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The Search Behavior of 12 to 14 Month-Old Infants on a Five-Choice Invisible Displacement Hiding Task*

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Twelve- to 14-month-old infants were presented with a series of invisible displacement hiding trials at a first location (A) and, subsequently, at a second location (B). Infants had to choose among five salient alternative search locations on each trial. Contrary to Piaget's Stage V task predictions, infants did not make the "A, not B" search error. That is, infants seldom searched at A during B-hiding trials. Instead, beginning with the first hiding trial at B (and at A), search responses tended to cluster at or near the correct hiding location. The results are interpreted in terms of a memory hypothesis which suggests that infants are generally able to encode, store, and retrieve at least some information concerning the current spatial location of objects during invisible displacements.

The various types of errors made by infants in the process of searching for hidden objects have, since Piaget's (1954) original observations, served as a rich source of data for making inferences with respect to the cognitive development of infants. For example, nine-month-old infants, having successfully found an object hidden at a first location (A), have been observed to continue searching at A when the object is hidden, in full view of the infant, at a second location (B). This "A, not B" or $\overline{AB}$ search error, originally noted by Piaget (1954) and replicated by others (e.g., Butterworth, 1975, 1976, 1977; Evans & Gratch, 1972; Gratch, Appel, Evans, Le Compte, & Wright, 1974; Gratch & Landers, 1971; Harris, 1973, 1974), is considered by Piaget to be typical of Stage IV in

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the Sensorimotor Period (8 to 12 months of age) and has been interpreted by Piaget as evidence that such infants are egocentrically concerned with their own actions and cannot yet appreciate the permanence of objects in space or the systematic nature of spatial relationships. However, this interpretation of the $\overline{AB}$ error has recently been called into question by the finding of the present authors that the $\overline{AB}$ error occurs primarily as an artifact of the almost universally employed two-choice hiding task (Bjork & Cummings, 1979; Cummings & Bjork, 1977). When only a two-choice hiding task is employed, there is only one incorrect location at which the infant can search on a B-hiding trial—the A location. Thus, any overt search errors made during B trials are constrained to be A-returning or $\overline{AB}$ errors.

Using hiding tasks with more than two choices, which do not constrain B-trial search errors to be $\overline{AB}$ errors, Cummings and Bjork (1977) found no tendency for nine-month-old infants to search incorrectly at the A location on B-hiding trials. Instead, searches during B trials clustered at or near the B location. From this pattern of responses, Cummings and Bjork concluded that nine-month-old infants are capable of encoding, storing, and retrieving some information about the current spatial location of an object as it is hidden in successive locations. However, these processes are not always sufficient to produce completely accurate search responses, resulting in incorrect searches clustered around the correct location. The finding that, when not constrained to make $\overline{AB}$ errors, nine-month-old infants show no tendency to incorrectly search at or near the A location during B-hiding trials, but rather tend to search at or near the B location, casts considerable doubt upon Piaget's contention that such infants link objects with the first location in which they act upon the object and, thus, apparently do not comprehend the substantive permanence of objects or the systematic nature of spatial relationships.

In addition to the implications for Piaget's assumptions concerning Stage IV infants, the findings of Cummings and Bjork (1977) have implications for Piaget's assumptions regarding Stage V (12 to 18 months) infants. Piaget contends that by Stage V in the Sensorimotor Period, infants have arrived at an appreciation of the permanence of objects and the objective nature of space, but only in situations in which the displacements of objects in space can be directly perceived. Stage V infants are not considered capable of symbolically representing an invisible object; thus, when faced with the task of finding an invisibly displaced object (e.g., an object first concealed in a larger container and then hidden), the infants are thought to revert back to cognitions based upon practical or action schemata. That is, when objects are not visibly displaced, infants are assumed to revert to their previous tendency of linking an object with the location in which they first acted upon it. Accordingly, in a search task involving two separate hiding locations and invisible displacement of the object, Stage V infants may be capable of finding the hidden object in a first location (A), but should incorrectly search again at A when the object is hidden in a second location (B). Piaget's observations (Piaget, 1954, pp. 66–78) tend to substantiate this prediction with regard to Stage V search errors. However, as was the case with Piaget's studies of the search behavior of 8- to 12-month olds, it is not clear that Piaget's Stage V infants were presented with a salient, alternative hiding location other than the A or B locations during B-hiding trials. Thus, the significance of infants incorrectly searching at the A location during B-hiding trials must be questioned. Is it the case that infants search at A during B-hiding trials because of a reversion to their previous tendency to link an object with the location in which they first acted upon it, consistent with Piaget's (1954) action-object theory of object permanence development; or is it the case that infants cannot always remember the object's exact current location, and incorrectly search at A during B-hiding trials because the constraints of the testing situation allow for no other overt search error, consistent with the assumptions of Cummings and Bjork's (1977) memory explanation of infant search behavior? The present study attempts to answer this question by determining if Stage V infants, in an unconstrained invisible displacement task, will continue to search at the A location during B-hiding trials.

METHOD

Subjects. A total of 48 infants (27 males and 21 females) whose median age was 13 months and 6 days, and whose ages ranged between 11 months and 26 days and 14 months and 7 days, were tested in the present study. Eight of these infants were not included in the data analyses because they made no errors during either A- or B-hiding trials, and thus might be considered to be in a later stage of development than Stage V. Five additional infants were omitted from consideration because they were incorrect on all A trials, although each was correct on at least one B trial. The data from these latter infants cannot be interpreted with regard to Piaget's prediction of $\overline{AB}$ errors, since for the A location to acquire a special significance for the infant, the infant must act upon the object at least once at the A location. Three further infants were excluded for failing to search on any trial. Thus, a total of 32 infants (14 males and 18 females; median age 13 months and 5 days; age range from 11 months and 26 days to 14 months and 7 days) were considered in the analyses for this study. The infants were located by means of birth announcements in a local newspaper, such announcements being automatically published whenever a birth certificate is issued.

Apparatus. A block of white foam rubber, 30 in (76 cm) long, 12 in (30 cm) wide, and 4 in (10 cm) thick, served as the basic apparatus. Five holes, 5 in (12.7 cm) high, 3 in (7.62 cm) across, and 1.5 in (3.81 cm) deep, were cut into the foam rubber block. Each hole was 4.5 in (11.43 cm) from the hole next to it measured from center to center, or 1.5 in (3.81 cm) from the hole next to it measured from the two closest edges. Of these five holes, only the far left and far right holes were used as hiding locations, and these holes were 18 in (45.72 cm) apart from center to center. Dark yellow felt pieces, slightly less than 3.75 in (9.5 cm) wide and 8.75 in (22.22 cm) long, were used as hiding covers. With the dark yellow hiding covers in place, adjacent covers were separated by an intervening space of the white foam rubber apparatus of slightly more than one inch. A red plastic key or a red octopus were used as search objects during warmup trials. A single rubber animal (a yellow duck or a blue bear) that could be squeaked to attract the infant's attention, but which did not make any noise when moved or dropped into the hiding hole, was used as the hiding object during experimental trials. A lidless, white plastic margarine container, 5 in (12.70 cm) in diameter, served as the vehicle for invisible displacement. Experimental toys could fit easily within the hiding hole, so that the felt cover hiding the toy would lie flat on the apparatus. Similarly, the toys fit within the margarine container so that, when turned upside down, no part of the toy was visible during displacement.

Design and Procedure. The infants were tested in their own homes on a convenient rug covered floor. The infants were positioned directly in front of the middle hole of the apparatus. The infant's mother sat directly behind the infant on the floor, while the experimenter sat directly across from the infant on the opposite side of the apparatus. A second adult recorded the infant's responses on each trial.

The infants were given four warmup trials to familiarize them with the apparatus and the task of retrieving toys from the apparatus. In two trials the infant found a toy uncovered and in two trials the infant found a toy partially covered at the A location. All infants were able to perform the warmup trials successfully.

The experimental trials began with the hiding of a toy five consecutive times at a first location (A). These trials were followed by five consecutive hidings of the same toy at a second location (B). Only the far left and the far right holes served as hiding locations, and each was assigned to be the A or B location equally often. Further, infants were assigned at random to one of the two possible A-B hiding sequences: far left-far right or far right-far left.

During experimental trials, the experimenter held the toy in one hand and the margarine container in the other, so that both were easily visible to the infant. The open side of the margarine container faced the floor at this time. The experimenter squeaked the toy to attract the infant's attention and then slipped the toy, in full view of the infant, into the upside down container, where it was held in place by the hand that was holding the container in such a way that no part of the toy was visible to the infant. The procedure was repeated if the infant stopped looking at the toy before it was hidden in the container. The hiding of the toy in the container always took place at a point just behind and above the middle hole of the apparatus. Next, the experimenter moved the container, still containing the toy, to a point just above the correct hiding location for that trial. The near edge of the felt piece covering the hiding location was then lifted by the experimenter's free hand and the container moved into position between the felt cover and the hole. The experimenter then released the toy from the container, allowing it to drop into the hiding hole. The container was next carefully removed so as not to show the toy to the infant and, at the same time, the felt piece was lowered to cover the toy. Then the experimenter moved the still-face-down container to a point just behind and above the middle hole. At this point, the inside face of the container was turned toward the infant, revealing to the infant that the container was now empty. Infants were never allowed to search until the inside of the container was shown to be empty, and the empty container was always held at this middle position until the end of the trial. Experimenters received considerable training prior to the actual test trials to ensure that they could perform this procedure without revealing the toy to the infant. The mother was instructed to gently restrain the infant by placing her hands on the infant's shoulders if an attempt was made to search before the hiding procedure was complete; however, such restraint was seldom necessary. After successfully finding the toy, the infant was allowed to play with it for several seconds before the next trial was begun. If the infant did not search for the toy successfully, the experimenter retrieved the toy for the infant before the infant could search further. The infant was then allowed to play with the toy for a few seconds before the start of the next trial.

The present procedure constitutes a departure from Piaget's hiding procedure in one respect: Piaget did not reveal the empty contents of the container to the infant after hiding. Piaget's infants had to search the displacement apparatus to assure themselves it was, in fact, empty before they could be certain that the toy was in one of the potential hiding locations. We felt that Piaget's procedure too closely resembled sleight-of-hand, and might produce errors due to confusion, rather than to an inability to represent objects symbolically in an invisible displacement. Our procedure requires the infant to keep track of the object's whereabouts during an invisible displacement, but does not place upon the infant the additional burden of having to guess whether the experimenter hid the toy in the hiding location or still had the toy in the container.

RESULTS

A-Trial Data. The frequencies of correct searches and of each type of search error made during the five A-hiding trials are presented in Table 1. As can be seen from this table, the infants revealed a strong tendency to search at or near the correct location on the first A-hiding trial, with this tendency increasing over subsequent A-hiding trials.

TABLE 1
Frequency of Search at the Five Alternative Search Locations During A-Hiding Trials

	Response Type[a]					
Trial Number	Correct Hole Searches (A)	Searches at 1st Closest Hole to A	Searches at 2nd Closet Hole to A (Middle Hole)	Searches at 3rd Closest Hole to A	Searches at 4th Closest Hole to A	Failures to Search
1	17	4	8	2	0	1
2	14	9	6	2	0	1
3	17	11	4	0	0	0
4	22	8	1	1	0	0
5	23	5	3	1	0	0
Total[b]	93	37	22	6	0	2

[a] N = 32; chance correct for each trial = 6.4.
[b] Chance correct for all A trials = 32.0.

As an index of the direction of search efforts, the number of searches made at the correct hiding location and at the location closest to the correct hiding location was compared to the number of searches made at the third and fourth closest locations to the correct hiding location on each of the five A-hiding trials. (The middle-hole data were omitted since, in the present context, it is ambiguous whether searches at the middle hole indicate knowledge or lack of knowledge of the correct hiding location.) Infants were significantly more likely to search at or near the correct location than at the two locations furthest from the correct location on each A-hiding trial ($X^2(1)=14.08$, $p < .001$; $X^2(1)=16.00$, $p < .001$; $X^2(1)=26.02$, $p < .001$; $X^2(1)=25.30$, $p < .001$; $X^2(1)=23.30$, $p < .001$, respectively). Clearly, from the first A-hiding trial, infant search efforts were not random or haphazard with respect to the correct location of the object. Rather, from the first hiding trial, search behavior reflected considerable knowledge of the correct spatial location of the hidden object.

B-Trial Data. The frequencies of correct searches and of the various types of search errors occurring on each of the five B-hiding trials are presented in Table 2. With respect to B-trial performance, the primary issue is whether infants perseverate by continuing to search at the A location, consistent with the prediction of Piaget's (1954) action-object account of infant search performance; or whether infants tend to search at locations close to the correct location (now the B location), consistent with the prediction of Cummings and Bjork's (1977) memory account of infant search behavior.

To test between these predictions, the number of searches made at the B location, and the location closest to the B location, was compared to the number of searches made at the A location, and the location closest to the A location, during each B-hiding trial. (Searches at the middle hole were omitted from these analyses because it is not clear whether middle hole searches indicate a tendency

TABLE 2
Frequency of Search at the Five Alternative Search Locations During B-Hiding Trials

	Response Type [a]					
Trial Number	Correct Hole Searches (B)	Searches at 1st Closest Hole to B	Searches at the Middle Hole	Searches at 1st Closest Hole to A	Searches at the First Hiding Location (A)	Failures to Search
1	10(8[b],7[c])	8(6,4)	7(6,4)	4(1,1)	3(2,1)	0(0,0)
2	16(15,10)	6(3,3)	5(2,2)	2(1,1)	3(2,1)	0(0,0)
3	18(16,12)	7(5,4)	3(0,0)	2(1,1)	2(1,0)	0(0,0)
4	22(18,14)	5(4,3)	2(0,0)	1(0,0)	1(1,0)	1(0,0)
5	24(19,15)	3(2,2)	0(0,0)	3(1,0)	1(1,0)	1(0,0)
Total [d]	90(76,58)	29(20,16)	17(8,6)	12(4,3)	10(7,2)	2(0,0)

[a] N = 32; Chance correct for each trial = 6.4 (4.6,3.4).
[b] Performance of infants correct on the fifth A trial; N = 23.
[c] Performance of infants correct on the fourth and fifth A trials; N = 17.
[d] Chance correct for all B trials = 32.0 (23.0,17.0).

to search in the direction of the correct location (B) or in the direction of the A location.) These comparisons revealed no tendency for infants to search at or near the A location; instead, they revealed a significant tendency for infants to search at or near the currently correct location during each B-hiding trial ($X^2(1) = 4.00$, $p < .05$; $X^2(1) = 9.48$, $p < .005$; $X^2(1) = 13.78$, $p < .001$; $X^2(1) = 19.86$, $p < .001$; $X^2(1) = 15.60$, $p < .001$, respectively). Further, an analysis involving only those infants who were correct on the fifth A-hiding trial revealed a similar tendency to search at or near the B location during each B-hiding trial ($X^2(1) = 5.88$, $p < .025$; $X^2(1) = 9.32$, $p < .005$; $X^2(1) = 14.08$, $p < .001$; $X^2(1) = 17.38$, $p < .001$; $X^2(1) = 14.08$, $p < .001$, respectively), as did an analysis involving only those infants correct on both the fourth and fifth A-hiding trials ($X^2(1) = 4.92$, $p < .05$; $X^2(1) = 9.60$, $p < .01$; $X^2(1) = 11.52$, $p < .001$; $X^2(1) = 15.06$, $p < .001$; $X^2(1) = 15.06$, $p < .001$, respectively). The search performance for these two subgroups of infants is shown, respectively, in the parentheses in Table 2. These results are particularly striking in light of the fact that, during A-hiding trials, not a single infant ever searched at what was to become the B-hiding location.

A- Versus B-trial Performance. It is of interest to determine whether infants performed more poorly on B-hiding trials than on A-hiding trials. As can be seen from a glance at Table 1, showing the A-trial data, and Table 2, showing the B-trial data, in terms of overall performance, the two blocks of trials produced essentially the same number of errors. However, the drop in correct performance between the last A-hiding trial and the first B-hiding trial is significant (McNemar $X^2(1) = 7.58$, $p < .01$).

DISCUSSION

Piaget suggests that for the 12- to 18-month-old infant "the object . . . still remains dependent on its context as a phenomenalistic whole, and on the practical and dynamic schema which it extends when it is subjected to invisible displacements" (Piaget, 1954, p. 77). The primary support for this contention derives from the supposed tendency for infants, during invisible displacement tasks, to search at the first location in which they found the object (A), when the object is hidden at a second location (B). However, the present experiment—employing an unconstrained, invisible displacement hiding task—found no evidence to support the notion that infants make $\overline{AB}$ errors on invisible displacement problems. To the contrary, the search performance obtained in the present five-choice invisible displacement task, like the results of Bjork and Cummings (1979) and Cummings and Bjork (1977) with respect to a five-choice visible displacement task administered to nine-month-old infants, implies that the $\overline{AB}$ error occurs primarily as an artifact of task situations, which either constrain infants to search at A when erring during B trials, or which provide the infant with no salient location, other than A, at which to search incorrectly on B trials.

It might be argued that infants did not make the $\overline{AB}$ error in the present situation because they were more advanced than Stage V. This argument is not persuasive, however, since the present infants were in the lower range of ages suggested by Piaget's work on Stage V (12 to 18 months), and more advanced Stage VI infants should, theoretically, not make any errors on an invisible displacement task. With respect to this point, it is important to note that only four of the 48 infants tested ever searched at the A location during B-hiding trials. It is also unlikely that the pattern of performance obtained on the present five-choice task occurred because this task was in some way easier than a two-choice task. Bjork and Cummings (1979) compared infants' performance on a two-choice apparatus, with hiding locations the same distance apart as in previous two-choice studies, to their performance on a five-choice apparatus of the present dimensions, and found that infants made an equivalent number of errors on visible displacement hidings on each apparatus.

In the present experiment, rather than searching at or near the A location during B trials, infants revealed a strong tendency to search at or near the B location. In fact, on each of the five B trials, infants searched most frequently at the correct location, with the number of searches made at an incorrect location systematically declining with its distance from the correct location. Further, since infants tended to search at or near the correct location on the first B trial and on the first A trial, it seems unlikely that search choices in either case can be attributed to Piaget's notion of practical learning. We believe that the pattern of search behavior obtained in the present unconstrained situation can be explained more cogently in terms of the memory hypothesis previously suggested by Cummings and Bjork (1977). According to this hypothesis, it would be assumed that the present infants are capable of encoding, storing, and retrieving information concerning the current spatial location of objects during invisible displacements, but that these memory processes are not always sufficient to allow for completely accurate search performance. Such an explanation is consistent both with the tendency demonstrated by the present infants to search at or near the correct location on A and on B trials, and with the observation that this trend was apparent from the first hiding trial at A and at B.

In addition, the current memory hypothesis can explain how infants, capable of correctly performing a visible displacement task, might not be capable of correctly performing an invisible displacement task. First, the processing demands and the memory load are greater in the invisible displacement task. For example, in the present task, the infant must notice and remember both that the toy has been concealed in the visible, larger container, and where the container was located when the toy was "invisibly" dropped from it into the hiding hole. Second, the invisible displacement procedure can be thought to function essentially like a distractor activity in a memory or recall task. That is, before searching for the hidden object, the infant must somehow realize that the object is no longer concealed in the larger container. In the present experiment, the infant must look at the container revealed to be empty by the experimenter; in other invisible displacement procedures, the infant must often search the container. Thus, either by increasing the processing and memory load placed upon the infant, or by requiring the infant to engage in a distracting activity just prior to the moment when the infant must retrieve the hidden object's location, the difficulty of encoding, retaining, and/or retrieving precise location information is increased; consequently more search errors occur.

Further, the improvement in performance over A trials, the drop in performance from the last A trial to the first B trial, and the rapid recovery of search accuracy over B trials—all observed in the present experiment—can be explained in terms of the present memory hypothesis. The general increase in correct searches from the first to the last A trial would be expected since, over successive hidings at the A location, the infant's encoding of the object's location should become more accurate and/or less vulnerable to loss through distraction. However, when, on the first B trial, the location of the object is changed, it is unlikely that the infant's processing of the object's location would be sufficient to produce an encoding that uniquely specifies this new location. More likely, on the first B trial, as on the first A trial, the infant's processing of the object's location would produce an encoding only accurate enough to direct search to the vicinity of the correct location. The occurrence of more errors on the first B trial than on the first A trial could arise because the information processing demands are greater during the first B trial than during the first A trial. On the first B trial, the infant must notice and encode for later retrieval both that the object is no longer being hidden at A and that it is now being hidden at B. Hence, the infant has relatively less time or capacity to come up with a precise encoding of the object's current location on the first B trial. However, by the second B trial, the information processing demands would be more similar to those present on the preceding A trials, and the infant's search performance could return to A-trial levels. In addition, having warmup trials at A might have enhanced first trial performance at A. Finally, it should be noted that there is nothing in the current memory explanation of search performance that precludes infants from searching at the A location on B-hiding trials. However, given the assumption that infants have the ability to process information concerning the current location of hidden objects, incorrect searches at A should be relatively uncommon whenever there are alternative (incorrect) locations that are closer to (or perhaps in some other way more confusable with) the correct location than A.

While the present results suggest that infants can effectively encode, store, and retrieve information concerning the spatial location of objects, it remains for future research to determine the relative roles of these processes in producing both successful and incorrect search behavior. It may turn out that infants have more trouble with one process than another at different stages of development. In addition, we feel that the relative effects of these processes on performance will most likely vary as a function of the nature or demands of the particular task to be performed—for example, the type of cues that are potentially available for encoding the object's location, or the type of distraction or interference occurring between hiding and search.

Findings from previous research can be interpreted to shed some light on this issue. For example, several studies (Bremner, 1978a, 1978b; Butterworth, 1979) have found that in two-choice visible-displacement hiding tasks, search performance is improved when covers of two different colors are used on a hiding apparatus of uniform color, but not when the covers are the same and each side of the hiding apparatus has a distinctive color. The differential effects of these two stimuli can be explained in terms of their potential to be noticed and used as encoding cues by the infants. The cloth covers are felt, picked up, and handled by the infants in performing the search task, making them highly salient stimuli in the infants' immediate surround and, consequently, more likely to be used by the infants as cues for encoding the hidden object's location. A similar interpretation can be made of Bremner's (1978b, Experiment 2) finding that infants make fewer search errors when the spatial relationship of a hidden object to the infant changes owing to movement of the infant rather than to movement of the object. As Bremner suggests, the movement of the infants could alert them to the fact that a change is taking place. We would further suggest that this movement alerts the infant to the need to encode the object's location in terms of a cue that will remain stable or invariant with respect to rotation. When such a cue is readily available—such as salient black and white covers—the infants' search errors are dramatically reduced. Thus, these results point to insufficient encoding as the primary source of search errors. Further, Gratch et al.'s (1974) finding that infants are no more likely to err in a 7-sec delay condition than in a 1- or 3-sec delay condition suggests that limited storage capacity is unlikely to be a principal source of search errors. However, research to date only hints at the primary source of the infant's difficulty, and considerably more work on this issue is necessary.

Our contention that performance in both invisible and visible displacement tasks can be accounted for in terms of memory processes requires a discussion of previous findings that have been interpreted as damaging to a memory explanation of the Stage IV error. In particular need of explaining is Harris's (1974, Experiment 1) finding that 12-month-old infants searched at an object's prior location (A) even when the object was visibly present at a new location (B). In this study, infants first received three pretest A trials in which a car, located behind a transparent barrier, was pushed down a track to one of two transparent doors, which the infants could open to retrieve the car. Infants then received, in counterbalanced order, one A test trial, in which the car was pushed to the same door as before, and one B test trial, in which the car was pushed to the opposite door, only now both doors were locked. On both A and B test trials, most infants first approached the door behind which the car was visible but, finding it locked, then approached the opposite or empty door. Thereafter, infants vacillated between the two locked doors.

Because infants approached the visibly empty A door on B test trials, Harris ruled out a memory explanation of the $\overline{AB}$ error. However, this interpretation ignores the finding that during A test trials, infants also approached the visibly empty B door after finding the A door locked. That is, approaching the empty door was not peculiar to B test trials or the $\overline{AB}$ error. Thus, a more plausible interpretation—consistent with performance on both A and B test trials—is that infants saw and understood where the car was, on either A or B test trials, and were merely trying all possible strategies to gain access to it. Further, since infants had been able to open the A door on three previous occasions, it seems unlikely that they would be more persistent in approaching the empty door during B-test trials than during A-test trials. Thus, the results of this study may reflect problem solving strategies and be largely irrelevant to a memory explanation of the $\overline{AB}$ error.

Similarly, the somewhat perplexing results of Harris's (1974) Experiment 2 would seem to be explainable in terms of problem-solving strategies. In this study, which tested both 10- and 12-month-old infants, the three pretest A trials were followed by a single B-test trial during which neither door was locked, but the B door was now opaque and the car was removed from the B location before search was permitted. On the B trial, the younger infants approached the opaque B door more persistently than the A door, were about equally divided on which door they approached first, and were significantly less persistent in approaching the A door than the older infants—a pattern of behavior inconsistent with the Piagetian viewpoint. On the other hand, the older infants, who were equally persistent in their approaches to both doors, showed a greater, though nonsignificant, tendency to initially approach the A door than the B door—a tendency which could be interpreted as inconsistent with a memory explanation of the $\overline{AB}$ error. However, in contrast to Experiment 1, where a memory explanation would lead one to expect most infants to initially approach the B door on B-test trials, as they did, there are several reasons why infants might not be expected to initially approach the B location in Experiment 2. First, the infants might not know at the start of the B-test trial that the opaque B door is openable; nothing in the procedure description indicates that the infants would have such knowledge at this point. Second, the infants only observe the car traveling in the direction of the B-side of the apparatus, and it is not clear from the procedure description what clues, if any, indicate to the infants that the car actually comes to rest behind the opaque B door and might, thus, be retrievable through it. Third, the process of removing the car from the B location, also not described, could have been detected by some infants. For any of these possibilities, infants would have no particular reason to initially approach the B location. Then, once the infants have discovered that they cannot retrieve the car through either door, their persistence in approaching the apparatus could reflect their continued attempts to somehow gain access into the apparatus, as in Experiment 1. Or, with the car not retrievable through either door, the alternate opening of the two doors may simply become the most interesting thing to do during the long 90-sec search period. (An analysis of how infants distributed their approaches throughout the 90-sec search period would have implications for this last possibility.) In summary, the behaviors observed in Experiment 2, as in Experiment 1, seem quite reasonably to reflect problem-solving strategies in a confusing situation rather than to speak either for or against a memory explanation of the $\overline{AB}$ error.

The effects of object visibility on search performance has also been investigated by Butterworth (1977), who compared performance in a two-choice visible displacement task when the object was (a) completely hidden at A and B (OH), (b) covered with a transparent cover at A and B (OC), or (c) visible and uncovered at A and B (OV). In all conditions, infants made more errors on the first B trial than on the first A trial, which in the OC and OV conditions might be considered as inconsistent with a memory hypothesis. However, B trials presented infants with a completely different problem than A trials, due to the introduction of a 3-second delay between hiding and search. Some infants may have looked away from the toy during this delay and, thus, not have taken advantage of the toy's potential visibility at the time of search. Moreover, as might be expected from a memory hypothesis, infants in the OV condition were generally correct, while performance in the OH condition was significantly worse and at chance level. On the other hand, the finding of no significant difference in the number of errors made in the OH and OC conditions is puzzling. If—in the OC condition—the object is still visible when covered, one might expect fewer errors than when the object is completely hidden. It may be that the transparent cover acts as a distractor, increasing the likelihood that infants would look away from location B after hiding and not look back at the time of search. Another possibility is that the toy was not clearly visible through the transparent cover except from a certain vantage point that was not assumed by all infants at the time of search. Clearly, further research is needed to determine the source of difficulty in this condition.

In conclusion, the present study has demonstrated that 12- to 14-month-old infants show little tendency to make the $\overline{AB}$ error in invisible displacement tasks when not constrained to do so by the design of the task situation. The observed tendency for infants to search at or near the currently correct location on both A and B trials is more consistent with a memory explanation of search errors than with an explanation suggesting a failure to comprehend the objective reality of objects and space. The performance obtained in the present five-choice hiding task demonstrates that infants perceive, encode, and remember more about the location of objects in space than has previously been indicated in two-choice hiding tasks.

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