>SS blocks at Females</td>
<td>3</td>
<td>242.04</td>
<td>80.68</td>
<td>1.16</td>
</tr>
<tr>
<td>SS error</td>
<td>60</td>
<td>4158.14</td>
<td>69.30</td>
<td></td>
</tr>
</tbody>
</table>
the correlation between the difference scores on the moving versus the stationary trials was $r = .77$, $p < .01$. For infants in the sphere-reinforced group, this correlation was $r = .69$, $p < .01$, and for both groups combined, $r = .73$, $p < .01$. 
DISCUSSION

The central issue addressed in the present study was whether Bower's position or the author's position concerning object permanence is correct. The data clearly support the author's position that infants can recognize the features of objects whether in moving or stationary form. Analysis of the discrete trials data from days 5 and 6 indicated that the infants were able to discriminate between the two objects in their stationary forms. Infants in the cube-reinforced group had a significantly greater number of cube fixation trials than did infants reinforced for fixating the sphere. Both the present study and Bower's hypothesis predicted this effect with stationary objects. The analysis of data from day 7 indicated the infants were able to maintain the discrimination in moving as well as stationary forms of the objects. This latter result is inconsistent with Bower's hypothesis. The present study indicates that, when training insures that the infant has attended to relevant perceptual features of stable objects, the infant is able to recognize the features of the object as being the same, despite its motion.

The ANOVA on the results from the fifth and sixth days of training with stationary objects showed only one main effect. The infants reinforced for fixating the cube had significantly larger cube discrimination ratios than did infants reinforced for staring at the sphere. Cube-reinforced infants preferred the cube on the majority of trials. Sphere-
reinforced infants as a group preferred the sphere on a majority of trials, though their preference was not as strong as that shown by the infants in the cube-reinforced group. It is possible that the cube was the more preferred object initially, and that reinforcement increased the strength of this preference for the cube-reinforced group. At the same time sphere reinforcement may have weakened the initial cube preference and led to a slight sphere preference in the sphere-reinforced group. Nevertheless, the differential behavior of the two groups is sufficient to indicate that the infants were able to discriminate between the features of the two stable objects.

This main effect is qualified, somewhat, by the various interaction effects that were also obtained. Though there was no main effect for the sex factor, the interaction of sex with group was significant. Males in either group preferred the object they had been reinforced for fixating. Females in both groups showed preferences for the cube. This preference for the cube was significantly greater for the cube-reinforced females than for the sphere-reinforced females. Nevertheless, sphere-reinforced females showed a slight preference for the cube rather than the sphere. This is a further indication that the two objects were differentially attractive to the infants from the outset of the experiment. Training may have only served to attenuate the preference for the cube of infants in the sphere-reinforced group. Finally, as Figure 4 indicates, cube-reinforced males showed a stronger preference for the cube than did cube-reinforced females, and
sphere-reinforced males had a stronger sphere preference than did sphere-reinforced females. Since the ages of both males and females were approximately the same, average age for males being 73 days, and females 70 days, this effect cannot be attributed to age. It appears that males benefitted more from the discrimination training than did females. A number of researchers have found differential learning effects for males versus females. Watson (1967; 1969) for example found that males learned to respond more readily for visual reinforcers, while females responded more to auditory reinforcement. However, the present study employed a reinforcer that incorporated both visual and auditory elements. Since the same effect for sex and group was not evident in the data of day 7, this finding may not have been reliable. Further studies must be done to explore the parameters limiting this effect for sex.

A groups X day X side interaction effect was also obtained. The cube-reinforcement group had higher cube discrimination ratios than those of the sphere-reinforced group in three of the four combinations of side and day. When the cube was presented on the right side of the display on day 5 the cube discrimination ratios of the two groups were not significantly different. It is possible that the change in procedure on day 5 may have influenced the child's discrimination strategy. Earlier days of training, or shaping, had not involved the discrete trials method of stimulus presentation. The infant was allowed to observe the experimenter
move the stimulus objects from side to side on the screen. On day 5 for the first time, the infant's view of the screen was blocked during stimulus changes. Instead of being able to track the object as it was moved, the infant was required to search and find it when allowed to again view the display. It was, at first, assumed that the change in the requirements of the task led some infants into adopting a side strategy at the outset of day 5. Previous research (Siqueland, 1964) has suggested that infants have a preference for their right side. Consistent fixations to the right side of the infant would mean he spent more time observing the object mounted on the left side of the stimulus display, rather than responding differentially. While the side preference hypothesis is tempting, it was not supported by the data of the present study. An examination of the means in Table 3 indicates that on day 5, when the cube appeared on the left of the display, the cube-reinforced infants fixated the cube, producing high positive cube discrimination ratios. The sphere-reinforced infants fixated the sphere, which was to the right side of the display, producing negative discrimination ratios. When the cube was presented on the left, in other words, cube-reinforced infants looked to the left, while sphere-reinforced infants, appropriately, looked right. When the objects were reversed, and the cube appeared on the right with the sphere on the left, the infants apparently failed to follow the change. The same order of presentation of objects was followed for all infants. Initially, the cube appeared on the
left and the sphere on the right of the display. This initial positioning seemed to determine the side preferences for the remaining trials. Cube-reinforced infants preferred the left side of the display, sphere-reinforced infants preferred the right. This side preference was evident only on day 5. The results of day 6 clearly show the appropriate discriminative responding without any qualifications due to side of stimulus presentation.

While the interactions of group X sex and group X days X side are significant, they do not cloud the interpretation of the strong main effect for groups in any serious way. Males formed a more obvious discrimination than did females, but females as well as males in both groups showed differential responding to the two objects. Both sexes in either group were discriminating. The main effect difference between groups was evident in three out of four conditions of side presentation and day of testing. Day 6 produced clear evidence that on the final day of training the infants were responding discriminatively, regardless of the side of the display on which the reinforced object was presented. Infants were able to perceive the differences between the sphere and the cube, at least in their stable forms.

The brief warm-up period on day 7 using the discrete trials procedure of days 5 and 6, permitted an estimate of the reliability of the observations. That is, the addition of a second observer who was unaware of the group to which each infant belonged, allowed for a measure of the consistency
of the response judgements. The 98 percent agreement between observers on this day 7 warm-up suggests that the observational technique used to obtain the data of days 5 and 6 is a reliable technique.

Analysis of the data obtained on the seventh day of testing, indicated, again, a main effect for groups, but with no qualifying interactions. Cube-reinforced infants looked longer at the cube than did infants in the sphere-reinforced group. Sphere-reinforced infants, overall, looked longer at the sphere than they did at the cube. The failure to obtain a sex X groups interaction for the day 7 data suggests that the interaction of those two factors for the data of days 5 and 6 was not a reliable finding. That is, males and females were not different in their differential group effects on day 7. The day 7 results support the hypothesis of the present study that infants are capable of discriminating the features of objects in their moving as well as in their stationary forms, showing some recognition of the fact that objects can move. Bower's hypothesis was not supported. An interaction of group X motion should have resulted had infants shown discrimination with stable objects but not when the same objects were presented in their moving forms. Results showed main effects for groups and for motion, but the two factors did not interact as Bower's position would predict.

The correlations between the difference scores for each infant on moving versus stationary trials lends further support to the present experiment's hypothesis. Infants who
had poorer discrimination with stationary forms, had poorer discrimination with moving forms as well. This result is consistent with the hypothesis that recognition of moving objects depends on prior discriminability of the features inherent in their stationary forms. The use of an operant training procedure insured the infants' attention to relevant featural details of the stable objects. Rather than relying on the initial preferences, or lack of preference, in the infant a preference was trained in the present study. The results of the present study suggest that an operant technique may have some value in yielding unique information about perceptual or cognitive capabilities that would not be available with techniques tapping only typical behavior.

A main effect for moving versus stationary form was obtained from the analysis of the cube-minus-sphere difference scores obtained on day 7. Infants in both groups had larger cube-minus-sphere difference scores with the objects in a stationary form than with objects in a moving form. A selective examination of this effect for the cube-reinforced group (See Figure 5) might lead one to attribute the result to a generalization effect. Higher cube-minus-sphere difference scores reflect longer fixations to the cube. Since the cube-reinforced infants were trained to attend to the stationary cube, the generalization effect would predict higher difference scores in the stationary than in the moving form. Though infants in the cube-reinforced group did fit a generalization interpretation, infants in the sphere-
reinforced group did not. The generalization effect would predict lower cube-minus-sphere difference scores in the stationary form than in the moving form for the sphere-reinforced infants. However, the cube-minus-sphere difference scores were larger in the stationary than in the moving discrimination trials for these sphere-reinforced infants. Thus, both groups looked at the cube more in the stationary form than in the moving form. A more plausible explanation for this moving versus stationary form effect is that, even without training, there may be a preference for the cube when the objects are presented in a stationary form, and more of a preference for the sphere when the objects are in motion. Phenomenologically, to the experimenter, the cube in motion was more of a change from the cube in stationary form, than was the moving sphere from the stationary sphere. As they rotated in their circular paths, both objects tended to revolve on the dowels as well. Since the sphere was a bull's eye with a concentric pattern, the revolving form was more similar to the original stationary form than was the non-concentrically patterned cube. The change, or complexity, of the cube in motion may have resulted in an increased preference for the more stable and familiar sphere. The preference for the cube in stationary form is consistent with data from days 5 and 6. This, again, suggests that the stationary cube may have been a more attractive stimulus for the infant than was the stationary sphere. This explanation for the moving versus stationary form effect can be tested in future studies,
either by the use of two concentrically patterned objects as test stimuli, or by weighting the stimulus objects so that they do not revolve on the dowels. With either of these changes, if the hypothesis is correct, a reduction in the moving versus stationary form effect should result.

The order of presentation by motion interaction was also significant. Infants fixated the stationary cube more than the moving cube only for orders 3 and 4. Order 1 produced results in the same direction as those of 3 and 4, though they failed to reach significance. Order 2 resulted in a reversal of the trend, though, again, the effect was not significant. The order effects may be attributed to the number of stimulus changes involved in the four orders. With orders 1 and 2 the stimulus objects changed from the left to the right side of the display following every trial. For orders 3 and 4 the position of the objects was reversed only every other trial. Fewer changes may facilitate the infant's ability to find the preferred object.

The second ANOVA performed on the data from day 7 evaluated the factor of sex instead of order of presentation. The only new effect was the blocks by sex interaction, which, apparently, was due to a tendency for males to fixate the cube more than females on blocks 3 and 4 of testing, though these differences were not significant in tests of simple effects. Considering the number of F-tests performed, there is a possibility that one of the tests could reach significance, at least at the .05 level, merely by chance. There was no main
effect found for either block or sex, and simple effects
tests shed no further light on the interaction obtained. The
effect is marginal at best. The lack of an interaction of
blocks X sex X groups ($F(3,60) = .6651, p = .58024$) indicates
this result in no way influences the interpretation of the
main effect for groups.

In summary, the results of the discrimination testing
with stable objects indicated infants were able to respond
differentially to the two stationary forms. This result
was consistent with the predictions made by Bower's hypothe­
sis and by the hypothesis of the present study. Results of
the analysis with data of the generalization data from day 7
indicated infants were able to maintain their discriminative
responding when the objects were set in motion. This result
contradicts the predictions of Bower's theory, but supports the
hypothesis of the present study. Infants, if trained to attend
to relevant featural differences, can indicate recognition of
the features of objects that are in motion. Failure to
demonstrate recognition of moving objects in Bower's studies
may be due to inattention on the infant's part, rather than to
a deficit in his concept of the object and its ability to
move.

Having shown that recognition of the features of
moving forms is possible for 10-week-olds, the various
parameters influencing this ability can be investigated.
For example, at some point the speed of the movement must
affect discriminability. At some point movement must be so
fast that discrimination breaks down and the infant may respond either by fixating both objects equally as long, as Bower's position would predict, or by being unable to track the objects at all, thereby failing to demonstrate object permanence. Featural differences between the two objects may also affect behavior. Infants may find some stimulus characteristics more salient than others, and fail to discriminate in certain stimulus situations, despite the operant training procedure. What the child is capable of perceiving can be separated from that which the infant does not discriminate due to inattention or lack of differential preference. Recent studies examining the development of specific neural channels sensitive to different spacial frequencies (Banks and Salapatek, 1975) have used the preference technique introduced by Fantz (1961). The operant training procedure used in the present study should be used in such research to examine infant perceptual capability development.

Some measure of the salience of particular stimulus features could also be obtained by the ease, or speed, with which the infant learns the discrimination. In a concept formation, or abstraction study, for example, different groups of infants could be reinforced for responding to different stimulus dimensions. The same set of stimulus objects, varying in a number of dimensions, would be presented, two at a time, to all groups, but the criterion for reinforcement would vary from group to group. One group might be reinforced for making a discrimination based on color, for
example, while a second group is required to discriminate on the basis of size or shape. The speed, or ease, with which a group develops discriminative responding relative to the other groups, would depend on the salience of the critical dimension for that group.

The operant techniques are useful in determining what the infant is capable of perceiving. However, if one is interested in determining the dimensions to which an infant habitually attends, an operant technique may not be essential in obtaining discriminative responding. A Fantz-like (1961) preference technique would demonstrate discriminability as long as the stimulus dimensions tested were particularly salient. For example, in the context of the present experiment, if the infant can show a strong preference for one stable object over another, these objects could be presented to the infant in moving form without prior operant discrimination training. Since a preference was already developed for the stable form, the infant should be capable of maintaining this preference with the moving forms. As in the present experiment, this study should also demonstrate that infants are able to conserve the identity of the features of moving objects.

Though, at times, a study such as the one outlined above, may yield the same information as one that involves extensive operant training, the operant approach has at least one significant advantage. Studies that depend on typical, rather than maximum behaviors run the risk of assuming a
slower development of capabilities than is really the case. What the infant does without training may be very different from what he/she is capable of doing, given a bit of reinforcement. For example, the interpretation of Piaget's (1952) theory of cognitive development, which is based on typical behaviors, may be underestimating the speed with which various behaviors develop. An operant approach to these areas could be a powerful tool which could have broad implications for much of child psychology.
REFERENCES


