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SEARCH BEHAVIOR ON MULTI-CHOICE HIDING TASKS: EVIDENCE FOR AN OBJECTIVE CONCEPTION OF SPACE IN INFANCY *

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Nine- to 10-month old infants were presented with a series of visible displacement hiding trials at a first location (A), and, subsequently, at a second location (B). Infants had to choose among 3, 5, or 6 salient alternative search locations on each trial. Infants seldom searched perseveratively during B-hiding trials, regardless of the number of alternative search locations presented. Instead, infant search attempts tended to cluster around the currently correct location during A- and B-hiding trials on all apparatuses. These findings suggest that infants do not err on visible displacement tasks because they (a) link objects with previous action-locations, (b) rely upon egocentric spatial reference systems, or (c) confuse different hiding locations as a result of a specific form of retrieval competition from the previous hiding location. The results are discussed as evidence for a memory explanation of infant search behavior which contends that infants comprehend the objective nature of spatial relationships, but are less effective information processors than older individuals.

Piaget (1954) observed that 8- to 12-month old infants, having successfully located on object hidden at a first location (A), often continue to search at A when the object is hidden at a second location (B). Numerous studies have replicated this finding (e.g., Butterworth 1977; Corter et al. 1980; Evans and Gratch 1972; Frye 1980; Harris 1974;

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Schuberth et al. 1978). According to Piaget, this perseverative pattern of search occurs because infants define the position of objects in space in terms of their own actions upon objects. Infants are said to be incapable of objectively representing the spatial location of hidden objects. Instead, when faced with the task of finding an object hidden at B, infants use practical schemata linking the object with the first place they acted upon it (A).

However, recent research (e.g., Acredolo and Evans 1980; Bremner 1978a, 1978b; Butterworth 1975, 1977, 1979) has shown that the nature of task demands can affect the likelihood of perseverative search. In some task situations infants have usually been found to search correctly during B hiding trials, while in other conditions infants have been shown to seldom search correctly. These results have led to a modification of Piaget's hypothesis. According to this modified position, infants are said to be capable to searching objectively, but objective search is dependent upon the availability of adequate cues regarding the external spatial framework. When spatial location cues are lacking or insufficient, infants are seen as reverting to an egocentric frame of reference, with a resultant tendency towards perseverative search.

More recently, Cummings and Bjork (1981a, 1981b) have questioned whether the hiding tasks employed in the literature to date can be interpreted to provide evidence that infants are unable to search objectively for hidden objects. They propose that the observed patterns of perseverative search are a result of the virtually universal use of two-choice procedures. Such procedures constrain infants either to search correctly during B-hiding trials or to make perseverative errors by searching at the A location. Thus, only perseverative errors are permitted by a two-choice task. Cummings and Bjork found that when infants are presented with more than two search alternatives, they do not tend to make perseverative errors during B-hiding trials. On the contrary, infant search attempts tend to be oriented towards the currently correct location. More specifically, when infants are presented with a five-choice hiding procedure in which the A and B locations are positioned on opposite sides of the apparatus, search attempts tend to form a spatial gradient around the currently correct location, i.e., search attempts at a given location become progressively more frequent the nearer the location is to the correct location.

Cummings and Bjork proposed a memory explanation to account for infant search behavior. According to this memory explanation, variations in search accuracy in different hiding situations can be accounted for in terms of differences in the information processing demands of tasks. For example, the relatively large number of errors found in the first B hiding trial can be attributed to greater information processing demands on that trial than on any other during typical AB testing sequences. During A hiding trials, the infant must notice and encode only that the object is hidden at A. On the first B trial, the infant must notice and encode 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. Under such conditions, an infant's processing of the object's new location would less often be sufficient to produce an encoding that uniquely specified this location. However, the encoding produced should usually be accurate enough to direct search to the vicinity of the new location. By the second B trial, the information processing demands would be less because the infant would have had another trial to make encoding of the object's location more accurate and/or less vulnerable to loss through distraction. Thus, infants should be able to produce a more precise encoding of the object's current location on the second B trial than on the first B-hiding trial.

This memory explanation is quite different from Piaget's hypothesis both theoretically and in terms of the predictions it makes regarding infant search behavior. In Piaget's theory there is a failure of memory in that the new location is not registered by the infant during B hiding trials; consequently, such information cannot in any way affect the infant's search choices. According to the present memory explanation, infants do comprehend the objective nature of objects and space, and thus search attempts should form a spatial gradient around the currently correct location. Infant errors are said to reflect inadequate, but nonetheless objective, spatial location codes. Errors are seen as indicating encodings of spatial location information that are accurate enough to direct search to the vicinity of the correct location, but are not accurate enough to produce correct search.

The present memory hypothesis and recent modications of Piaget's theory (e.g., Acredolo and Evans 1980; Bremner 1978a) are in agreement in the sense that both interpret correct searches as indicating a reliance on objective spatial location codes. However, there is disagreement with regard to the need to employ a concept of egocentrism to explain infant search errors. Evidence in support of an egocentrism notion can be questioned because the two-choice tasks employed in most studies constrain all search errors to be "egocentric." Further, the patterns of search found in five-choice tasks reveal no evidence of reliance on an egocentric frame of reference when infants err.

Finally, the present memory explanation should be distinguished from the proactive interference hypothesis suggested by Harris (1973). Harris accounts for infant errors in terms of a specific type of interference during B hiding trials owing to retrieval competition from previous hiding locations. The current memory approach proposes that much broader consideration be given to the information processing demands of task situations. Prior search at the A location is seen as only one of many factors potentially influencing search behavior during B hiding trials. In addition, although it may be the case that retrieval competition can be made into a relatively important fator affecting infant search behavior by means of some manipulations of the task situation (for example, by making A location cues highly similar to B location cues in a multi-choice apparatus), Cummings and Bjork's findings suggest that this specific form of retrieval competition resulting from A location hiding trials has probably not been a significant source of error during B hiding trials in the task situations typically reported in the literature.

The current research further investigates these issues. Cummings and Bjork only report results for 12- to 14-month old infants on invisible displacement tasks. One purpose of the present study is to determine if their findings extend to the behavior of 9- to 10-month old infants on visible displacement procedures. A second aim is to examine whether the patterns of search behavior reported in Cummings and Bjork might in some sense be a function of hiding objects at the end locations in a five-choice task. To test this possibility infants are presented with 3-, 5-, and 6-choice visible deplacement tasks, and target objects are hidden at the midline as well as at end locations.

Method

Subjects

The subjects were 54 infants (29 males and 25 females) whose median age was 9 months and 18 days and whose ages ranged from 9 months 1 day to 10 months 15 days. There were 45 9-months old infants and 9 10-month old infants. Three additional infants were excluded for failing to search correctly on any A-location experimental trial. 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

Three blocks of white foam rubber, 30 in. (76 cm) long, 12 in. (30 cm) wide, and 4 in. (10 cm) thick, served as hiding apparatuses in the study. One block of foam rubber had 3 holes cut into its surface, one had 5 holes, and the other had 6 holes. Holes in the 3 hole apparatus were circular and 5 in. in diameter, whereas holes in the 5 and 6 hole apparatuses were rectangular, 5 in. (12.7 cm) long, 3 in. (7.6 cm) and 2.5 in. (6.4 cm) wide, respectively. In each case, holes were 1.5 in. (3.81 cm) deep. The distance of holes from each other, measured from the nearest edges, was 4 in. (10.2 cm), 1.5 in. (3.8 cm), and 1.5 in. (3.8 cm) for the 3-, 5-, and 6-hole apparatuses, respectively. However, only the end holes and the middle holes were used as hiding locations on the 3- and 5-hole apparatuses, and only the holes adjacent to the end locations were used as hiding locations in the 6-hole apparatus. Therefore, the closest distance between hiding locations, measured from the nearest edges, was 4 in. (10.2 cm) on the 3-hole apparatus, 6 in. (15.6 cm) on the 5-hole apparatus, and 9.5 in. (24 cm) on the 6-hole apparatus. Felt pieces were used as hiding covers. A red plastic key and a small red octopus acted as hiding objects during warmup trials. A single toy that could be squeaked or shaken to attract the infant's attention but which made no noise when lowered into the hiding hole (a rubber animal or a rattle) was used as the hiding object during experimental trials.

Design and procedure

Subjects were tested in their own homes on a convenient rug covered floor. Infants were positioned one or two feet away from the apparatus directly in front of the middle hole. The infant's mother sat behind the infant on the floor while the experimenter sat across from the infant on the opposite side of the apparatus. A second adult recorded the infant's responses and timed the delay interval involved.

Eighteen infants were tested on each of the 3 hiding apparatuses. Warmup trials in each case consisted of two trials in which the infant found a toy uncovered and two trials in which the infant found a toy partially covered at the A location. All infants were able to perform warmup trials successfully. Experimental trials began with the complete hiding of a toy 3 consecutive times in a first location (A). This was followed by 3 consecutive hidings in a second location (B). All possible orders of assigning the designated hiding locations were used. This resulted in the following 6 orders of assigning hiding locations (left, middle, and right holes) to A- and B-hiding trials in the 3-choice task: left-middle; right-middle; left-right; right-left; middle-left; and middle-right. There were also 6 hiding orders employed for the hiding locations (far left, middle, and far right holes) in the 5-choice task: left end–middle; right end–middle; left end—right end; right end–left end; middle–left end; and middle–right end. Finally, left–right and right–left hiding orders were used for the 2 designated hiding locations (hole adjacent to the left end hole and hole adjacent to the right end hole) on the 6-choice task. In the case of each task condition infants were randomly assigned to hiding orders, with the constraint that each hiding order for a given apparatus be used equally often.

During experimental trials, the experimenter shook or squeaked the toy over the hole in which it was to be hidden until the infant looked at the toy. The toy was then lowered into the hole and covered. The procedure was repeated if the infant stopped looking at the toy before it was covered. Infants were required to wait for 3 sec after the toy was covered before searching for the toy. A head nod by the adult recording infant responses was the signal to the experimenter that the 3-sec interval was completed. If infants tried to reach for the toy before 3 sec had elapsed, mothers were asked to restrain them by gently holding their shoulders or, if infants continued to reach, by putting their arms to their sides. After successfully finding the toy, infants were allowed to play with it for several seconds before the next trial was begun. If infants unsuccessfully searched for the toy, the experimenter retrieved it for them before they could search further. They were then allowed to play with it for several seconds before the start of the next trial.

Occasionally an infant would grab or touch more than one cover while reaching towards the apparatus. In such cases, the experimenter recording the infant's responses made a decision as to which hole the infant was trying to uncover. These decisions were usually obvious. Interrater reliability (agreements/agreements plus disagreements) for these decisions, based upon 10 sessions in which two raters accompanied the tester, was 100%.

Results

The frequencies of search at each location during 3-, 5-, and 6-choice tasks are presented in tables 1, 2, and 3, respectively. Italicized numbers indicate the frequencies of correct searches during each hiding trial. The left versus right orientation of hiding locations did not affect search patterns. Thus, the tables are simplified to show only whether the object was hidden at the midline or the ends of an apparatus. These data retain the relative positioning of search attempts in terms of proximity to the currently correct, previously correct, and non-hiding locations. To illustrate, the first three rows of table 1 present search frequencies at the A location for the 6 infants whose A trials were either in the left or right holes, and whose B trials were in the middle location.

Three-choice task

Three-choice tasks have several limitations which affect their usefulness for examining infant search patterns. Most seriously for the issues considered here, the previous hiding location is also the closest hole to the correct location during B-hiding trials employing the middle-end hiding sequence. According to the present memory hypothesis, this should tend to increase the incidence of searches at the A location during these trials for reasons other than perseveration. Another problem is that when the correct location is the middle hole, the gradient of search attempts around the currently correct location canot be examined. The analyses below that address the predictions of the currently proposed memory hypothesis for the 3-choice task are thus confined to instances in which the correct location is an end hole.

The pattern of infant search attempts during A- and B-hiding trials on the 3-choice task is consistent with the notion that infants are generally guided by an objective frame of reference during search. During each A-, and the last two B-, hiding trials infants searched at the correct location and closest hole to the current location with a

Table 1
Frequencies of search at each location for different hiding sequences on the 3-choice apparatus.

	First end hiding location	Middle location	Second end location	Failure to search
End – middle sequence [a]	A	B		
Trials				
A1	*5*	1	0	0
A2	*5*	1	0	0
A3	*4*	2	0	0
B1	0	*6*	0	0
B2	0	*4*	1	1
B3	0	*6*	0	0
End – end sequence [b]	A		B	
Trials				
A1	*5*	1	0	0
A2	*4*	2	0	0
A3	*6*	0	0	0
B1	1	4	*1*	0
B2	0	3	*3*	0
B3	0	1	*5*	0
Middle – end sequence [c]	B	A		
Trials				
A1	0	*6*	0	0
A2	0	*4*	1	1
A3	0	*4*	0	2
B1	*2*	2	0	2
B2	*3*	0	0	3
B3	*3*	2	0	1

Note: Frequencies of search at correct locations are italicized.
[a] Combines left–middle and right–middle hiding orders.
[b] Combines left–right and right–left hiding orders.
[c] Combines middle–left and middle–right hiding orders.

greater frequency (100%) than would be expected by chance (67%), $ps < 0.05$, binominal tests. On the first B-location hiding trial, there was a greater frequency of errors at the closest hole to the correct location than at the farthest hole from the correct location, $p = 0.06$, binominal test.

Infant errors did not tend to be perseverative during B-hiding trials. Only 3 perseverative errors were made on the first B-hiding trial, and only 5 perseverative errors were made altogether during all 3 B-hiding trials. On the first 2 B-hiding trials fewer errors were directed at the A location than were directed at the non-hiding location. As predicted, most searches at the A location during B-hiding trials (4 of 5) occurred when the A location was also the closest hole to the currently correct location. Success during A-hiding trials did not predispose infants to perseverate during B-hiding trials. The eight infants who searched correctly on all three A-hiding trials made only one perseverative error on the first B-hiding trial.

Finally, infants were able to search more accurately for objects hidden at the middle hole than for objects hidden at the end location during B-hiding trials. An analysis comparing performance during middle location hidings versus the combined performance during end location hidings was statistically significant on the first B-hiding trial, X^2 $(1) = 6.25$, $p < 0.05$.

Five-choice tasks

The 5-choice task allows for a better evaluation than the 3-choice task of objective versus perseverative notions concerning infant search behavior. The addition of 2 extra holes makes possible a more detailed mapping of children's conceptions regarding the location of the hidden object.

The pattern of search behavior on the 5 choice task is also consistent with the notion that infants employ an objective frame of reference both when searching correctly, and when erring, during A- and B-hiding trials. Infant search attempts at the correct location and the two closest holes to the correct location were more frequent (88% or more) than would be expected by chance (60%) during each A- and B-hiding trial, ps < 0.05, binominal tests. As can be seen from an examination of table 2, search attempts during both A- and B-hiding trials tended to form a spatial gradient around the currently correct location.

There was again little support for the notion that infant search is perseverative during B-hiding trials. Only 1 error on the first B-hiding trial was perseverative, and only 4 perseverative errors were made across the entire sequence of B-hiding trials. The 10 infants who were correct on all A-hiding trials made only one error at the A-hiding location during the first B-hiding trial. The 3 non-hiding locations elicited many more errors than the first hiding location during B -hiding trials. There were 6 errors at non-hiding locations on the first

Table 2
Frequencies of search at each location for different hiding sequences on the 5-choice apparatus.

	First end hiding location	Non-hiding location	Middle location	Non-hiding location	Second end location	Failures to search
End – middle sequence [a]	A		B			
Trials						
A1	*6*	0	0	0	0	0
A2	*6*	0	0	0	0	0
A3	*3*	2	1	0	0	0
B1	0	0	*6*	0	0	0
B2	0	1	*4*	1	0	0
B3	0	0	*3*	3	0	0
End – end sequence [b]	*A*				*B*	
Trials						
A1	*5*	0	0	0	0	1
A2	*6*	0	0	0	0	0
A3	*5*	1	0	0	0	0
B1	1	0	0	2	*3*	0
B2	1	0	2	0	*2*	1
B3	0	1	1	1	*3*	0
Middle – end sequence [c]	*B*		*A*			
Trials						
A1	0	1	*4*	1	0	0
A2	0	1	*5*	0	0	0
A3	0	0	*5*	1	0	0
B1	*1*	4	0	0	0	1
B2	*3*	1	1	1	0	0
B3	*2*	3	1	0	0	0

Note: Frequencies of search at correct locations are italicized.
[a] Combines left end–middle and right end–middle hiding orders.
[b] Combines left end–right end and right end–left end hiding orders.
[c] Combines middle–left end and middle–right end hiding orders.

B-hiding trial, and a total of 21 errors at non-hiding locations across the 3 B-location hiding trials.

Search was again more accurate during the first B-hiding trial when the correct location was the middle hole than when it was an end location, $X^2\ (1) = 4.79$, $p < 0.05$.

Six choice tasks

An advantage offered by the present 6-choice task is that the two closest holes to the correct location, and the previous location, do not overlap. Infants again evidenced a consistent pattern of objective search on the 6-choice task. Infants searched at the correct location and the 2 closest holes to the correct location more often (89% or more) than would be expected by change (50%) during each A- and B-hiding trial, $p < 0.01$, binomial tests. Further, there was never an instance of search at the 2 locations furthest from the correct location during either A- or B-hiding trials. Interestingly, while infant errors were clearly clustered near the correct location during B-hiding trials, the large majority of these errors occurred at the midline rather than the end location closest to the correct location.

The findings with regard to the notion that infant errors are perseverative during B-hiding trials were striking. There was not a single instance of an infant erring at the A location during B-hiding trials (eight infants searched correctly on every A-hiding trial).

Finally, there were no sex differences in performance on any of the above task situations.

Table 3
Frequencies of search at each location for different hiding sequences on the 6-choice apparatus.

	End location	First hiding location	Midline location	Midline location	Second hiding location	End location	Failures to search
Sequence [a]		A			B		
Trials							
A1	1	*13*	4	0	0	0	0
A2	2	*13*	2	1	0	0	0
A3	1	*14*	2	1	0	0	0
B1	0	0	2	5	*11*	0	0
B2	0	0	1	4	*13*	0	0
B3	0	0	0	4	*12*	1	1

Note: Frequencies of search at correct locations are italicized.
[a] Combines left–right and right–left hiding orders. Only the holes adjacent to the end locations were used as hiding locations on this apparatus.

Discussion

The findings of the present study are inconsistent with the propositions that infants err on visible displacement tasks because they (a) link objects with previous action-locations, or (b) confuse different hiding locations as a result of a specific form of retrieval competition from the previous hiding location. In addition, there was no evidence that infants rely upon an egocentric spatial reference system when they err, although it might be argued, in defense of this notion, that the present visible displacement tasks don't present infants with a salient egocentric alternative. As predicted by the currently proposed memory explanation, infant search attempts tended to cluster around the currently correct location during A- and B-hiding trials in all 3 task situations. Thus, the pattern of results are consistent with the notion that the search behavior of 9- to 10-month old infants on visible displacement tasks is guided by an objective understanding of spatial relationships.

The central point of the present work is that hypotheses based upon the notion that infant search behavior is perseverative don't account for infant errors on straightforward multi-choice visible displacement tasks that simply involve hiding objects under covers. It is not our claim that infant errors may never reflect retrieval competition, or that infants, like older children (e.g., Acredolo 1977), don't sometimes reveal patterns of search that appear egocentric (however, see Cox (1980) for discussions regarding the usefulness of the egocentrism notion). Different task situations may produce different patterns of search both in infants and in adults. For example, with regard to infants, one would expect frequent errors at the A-location even on 5- and 6-choice tasks if the A location were made the closest hole to the correct location. We do contend, however, that an information processing analysis of task demands which assumes that infants are objective, albeit less effective, processors of information can best account for search patterns across the entire range of hiding situations.

At the present time, the currently proposed memory explanation is not sufficiently developed to be considered more than simply a general framework for thinking about infant search errors. It remains for future research to investigate many issues, such as the ways in which the encoding, storage, and retrieval processes may be different or limited in the infant as compared to older individuals, or what the relative roles of these processes are in producing both successful and incorrect search behavior in the infant. For example, it may turn out that infants have more trouble with one process than another at different points in their development. Perhaps storage capacity remains relatively constant throughout development and from individual to individual, while encoding and retrieval processes are more subject to individual patterns of development through exposure to different types of experiences and training that lead the infant to develop encoding and retrieval strategies of varying degrees of effectiveness.

Some light has already been shed on the factors that may influence the infants' processing of spatial location information. Infants have been found to be better able to encode a hidden object's location when covers are of two different colors than when each side of the apparatus is a different color (Bremner 1978a; Butterworth 1979). Further, 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 movement of the object (Bremner 1978b). These results may be interpreted to indicate that the relative saliency of spatial location cues importantly influences ease of coding and/or retrival. Acredolo and Evans (1980) have shown that infants as young as 6 months of age are better able to keep track of positions in space when landmarks are provided, but it is not until 11 months of age that infants can take advantage of landmarks associated with the *irrelevant* position. This research suggests that as infants get older they are better able to encode and/or retrieve a broad range of spatial location cues.

In the present study, infants were more often correct during B-hiding trials in 3- and 5-choice tasks when the object was hidden in the middle hole than when it was hidden at an end location. This result is consistent with Butterworth's (1975) finding that infants search more accurately in a 2-choice task when the object is hidden on the infant's midline than when it is hidden away from the midline. We suggest that hiding an object in the middle hole faciliates accurate encoding and/or retrieval because it uniquely specifies the location of the object both in relation to the infant and in relation to other locations on a multi-choice apparatus (note that only the former of these cues was present in Butterworth's procedure). Butterworth also found that the use of a semicircular hiding apparatus in which the midline and peripheral locations were equidistant from the infant (in a horizontal or flat apparatus the midline hole is always closest to the infant) eliminated any advantage resulting from hiding the object at the midline. This finding suggests that proximity may be an important variable affecting salience of the midline for encoding and/or retrieval. The fact that infant errors tended to occur at the midline location closest to the correct location during B-hiding trials on the 6 choice task may indicate that when an object is hidden at an inside location infants can more easily encode that the object is *not* hidden at an end location than they can encode the precise inside location at which it is hidden. Alternatively, a response bias on the part of infants to search at locations nearest to them may have been a factor on the 6-choice task (Lasky et al. 1980). However, given two locations equally close to the infant, the preference during search was clearly for the closest location to the currently correct location.

Several studies in the literature provide support for a memory explanation of infant search behavior. Harris (1973) and Gratch et al. (1974) found it was necessary to insert a delay between the time the object is hidden and the time the infant is allowed to search for the object in order to produce errors during B-hiding trials. Further, Webb et al. (1972), using a 3-choice paradigm involving 14 and 16-month old infants, concluded that the high incidence of correct searches obtained when 16-month old infants were given a second opportunity to search for objects indicated at least some information about the objects' last location had been stored in memory. In addition, recent studies (Fox et al. 1979; Kagan and Hamburg 1981) suggest that there is a major enhancement of memory capabilities in the last half of the first year, coincident with the infant's rapid improvement on object permanence tasks during this period (Gratch and Landers 1971).

However, there are some results obtained using 2-choice hiding tasks that seem to be at odds with the present memory explanation of infant search behavior. Harris (1974) and Butterworth (1977) have reported that infants err even when the object is visible during B-hiding trials – findings that, on the surface at least, appear to be inconsistent with the notion that B-trial errors are primarily produced by memory failures (note, however, the discussion of these results in Cummings and Bjork 1981a). Recently, Frye (1980) evaluated several hypotheses regarding the AB error by means of a paradigm in which various tasks were introduced after A hiding trials. When this task was a total hiding procedure or a Piagetian support problem, fewer errors resulted during subsequent B-hiding trials than when the task was a partial hiding procedure, a distractor activity, or a no activity (control) condition.

Frye interprets these results as evidence for a Piagetian intercoordination of schemes hypothesis. However, the currently proposed memory explanation can at least partially account for Frye's results. The total hiding procedure can be seen as providing infants with practice in skills directly relevant to success on hiding tasks, resulting in improved performance during B-hiding trials (see Jackson et al. 1978). The distractor, partial hiding, and control conditions would not be expected to improve performance relative to the total hiding procedure because these conditions did not provide such practice. Performance on the support problem is more puzzling; an explanation in terms of the currently proposed memory hypothesis awaits further investigations of the information processing variables influencing infant performance on this task.

Some findings have been reported that might be seen as consistent with the notion that infants search perseveratively on multi-choice tasks. Piaget (1954) conducted several trials in which infants had to find an object hidden at a third location; infants in these instances were thus presented with three possible alternatives. However, the fact that infants searched at the previous (A or B) hiding locations on these trials is inconclusive as a test of perseveration because infants were not given search alternatives at non-hiding locations. In their reply to Cummings and Bjork (1981a), Schuberth and Gratch (1981) reported a small replication study ($N = 8$) using an invisible displacement hiding procedure in which 62% of the infants made perseverative errors on the first B-hiding trials in a 5-choice task. Seven of these infants completed a subsequent 2-choice task and a majority again made perseverative errors on the first B-hiding trial. In a rejoinder to this reply, Cummings and Bjork (1981b) argued that the small sample size involved and the non-significant nature of the perseverative trend found on the first B-hiding trial make these results inconclusive, although it remains possible that procedural differences between the studies produced the difference in results. In a study completed prior to Schuberth and Gratch's research, Bjork and Cummings (1979) found that infants who made perseverative errors on the first B-hiding trial on a 2-choice task never made perseverative errors on the first B-hiding trial of a 5-choice task in which A and B trials were conducted at opposite ends of the hiding apparatus. In the 5-choice task infant errors formed a spatial gradient around the correct location on B-hiding trials. This study is particularly significant because it demonstrates that differences in the outcomes of 2-choice and multi-choice studies cannot be attributed solely to differences in subject selection or hiding procedures. As might be expected from an analysis of the information processing demands of these tasks, infants completing both tasks were somewhat more likely to err during A (23%) and B (19%) hiding trials on the 5-choice task than on the 2-choice task.

Finally, infants may not always take advantage of their proposed ability to objectively encode, store, and retrieve spatial location information from memory. Infants that are inattentive, distressed, or overwhelmed by the information processing demands of tasks might be expected to search less objectively. Acredolo has nicely illustrated this performance – competence distinction (see also Lingle and Lingle 1981). She found that infants were more likely to perform accurately when they were tested in the home than when they were tested in the laboratory (Acredolo 1979). However, in a subsequent study (Acredolo 1981), it was discovered that infant performance in the laboratory was comparable to performance in the home if infants were first given a short "get acquainted" period prior to testing. Acredolo concludes that these results indicate the importance of the infant's feelings of security to performance on spatial localization tasks.

In conclusion, the present research suggests that the infant's understanding of the nature of objects and space has been underestimated in previous studies, and demonstrates the need in infancy research to examine experimental paradigms for features that may inadvertently prevent infants from fully revealing what they understand about the nature of objects and space.

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