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Object permanence in cats and dogs

ESTRELLA TRIANA and ROBERT PASNAK
George Mason University, Fairfax, Virginia 22030

Object permanence was assessed for cats and dogs, using tasks analogous to those typically employed for human infants. Neither species solved all of the problems correctly when rewarded only by the discovery of a hidden toy. However, both species showed that they had fully developed concepts of object permanence when the problems were changed so that the animals had to search for hidden food in an odor-control procedure. These results indicate that sensorimotor intelligence is completely developed in these nonprimates.

Children and nonhuman primates have fully developed concepts of object permanence, which is the culmination of the sensorimotor stage of intelligence (Vaughter, Smotherman, & Ordy, 1972; Wise, Wise, & Zimmerman, 1974; Wood, Moriarty, Gardner, & Gardner, 1980). Recent experiments have shown that nonhuman primates share with children at least some aspects of representative intelligence, as indexed by the various conservations (Pasnak, 1979; Woodruff, Premack, & Kennel, 1978). These findings are not incompatible with the suggestion of Piaget and Inhelder (1966) that the cognitive operations involved in object permanence provide the basis for further intellectual growth.

Gruber, Girgus, and Banuazizi (1971) reported that cats demonstrated four of the six stages of object permanence delineated by Piaget in his work with children. In their experiments, cats did not show satisfactory evidence of the ability to persist in the discovery of a hidden object after distraction. Their report provides the only evidence of a mammal in which the development of object permanence, once begun, does not proceed to its culmination. These authors did not attempt to measure the cat's ability to solve problems involving successive visible or invisible displacements.

At first glance, it seems improbable that such an advanced carnivore would fail to find an object from which it had been momentarily distracted, especially when there was only one possible hiding place. The same is true of tracking an object visually through several hiding places (successive visible displacement) and proceeding directly to the last one. Even successive invisible displacement does not seem too difficult for a species that lives by hunting.

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It has already been shown that birds have object concepts (Cerella, 1979; Herrnstein, Loveland, & Cable, 1979) and that rats are sensitive to the sequences in which significant objects (food pellets) may be found (Hulse & Dorsky, 1979). Thus, there is some empirical evidence that nonprimates make some of the inferences central to object permanence. While it may indeed be that, as Gruber et al. (1971) suggest, cats regularly fail to solve distraction tasks because their concept of object permanence is not fully developed, a more thorough test is indicated. Moreover, their ability, if any, to produce logical solutions of successive visible displacement and invisible displacement tasks has never been assessed. As far as is known, only humans and their near relatives, the nonhuman primates, can consistently solve all types of object permanence problems on a logical basis.

The present research was conducted to provide a more thorough test of the extent to which nonprimates possess the concepts indexed by object permanence. Both cats and dogs were tested, so that misleading interpretations would not result from the idiosyncracies of one species. Variations in the age at which different domestic breeds or specific individuals master a particular phase of object permanence is not of great importance to psychologists. Hence, a power study was deemed appropriate; what one dog or cat can do, others must also be able to do, albeit a bit sooner or later.

A power study, because it depends on the behavior of one or a few individuals to provide evidence for the existence of a given conceptual ability, does not permit inter- or intraspecies comparisons. Yet, tabulating or statistically comparing the relative success and failures of multiindividual samples of animals would not identify the intellectual *capacity* of a species satisfactorily and, in fact, is often quite misleading. If one individual can consistently and reliably demonstrate a given level of concept attainment, the performance is proof that this level is within the capacity of the species. Many failures by other individuals

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cannot invalidate this conclusion; they may identify the typical *performance* of a species, but not the conceptual *ability* of the species. Inasmuch as motivational and attention variables interfere with many animals' performances on conceptual tasks, especially in free response situations, this approach is the one that has had to be used in studies of object permanence in animals (Vaughter et al., 1972; Wise et al., 1974). The most convincing studies of higher level conceptual behavior in animals (Czerny & Thomas, 1975; Gardner & Gardner, 1969; Pasnak, 1979; Woodruff, et al., 1978) likewise are power studies and report the behavior of one or a few subjects. Such an approach may require, however, that enough individuals be tested to ascertain the upper limit of performance. Otherwise, one might erroneously conclude, on the basis of a string of failures, that a species was incapable of a certain level of conceptual behavior.

EXPERIMENT 1

Method

Subjects. Ultimately, 32 cats and 23 dogs were tested; none had had any prior experience with the test operations and materials. Fifteen cats were from a local animal shelter, 5 were from a pet shop, and 12 were from private homes. Twelve dogs were from the animal shelter, 3 from the pet shop, and 8 from private homes. The responses of the individuals of each species that consistently produced the best performances are described in detail. These individuals were an 11-month-old male golden retriever and a 4-month-old female Abyssinian cat from private homes.

Apparatus. Soft fabric pillows measuring $6 \times 6 \times 2$ cm were used as toys. Three 31×31 cm plywood squares with 7-cm metal legs were completely draped with 48×48 cm squares of cloth and used as covers to hide the toys as needed. The cloth-covered plywood squares, all toys, and the sheet used to cover the test area were laundered in the same washer load with the same brand of detergent after each subject's test. A styrofoam cup measuring 6×6.5 cm was also employed in some experimental tasks.

Procedure. There were two experimenters; one manually restrained the animal before each trial and the other hid the toy under the appropriate cover. All testing was conducted either in a quiet, isolated room in the animal shelter, in a secluded area in the pet shop, or in the private home where the animal lived. Each animal was allowed 15 min to adjust to the test area and to the experimenters. After this time period, the animal went through a step-by-step test procedure based on the "human analogue tasks" of Wise et al. (1974). The animal is considered to shock object permanence at the level measured by each of these tasks if he makes a persistent effort to retrieve the toy from the place where it should logically be found. Because attention is a critical variable, trials were repeated when the animal's attention lapsed. A criterion of five consecutive persistent and accurate solutions on six trials wherein the animal appeared to be attentive was adopted.

The tasks were as follows:

Task 1. Visible displacement: The animal was induced to play with a toy and then, as the animal watched, the toy was hidden under the single cover in the animal's visual field.

Task 2. Visible displacement with three covers: The animal was to watch as the toy was hidden under one of three covers placed in a line (frontal plane). A random order was used to select the cover under which the toy was hidden.

Task 3. Successive visible displacement: The animal was required to watch as the toy was apparently hidden under each of the three covers, in random order, and left under the last one.

Task 4. Superimposed covers: The animal was to watch as the toy was hidden under one cover, which, in turn, was covered with the second cover and then with the third. [Each cover could be made to fit snugly over a lower cover by being rotated a few degrees. In this position, its cloth drape would completely hide the lower cover(s) and the floor below.]

Task 5. Invisible displacement: One cover was present in the visible field; the animal was to attend to the toy as it was hidden under Styrofoam cup, which, in turn, was hidden under the single cover. The cup was then taken from under the cover (leaving the toy behind) and displayed to the animal to show that it was empty.

Task 6. Invisible displacement with three covers: Three covers were present in the visible field (two had no role in the task, but could be perceived as alternative hiding places). As in Task 5, the toy was hidden in a Styrofoam cup, which, in turn, was hidden under one of the three covers. The toy was deposited under the cover and then the cup was shown to the animal to demonstrate that it was empty. (A random protocol was used to select the cover under which the toy was hidden on any given trial.)

Task 7. Successive invisible displacement: The toy was concealed in the cup; then, as the animal watched, the cup was apparently hidden under each of the three covers in sequence. (The sequence used was varied randomly from trial to trial). The toy was left under the last cover in the sequence and the empty cup was displayed to the animal.

Task 8. Distraction: One cover was present in the visual field. After the animal was induced to play with one toy, it would be distracted with a second toy (by the experimenter who restrained the subject). While the animal was distracted, the first toy would be hidden under the cover by the other experimenter. The distracting toy would then be taken away, and the animal allowed to search for the hidden toy.

Results and Discussion

While many of the dogs tested could solve Tasks 1-5 with little difficulty, only one could solve Task 6 (invisible displacement with three covers) consistently. None could solve Task 7 (successive invisible displacement). Typical performances of the best animal (an 11-month-old male golden retriever) are described below.

> *Task 6.* The dog watched as the cup was hidden under the right cover (where the toy was deposited). Then the cup was removed and shown to be empty. Immediately the dog walked up to the right cover, lifted it up with his nose, and seized the toy with his jaws.

> *Task 7.* The dog watched as the cup was moved from under the right cover to under the center cover and then to under the left cover, where the toy was deposited. The dog watched as the cup was removed from the left cover and shown to be empty. Without hesitation, he walked straight to the central cover, lifted this cover enough to be able to sniff this area, then backed away and let the cover drop.

Responses to Task 7 were not systematic for any dog. However, many dogs were able to solve Task 8 (distraction). Table 1 shows the number of animals that solved each task.

Table 1
Individual Performances on Object Permanence Problems

	Task 1	2	3	4	5	6	7	8
Cats	16	7	1	8	0	0	0	7
Dogs	18	19	16	14	7	1	0	10

Note—The data presented represent the number of individuals making five consecutive accurate and persistent solutions for the given tasks. Three dogs and 14 cats ignored the task presentations altogether.

Many cats solved Tasks 1, 2, 4, and 8. A single cat (a 4-month-old female Abyssinian) was able to solve Task 3 (successive visible displacement) consistently. A typical segment of its performance record is presented below.

Task 3. The cat watched as the toy was placed first underneath the left cover, then underneath the center cover, and finally underneath the right cover and left there. The cat walked slowly up to the right cover, then put one paw underneath this cover and followed with the other paw until she had batted the toy out.

On Task 5 (invisible displacement), no cat, no matter how old, gave any indication that it knew where the toy was. A typical performance of the only cat that had solved Task 3 consistently was as follows.

Task 5. The cat watched as the cup was taken from underneath the only cover present in her visual field. The cup was presented empty to the subject. The cat just lay down and continued to look straight ahead. Finally, the cat sat up and licked herself.

Likewise, no cats were able to master Task 6 or Task 7.

It is noteworthy that animals of both species failed to solve invisible displacement tasks but were able to solve the task involving distraction. Their relative difficulty for human infants has not yet been determined, but both types of task require a higher level of inference from the subject than do the other object permanence tasks. It appears that the animal's difficulties with invisible displacement tasks represent a performance deficit rather than a conceptual deficit. While it was usually possible to induce an animal to play with a toy that the experimenter moved about, they seldom gave any evidence of motivation to seek a covered toy. Many cats would not attempt even Task 1, and some of the cats and dogs that did respond did so lackadaisically and erratically. Complicated procedures that necessitated a short wait before the animal could be allowed to hunt for the toy exacerbated the problem of maintaining the animal's incentive. It is not clear why an animal should seek to retrieve a silent, odor-free, unmoving, hidden object. Many cats tested very carefully made no response at all that would indicate an ability to solve Task 3 or any higher tasks, and it is easy to see why Gruber et al. (1971) concluded that cats could not solve Task 8. Some of the more motivated ones do produce consistently correct solutions of Task 8, however, and there is even a hint of this in the behavior of one home-reared kitten tested by Gruber et al., although that kitten was not persistent enough to be accounted successful.

Odor controls are difficult, given the olfactory acuity of these animals. The primary control here was to launder together the plywood covers and drapes, the cloth toys, and the sheet on which they were presented, which should have imparted an identical odor to all of them. Different objects were employed on each trial to prevent an accumulation of odor from handling. The many failures of the animals tested indicate that there was no odor cue available to give away the hiding place of the toy. Yet, by using an odorous object (food) in a deception procedure, it is possible to provide more conclusive proof that no odor cues are present. Such a procedure might also solve the problem of adequately motivating the subject. For both of these reasons, and because the fact that the animals failed to solve some tasks (Task 7 in the case of the dogs and Tasks 5-7 in the case of the cats) but still solved the distraction problem could lead to fanciful interpretations, a second experiment was conducted.

EXPERIMENT 2

Method

Subjects. Two dogs and three cats from private homes were tested. The performances of the first animals tested, a 4-year-old male Labrador retriever and a 15-month-old female Abyssinian cat, are described in detail. All of these animals were experimentally naive.

Apparatus. The apparatus was the same as that used in Experiment 1, except that Dog Yummies and chunks of cooked hamburger were substituted for the small cloth pillows.

Procedure. Tasks 3-8 were administered to these animals using pieces of food rather than toys as bait. The tasks were modified to control for odor cues. Essentially, control was accomplished by covertly hiding the food at some place other than the place where logic would indicate that it had been hidden. By observing where the animal sought the food, solutions based on logic could be distinguished from those based on odor cues.

The tasks were administered as follows:

Task 3. Successive visible displacement: Three covers were present in the visual field (frontal plane). The experimenter held her hand palm down with a bit of food in her fingertips. The experimenter hid her hand under each cover in a random order. When her hand emerged from under the first two covers, the animal could easily see that the food was still in the experimenter's fingertips. However, the hand appeared to be empty when it emerged from under the third cover. The experimenter (who had palmed the food) returned her hand to her lap, never allowing the animal to see that the food was in her palm rather than under the last cover.

Task 4. Superimposed covers: The experimenter hid the food under one cover. With one hand, she placed the second cover over the first, rotating it slightly so that it fit snugly. While she placed the third cover over the other two, she removed the food with her second hand (which was entirely screened).

Task 5. Invisible displacement: The animal watched as the food was hidden in a cup and the cup was hidden under the single cover in the visual field. Before the cup was brought out from under the cover, the food was covertly removed from within the cup and hidden in the experimenter's hand so that the cup could be shown to be empty to the animal. The experimenter then returned the cup (and her hand) to her lap.

Task 6. Invisible displacement with three covers: This task was similar to Task 5 in all respects except that three covers were present in the visual field. The cover under which the food was ostensibly hidden was chosen randomly. The other covers had no role in the task, except that they could be perceived as alternative hiding places.

Task 7. Successive invisible displacement: Three covers were present in the visual field. The subject watched as the food was hidden in the Styrofoam cup; then the cup was moved under each cover, in random order. The food would be surreptitiously left under one of the first two covers. The cup was shown to be empty as it was removed from under the last cover.

Task 8. Distraction: One cover was present in the visual field. After the animal was teased with a piece of food, it would be distracted with a toy. The experimenter would hide the food in the palm of her hand and place her hand in her lap. The toy would be removed, and the animal was allowed to search for the food.

Results

All five animals tested with food as an incentive solved all problems readily. Intense attention and vigorous responding were the rule, especially when cooked hamburger was used as bait. The following transcript provides an example of the first dog's response to Task 7:

> *Task 7.* The cup was first placed under the center cover (where the food was dropped covertly), then under the left cover, and then under the right cover. The cup was then shown to the dog to be empty. The dog quickly moved to the front of the right cover, put his nose underneath the cover, and then pushed the cover upward to expose the place where the food should logically have been hidden.

Likewise, the cats consistently solved each of the tasks in a logical manner. The following is a transcript of an Abyssinian's first reaction to Task 6 (invisible displacement with three covers):

> *Task 6.* As soon as the cup was removed from under the left cover and shown to be empty, the cat hurried to this cover (not to the experimenter's hand where the food, in fact, was). The cat then persistently pushed back the cover until the place where the food should have been was entirely revealed. The cat continued to poke at the cover with its forepaws and tried to push its face underneath for approximately 3 more minutes.

This cat's solutions to Task 7 and the other tasks were logically correct and were pursued with a great deal of intensity and persistence. When two other cats were tested as a check, one had difficulty in actually reaching under the covers far enough for (theoretically) retrieving the bait in Task 4, although it sought persistently for it under the stack of covers on all six trials. Otherwise, these cats had no difficulties, and appeared to be quite attentive and alert throughout the procedure.

DISCUSSION

These results indicate, in contrast, with those of Gruber et al. (1971), that cats do possess the full range of concepts involved in object permanence. It appears that "sensorimotor intelligence" is fully developed in these animals and also in dogs, which have roughly comparable cortical development. The differences between the present findings and those of Gruber et al. are mostly due to methodology. The real difficulty is that there is no reward for the great majority of cats in retrieving an unmoving, silent, odor-free, covered-up object from which their attention has been distracted, and hence the cats will not show that they know where it is. Thus, Experiment 1, which involved a methodology similar to that of Gruber et al., produced similar results, except that some cats tested in the present research mastered the problem involving distraction. However, Experiment 2, employing food as a bait, produced evidence that both cats and dogs could master all tasks. In this respect, Experiment 2 resembles the work of Wise et al. (1974) and of Vaughter et al. (1972), who used food baits to produce evidence that object permanence was fully developed in their subjects (nonhuman primates).

The many failures to respond (or to respond systematically) in Experiment 1 do not indicate that most of the animals were deficient in concept development nor that the more successful ones were peculiar cases. Rather, it is necessary simply to set up a situation where any given animal will show what it knows.

The fact that correct solutions immediately ensued when an odorous bait was used in these tests inevitably suggests that odor cues provided the basis for the solutions. However, the procedure used in fact provides an unequivocal proof that the solutions were not based on odor cues. When the food could have been hidden under any of the three covers, both animals consistently selected the cover where the food should have been, according to logic, rather than the cover where it actually was hidden and possibly emitting odors. Similarly, when the food was hidden in the experimenter's hand and lap, rather than under cover, both animals searched for it under the cover where it should logically have been hidden, rather than smelling it out in its actual hiding place.

Note that in Task 8, the food was never under the cover, not even briefly, yet that is where the animals searched for it. Hence, these animals could not have been responding on the basis of their olfactory senses. It is apparent that the efficacy of the food bait lies in its role as an incentive, not in confounding odor cues. Probably the same is the case in the studies involving nonhuman primates, although those studies do not provide as clear a demonstration that odor cues are not involved.

The present tasks are the same as those used with infants; this is necessary—otherwise, as Wood et al. (1980) point out, task specifics must becloud interpretations and comparisons. Yet there has never been a formal methodological control for "clever Hans" effects in any human or primate research employing those tasks, even though presentations inevitably vary at least a little from trial to trial. There are several reasons for rejecting a "clever Hans" interpretation of the performances of either the present animals or of the human and nonhuman primates tested on similar object permanence tasks. First, the tasks intrinsically involve exceedingly obvious cues, so that solutions based on less obvious cues from the experimenter would be of a higher order of difficulty. Secondly, it is not easy to induce correct solutions by individuals deficient in the requisite cognitive abilities, even with the most obvious cuing, such as pointing to the correct hiding place. Finally, solution on the basis of "clever Hans" effects would require a prolonged opportunity to learn the meaning of the very subtle cues that might be produced by a familiar tester. When experimentally naive animals immediately produce correct solutions with strange testers, the conditions for a "clever Hans" effect have not been met.

It has become increasingly apparent that nonhuman primates are capable of some of the conceptual behavior involved in representative intelligence (Czerny & Thomas, 1975; Pasnak, 1979; Woodruff, Premack, & Kennel, 1978). Although some experiments (Herrnstein, Loveland, & Cable, 1976; Hulse & Dursky, 1979) have indicated that nonprimates are capable of inferences central to object permanence, it has been tempting to conclude from the work of Gruber et al. (1971) that object permanence—and hence sensorimotor intelligence—was not completely developed in nonprimates (Piaget, 1970). The present research indicates, however, that nonprimates as well as primates are capable of all of the inferences indexed by object permanence problems. Hence, it would appear that these nonprimates do, in accordance with all current versions of the Piagetian model, have the cognitive prerequisites for the next stage of cognitive development. A straightforward extension of the learning set theories that have been applied to the Piagetian model (Gagné, 1968; Klahr & Wallace, 1973) must then predict the development of at least the first stages of representative intelligence in these nonprimates. The alternative is to suppose that neural developments or learning experiences that are peculiar to primates are necessary conditions for the development of representative intelligence.

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