NATURAL CONCEPTS IN THE DOMESTIC DOG

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The current study investigated concept formation in domestic dogs, specifically that of a toy concept. The dog's differential responding (retrieval vs. non-retrieval) to two sets of stimuli suggested a toy concept. Differential responding occurred from the very first trial, indicating that the concept had been formed in the natural environment, not during the experiment. It was hypothesized that a common response may be responsible for the emergence of the class in the natural environment. The results demonstrated that it was possible to expand the class by adding previously non-retrieved objects to the toy class through a common response. It was also shown that the toy concept passed the more stringent criterion (transfer of function test) required to validate it as a concept.

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INTRODUCTION

Herrnstein and Loveland's 1964 study about the ability of pigeons to respond correctly to stimuli on the basis of a concept of "human" largely initiated the field of behavioral research into complex concepts in animals. Much research has since been generated to investigate various species and what concepts they can form, including recent research into concepts in dogs (Range, Aust, Steurer, & Huber, 2008). Range et al. demonstrated that dogs could differentially respond to pictures with dogs and without dogs present, and this performance continued when novel exemplars were presented. While the results of both studies could be considered demonstrations of a concept, there is debate over what criteria must be met to demonstrate a concept, and not all studies purporting to show a concept may meet the more stringent criteria.

With the first demonstration of a complex concept in an animal, Herrnstein and Loveland (1964), suggested the basic criterion for concepts. Their demonstration of a concept involved pigeons differentially responding to a set of positive stimuli containing humans and another set of negative stimuli that did not contain humans. Their criterion, then, was differential responding to two sets of stimuli. Keller and Schoenfeld (1950) similarly defined concepts as, "generalization *within* classes, and discrimination *between* classes" (p. 155).

Although the criterion of differential responding is maintained in all definitions of concepts, other researchers (e.g., Herrnstein, 1990; Lea, 1984) have added additional criteria for concepts and some of these criteria disqualify a performance as being a concept if stimulus generalization can account for it. In considering this matter, Herrnstein (1990) attempted to clarify the different ways in which an organism could correctly respond to complex stimuli by outlining five levels of categorization. He identified two levels that particularly pertain to the current study: open-ended categories and concepts. Open ended categories are those categories that have so many members that they cannot be learned by rote, as could a small set of exemplars; however, the range of stimulus feature variation within the category allows an organism to respond the same way to all members, even novel exemplars. The example Herrnstein provided was that of a squirrel that could not possibly learn all of the individual instances of an acorn, but would respond appropriately to new instances of an acorn due to feature similarity across all acorns.

Concepts, on the other hand, would be a category much like the open-ended category, but one that is sensitive to the contingency of reinforcement, such that if the contingency changed all members of the category would change in accordance with the new contingency. In Herrnstein's (1990) example, if acorns suddenly turned sour, the squirrel would respond to novel acorns as if they were also sour. Herrnstein proposed that this criterion should be met before an organism's responses to a set of stimuli can be considered a concept; typically, this is addressed through a transfer of stimulus function test. He developed this argument from Lea (1984) who also distinguished generalization by stimulus feature analysis from concept formation. Lea also recommended a test such as a transfer of stimulus function. However, Lea went further and added the negative criterion that any responding during the transfer test could not be accounted for by stimulus generalization. That is, similarity in stimulus features of the trained exemplar and the novel stimulus could not account for responding to the novel stimulus.

Thus, the literature provides several criteria that serve as benchmarks for evaluating an animal's performance as demonstrating a concept: 1) differential responding to two sets of stimuli; 2) sensitivity to changes in the reinforcement contingency, and 3) sensitivity to a change in the reinforcement contingency cannot be accounted for by stimulus generalization. These criteria are useful in evaluating an animal's behavior as demonstrating a concept or not.

Given that a performance can be considered as evidence of a concept, the next question that arises is on what basis is the animal responding when it performs in accordance with a concept? Several popular models of general concept formation are found in the psychological literature, including the classical, exemplar, and family resemblance views. In the classical view the concept consists of the actual information of what the necessary and sufficient features are for membership in the class (Komatsu, 1992). Responding then is based whether the novel stimulus has the necessary and sufficient features to be a member of the concept. In the exemplar model the class is represented by all of the past exemplars of the class without any abstraction occurring (Komatsu, 1992). The organism then references all of those past exemplars and if one closely coincides with the novel stimulus the organism responds in accordance with other members of the class. This is in contrast to the family resemblance model in which an organism generates a summary representation (an average member of the class) based on many exemplars of the class. Responding based on the family resemblance model is then based on whether or not the novel stimulus matches the summary of class members. Lea and Harrison (1978) and Catania (1998) also proposed polymorphous classes, especially when discussing naturally occurring stimuli (such as trees or fish). Polymorphous classes have some number of relevant features, and as long as a certain number of those features are present in the novel stimulus, the organism responds to the novel stimulus as an instance of that class. All of these models for concept formation rely on stimulus feature similarity. That is, some subset of stimulus features must be found in all of the exemplars to permit generalization within the class.

However, some concepts can be seen *not* in terms of feature similarity but instead appear to be related though common contingencies. Premack (1983) recognized this distinction and doubted that animals have the latter, stating, "…pigeons have never been shown to have functional classes—furniture, toys, candy, sports equipment—where class members do not look alike; they only recognize physical classes" (p.358). In this sense, the performance of dogs in the study by Range et al. (2008), which was feature based, would be an incomplete demonstration of a concept in two ways: it could be accounted for by generalization across stimulus features and the performance metric was only differential responding. This may be why the authors referred to their results as visual categorization in dogs, and not demonstration of a concept. This leaves open the question, still, of whether dogs could have a concept and one that was not feature based.

In addition to the criteria required to demonstrate a concept and on what basis an animal might respond to demonstrate a concept, how these concepts are acquired, especially in the natural environment, is a vital question. In the laboratory, researchers have been successful in demonstrating concepts, but these concepts were apparently explicitly trained in the experimental environment. Procedures such as match-to-sample (e.g., Galizio, Stewart, & Pilgrim, 2008), go/no-go (e.g., Herrnstein, Loveland, & Cable, 1976, Range, et al., 2008, Siegel & Honig, 1970), or contingency reversals (Vaughan, 1988) are commonly employed to bring about differential responding to sets of stimuli. However, Herrnstein and Loveland (1964) suggested that their pigeons demonstrated a natural concept in their differential responding to slides with and without humans present. The pigeons reached criterion responding so quickly to very complex stimuli that the researchers suggested that the pigeons had entered the experiment with the concept already formed, and the experimental procedures were only required to reveal the concept. This begs the question of how concepts are formed in the natural environment.

Sidman (2000) provided a plausible mechanism for class formation, especially in the absence of physical feature similarity, although it easily accounts for feature-based classes as well. In his formulation of how equivalence relations are formed, Sidman described the formation of stimulus classes through common conditional or discriminative stimuli, as well as common reinforcers and responses, without the stimuli ever having been directly related to one another. If classes can be united by common reinforcers or common responses, this provides a basis on which non-feature-based concepts might be formed. It also provides a way for understanding how complex concepts can be formed in the natural environment where common conditional or discriminative stimuli might be absent.

The current study investigated whether a domestic dog has a concept of toys. The concept toys was chosen as the concept of interest because toys are not a class that is feature based, but rather one that is defined through the contingencies in which the animal encounters a given object. This is not to say that generalization to other objects with features similar to some members of the class does not occur, but that toys are not bounded by physical feature similarity. Additionally, a pet dog likely has had extensive history with a variety of play objects and may have formed the toy concept in the natural environment. This allows for investigation into how that concept was formed in the natural environment.

To test for a concept I measured a dog's retrieval response to various objects to determine if there were two sets of objects to which the dog differentially responded. I then attempted to add new members to the class by giving them a relevant history through common-response (play) training. To further test whether this differential responding met the more stringent criterion of being sensitive to contingency changes to one member of the class, I conducted two transfer of function tests: one with successive stimulus presentations and one with simultaneous stimulus presentations. The results are discussed in terms of concepts in animals, the formation of concepts in the natural environment, and the importance of procedural considerations for investigating complex behavior.

METHODS

Participant

Aero, a male German shepherd dog, *Canis familiaris*, participated in this study. Aero was 6 years old at the start of the study, and 8 years old at the end of the study. He has resided with me since he was 6 months old. He was selected as the study's participant because of an extensive training history (clicker training), as well as an extensive history playing with toys, largely through games of "tug-of-war" and "fetch." In addition, I was aware of his history with different objects, which facilitated choosing objects for the study. Aero had many responses already in his repertoire that were useful in this study: "sit," "stay," toy retrieval, and a paw touch.

General Setting

Sessions took place in the living room and/or kitchen of Aero's home. The kitchen was partially separated from the living room by a wall, such that anyone walking from the kitchen to the living room would have to make a 90 degree turn upon exiting the kitchen to enter the living room. Before each session I cleared the experimental area of any obvious distractions (e.g., other toys and food), but left the regular household setup of tables, chairs, and the smaller objects on the tables. For all training and testing sessions that involved the object being on the floor, I placed a small (21 in x 40 in) woven rug on the carpet; the rug was a different color than the carpet in the room. When applicable, I conducted training sessions on that rug, and placed objects in the center of the rug.

Stimuli

Through five preliminary trials, I identified five objects that Aero reliably retrieved and six objects that Aero did not retrieve. The initial 11 objects used in the experiment were: a medium-sized red rubber Classic KONG® (KONG) toy (The Kong Company, LLC, Golden CO, www.kongcompany.com), a red plastic flying disc (red disc), an orange rubber dumbbell (orange dumbbell), a blue rubber tug (blue tug), a black rubber squeaky dumbbell (black dumbbell), a plush orange bear (orange bear), a plush round alligator (alligator), a piece of fake lambswool tied in a knot (lambswool knot), a piece of soft cotton fabric tied in a knot (cotton knot), a set of interlaced rope rings with tennis balls on each ring (rope rings), and a plush toy with four small ropes spiking out of it (plush geometric). If any of the objects began to show wear and tear (usually due to the common-response training), the object was traded out for a new object that was exactly the same as the original. This occurred for four objects in the study, but replacing the objects did not disrupt Aero's performance. As the experiment progressed I added other stimuli to maintain a balanced number of retrieved and non-retrieved objects. These included a blue flexible plastic flying disc (flying disc), a rubber tree branch (branch), a rubber purple bone with an attached rope (purple bone), a green rubber disk with an attached rope (green disk), a rubber squeaky doughnut (doughnut), a solid rubber bone (blue bone), a red KONG wrapped in a cotton cover with a fabric tail (covered KONG), a plastic football (football), a set of three interlaced rubber rings (rubber rings), a pyramidal rubber tug (pyramidal tug), a honeycombed red rubber ball (red ball), a blue round plastic squirrel (squirrel), and a rubberized plastic blue geometric shape (blue geometric). These last objects were not used in the study if, on any trial, Aero retrieved the object or put his mouth on the object, even if it did not meet the criteria for a retrieval response.

All of the objects were purchased from pet supply stores and all but two of the initial 11 were novel; that is, Aero had not had any experience with that particular object, or any object with the exact features, although some items shared some features with other toys that Aero had played with in his daily life (e.g., plushiness, and the presence of ropes. Of the two objects that were not novel, one was in the retrieved category (black dumbbell) and one in the non-retrieved category (KONG), so that the two groups (i.e., objects that Aero retrieved and those that he did not retrieved) remained balanced in terms of Aero's familiarity with the objects. All of the objects that were added as stimuli later on in the experiment were also novel to Aero. During the duration of the experiment, Aero did not have any access to the objects used in the study other than during the training and test session.

Measurement

All sessions were videotaped and I scored the tapes for the relevant behaviors. In the Stimulus Class Test phase and the adding objects to the class phases of the study of the study, I scored Aero's performance as "retrieve" or "not retrieve" for the various objects. Thus, the retrieval response was used to define the stimulus class and to determine whether objects had been added to the class. Retrievals were defined as Aero picking up the object in his mouth and carrying it far enough back towards the kitchen that, when he dropped the object, it did not fall on the rug. I scored non-retrievals 1) if Aero did not go within 6 in of the near edge of the rug (first 9 baseline trials), 2) if Aero picked up the object and dropped it back onto the rug, 3) if Aero ran past the object, 4) if Aero ran out to the object and touched it with his paw or nose, or 5) if Aero approached the object and scanned back and forth.

In the first transfer test, during which I presented the objects successively, I scored whether Aero touched the object with his paw or sat after approaching the object. A paw touch was defined as one of Aero's front paws extending forward and touching the object while Aero was in a standing position. Sitting was defined as Aero's hindquarters touching the floor while his front legs remained in a vertical position.

In the second transfer test, during which I presented a pair of objects simultaneously, I scored which of two objects Aero touched with his nose. A nose touch was defined as the tip of Aero's muzzle (nose or lips, or chin) coming into contact with the object. The most common topography of the response was for Aero to touch the object with the extreme tip of his nose. While this response typically displaced the object, displacement was not included in the behavioral definition as different objects weighed different amounts and had more or less friction on the table surface.

Stimulus Class Test

Trials and Sessions

I stood at the junction of the kitchen and living room facing Aero, who was in a sit-stay in the kitchen and was approximately 3 ft from me. The object was placed to my left approximately 10 ft away in the living room in the middle of the small rug. Because of the dividing wall, Aero was not able to see into the living room where the objects were placed. When I had returned to the designated position facing Aero I cued him to retrieve the object by pointing to the living room and saying, "Go get it." Aero ran past me into the living room toward the object. If Aero picked up the object and began to return to me I said, “Yes” as he approached. When he returned to the kitchen, I gave him a treat, consisting of an approximately ½ in x ½ in piece of Dick Van Patten’s Natural Balance® (Natural Balance) dog food (Natural Balance Pet Foods, Inc., Pacoima, CA, www.naturalbalanceinc.com), regardless of whether Aero had carried the object all the way back, or dropped it along the way. If he did not pick up the object I said, “Here,” to recall him and gave him a piece of Natural Balance when he returned to me. After he had returned to the kitchen I cued Aero to “sit and stay” to prepare for the next trial. I initially cued Aero only once with the simultaneous “Go get it” and finger point cues. However, on some trials with non-toys Aero did not go all the way out to the object. Beginning in Baseline Session 10, I would re-cue Aero when necessary, until he came within 6 in of the near edge of the rug (approximately 16.5 in from the center of the object). This ensured that Aero came into contact with all objects; typically only one re-cue was required, although occasionally two additional cues were necessary.

Each object was tested once/session. The sequence of presentation of the objects was random except that no more than two objects that I anticipated Aero would retrieve or would not retrieve (initially based on the five preliminary trials) were presented in a row. This restriction was waived in later trials because there were so many retrieved objects that it was impossible to maintain that constraint. Sessions were run once a day, but not every day.

Adding Objects to the Class

Common Response Training

All training sessions took place in the living room on the small rug. I stood facing Aero, no more than 1 ft away.

Tug-of-War Training

In tug training sessions I initiated the sessions by presenting an object with both hands at Aero's eye level and approximately 6 ft from Aero's nose, a typical way of initiating a game of tug with Aero. When Aero grabbed the toy, I engaged in a typical bout of tug-of-war, pulling backwards or side to side on the toy. After approximately 30 s, I cued Aero to drop the toy by saying, "Leave it." When Aero released the toy I offered it to him again, and another bout of tug-of-war ensued. This sequence was repeated until 5 min had elapsed, at which point I cued Aero to drop the toy. After he dropped the toy I gave him either a piece of Natural Balance or another toy not in the study. In each 5-min session 5-10 bouts of tug occurred.

Fetch/Tug-of-War Training

In fetch/tug training sessions I placed the object on the rug and initiated a game by making a fast hand movement toward the object. This was a typical way to initiate play with Aero. After Aero picked up the object I played a bout of tug-of-war before cueing him to drop the toy. At this point I placed the object back on the rug and initiated the game in the same fashion. This was repeated until 5 min had elapsed. Then I cued Aero to drop the toy and gave him a piece of Natural Balance, or another toy not in the study when he did so. In each 5-min session, 5-10 bouts of fetch/tug occurred.

Interspersed Training

The interspersed training sessions were similar to the Fetch/Tug-of-War sessions, except play bouts alternated between the target (non-toy) object and a toy (an object that Aero already consistently retrieved in the stimulus class test trials discussed above). I initiated play bouts in one of two ways: for play bouts involving a toy I placed both the toy and the target objects on the rug and initiated play by making a fast hand movement toward the object; for play bouts involving the target object I placed only the target object on the rug because Aero typically picked up the toy when both objects were available. After Aero picked up the toy, I engaged in a bout of tug with Aero. After approximately 30 s of tug, I cued Aero to drop the object and subsequently initiated another play bout with the other object. Play with the two objects thus alternated throughout the 5-min session. The toys that I used during this training were 1) the black dumbbell or 2) the rope rings. In each 5-min session approximately 10 alternations occurred, so that each object was involved in five bouts of tug/session.

Probe Retrieval Training

Twelve probe retrieval sessions were conducted after the second training phase for the KONG ended. Interspersed training was conducted prior to some of these sessions. These interspersed training sessions were comprised of play alternations as described above, but involved multiple objects. For the probe retrieval sessions that occurred during the first discrimination training and transfer test, the plush geometric (the toy used to train the discrimination for the first transfer test) was used in the interspersed training sessions, along with the three objects targeted for class inclusion. For the probe retrieval sessions that occurred during the second discrimination training and transfer test, the black dumbbell (the toy used to train the discrimination for the second transfer test), was also added to the interspersed training sessions, for a total of five objects. These toys were added into the session to help reduce any disruption to the original retrieve response that might occur due to extensive training of another response to the object.

These interspersed training sessions consisted of alternating 30 second play bouts between the various objects until all of the objects had been played with once, and then this sequence of play was repeated two more times. The sequence of object play was the same throughout the three cycles of a play session, but varied between sessions. Because of the additional toys, training sessions were not limited to 5 min, but rather continued until all objects had been played with for 30 s three times each.

Testing

The test sessions were conducted exactly as they were during the stimulus class test phase (baseline).

Experimental Design

The experiment consisted of a multiple baseline across three objects. Only one target object was trained at a time, such that after the training phase ended for a particular object, no further training sessions occurred with that object. For example, after the phase in which the KONG was the target object for common response training ended, training for the KONG stopped and training switched to the red ball.

Transfer of Function Test: Successive Presentations

To further examine the putative toy class, I trained Aero to paw touch in the presence of a toy (plush geometric) and to sit in the presence of a non-toy (blue geometric) and tested whether this new response transferred to the other nine objects used in the stimulus class test.

Pre-training

To train this discrimination I ensured that Aero's "paw touch" and "sit" were under control of a voice cue. Aero already had a sit response under control of the vocal cue "Sit." The paw touch was not under control of a voice cue, but that response was in Aero's repertoire. To add the cue "Paw" to the paw touch response, I evoked a paw touch by presenting one of Aero's toys (one not used in the study) and stood silently with treats in a small plastic tub, a discriminative stimulus for Aero to offer behaviors. One of the behaviors he typically offered was a paw touch; I clicked and treated whenever he emitted a paw touch. When Aero was almost exclusively offering paw touches, I introduced the cue by saying, "Paw," just as Aero was going to touch the toy. I gradually faded the word back earlier in the behavior chain until I could say "Paw" when Aero was over 4 ft away from the object and he would approach the toy and touch it with his paw. Once both responses were under the stimulus control of the verbal cue, I began the discrimination training in which I trained Aero to emit a paw touch in the presence of the plush geometric object (toy) and a sit in the presence of the blue geometric object (non-toy).

Discrimination Training

For these training sessions, I stood in the living room at the edge of one of the short sides of the small rug used previously. The rug was placed in the living room in the same location as in the other experiments. A small table was behind me where I kept the two objects involved in the training. In the first step I presented the object and ensured a correct response by giving the associated voice cue before placing the object on the rug. In the second step I presented the object, but now waited to give the voice cue until after the object was placed on the rug. The third step involved further delaying the voice cue so that I presented the object, placed it on the rug, and waited 1 s before giving the voice cue. This delay was enough time for Aero to emit the response before I gave the voice cue. In the last step I presented the object but did not give the voice cue.

During each of the discrimination training sessions I began the session by tossing a treat into the kitchen so that Aero would move away from the rug. As he was retreating to follow the treat, I picked up the designated object (plush geometric or blue geometric) for that trial and held it behind my back. As Aero returned to the rug and his nose passed the plane of the near edge of a wood chest in the room (putting Aero approximately 2.5 ft away from the rug), I stretched my arm out and presented the object in my hand, holding it at Aero's nose level for approximately a half second. If it was a session from the early stages of training, I would say, "Paw" if the object was the plush geometric or "Sit" if the object was the blue geometric before I placed the object on the rug. If it was a session from the final stage of discrimination training, I placed the object on the rug after presenting it in my hand. After placing the object in the center of the rug I stood straight up, keeping my eyes on the ground approximately 1 ft past the object. If Aero emitted the correct response for that object (i.e., a paw touch to plush geometric or a sit to the blue geometric), I clicked and tossed a treat into the kitchen, so that Aero would move approximately six ft away from the rug, allowing me to present the next object. If, however, Aero emitted an incorrect response, I conducted a correction trial by cueing Aero to move away from the rug by saying, "Go on" and pointing my hand behind Aero. At this cue, Aero made a small circle and approached the table again, and I presented the same object. If Aero then made a correct response I delivered a click and treat and proceeded to the next trial. If he made another incorrect response I conducted another correction trial.

The sequence of object presentations followed the guidelines of Fellows (1967), with the added restriction that no more than two trials with the same object occurred in a row. During these early training stages, sessions consisted of 20-40 trials, but once the voice cue was eliminated from the trials, sessions were limited to 20 trials. Training sessions continued until Aero met the criterion of responding at or above 90% correct for 5 consecutive sessions. All correction trials were omitted from the calculation of percent correct in each session.

Successive Testing

Once Aero met the accuracy criterion I began the testing phase. Trials followed the same procedures as in the final stage of discrimination training. I started the session by tossing a treat behind Aero, and presenting the object as he passed the near edge of the wood chest. I held it in my hand for approximately half a second and then placed it on the rug. In the testing phase I reinforced all trials involving the untrained objects, regardless of whether Aero emitted a paw touch or a sit, as well as correct responses to the two trained objects with a click and treat. Incorrect responses to the two trained objects resulted in correction trials before proceeding to the next object.

Sessions involved 19 trials: five trials each with each of the two objects used in the discrimination training and one trial with each of the nine other objects from the stimulus class test describe earlier. After each trial involving one of the objects used in the discrimination training, I presented one of the nine objects *not* used in the discrimination training. In this way, the objects used in the discrimination training alternated with the non-trained objects. No more than two objects that belonged to either the toy or non-toy class were presented in a row. The same object sequence was used in all four transfer test sessions.

Probe Retrieval Testing

During four days of discrimination training prior to the transfer test, two of the days of the successive transfer test, and the day after the transfer tests were completed, I conducted probe retrieval sessions. Some of these sessions were preceded by a probe retrieval training session. On days when a probe retrieval session occurred on the same day as discrimination training the probe retrieval training session occurred first (if one was scheduled), followed by a probe retrieval test session, and finally the discrimination training session. On the days of the transfer test that a probe retrieval session was conducted, the probe retrieval training session occurred first (if one was scheduled), followed by a probe retrieval test session, and finally the transfer test session.

Transfer of Function Test: Simultaneous Presentations

I also assessed the putative toy class with a transfer test in which I trained Aero to touch a toy with his nose when a toy and non-toy were presented simultaneously. This tested whether or not this response had transferred to other toys.

Pre-training

To train this discrimination I started by training Aero to nose touch a green paper held in my hand, a response that Aero offered when presented with an object in my hand during a training situation (i.e., when I was carrying treats). During each correct response I clicked and delivered a treat to Aero. Once Aero was reliably touching the green paper in my hand, I taped the green paper to a toy that Aero regularly played with but was not part of the study. Gradually I lowered the object with the green paper onto a small table (approximately 18 in high x 35 in long x 21.5 in wide) and then faded my hand away from the object, until Aero was nose touching the object consistently without my hand near the object. Once the object was on the table Aero had to push the object with the tip of his nose so that he displaced the object, by at least ¼ in. I then removed the target and Aero continued to respond correctly. Beginning in the trials in which I faded my hand away from the object, I also began alternating onto which end of the table I placed the object.

At this point I implemented the same training procedure, but now with the black dumbbell (toy). Once he was reliably touching the black dumbbell without the green paper or my hand as prompts, I began discrimination training trials, in which the black dumbbell (toy) and the blue geometric (non-toy) were presented simultaneously.

Discrimination Training

The table was oriented lengthwise in front of me and I was seated at the midpoint of the long side of the table, indicated by a small yellow dot placed on the table and Aero was on the other side of the table. I had also pre-marked the table with two blue dots on which I would place the two objects. The dots were each 4 in from the side of the table nearest Aero, and 6-¾ in away from the end of the long side of the table, so that the objects' midpoints were always 22 in apart, although the distance between the edges of the two objects varied with the objects' size.

I tossed a treat approximately 10 ft behind Aero to begin the first session. As Aero moved away from me I placed the two objects on two blue dots and returned my hands to my lap, in which I held a small plastic tub of treats and a clicker. As Aero returned to the table, I remained motionless, staring straight ahead at the back wall of the room. After finding the treat Aero returned and made a nose touch to one of the objects. If he nose touched the toy I clicked and tossed a treat again approximately 10 ft behind Aero to reset him for the next trial (i.e., he moved away from the table so that he could approach again). Then I reset the objects on the table. If Aero made an incorrect response, I removed both objects and remained motionless for 2 s. Then I tossed a treat to reset Aero and placed the objects in the same position they were in when he made the error. If he made a correct response on the correction trial I clicked and tossed a treat and moved on in the trial sequence. If he made another error the aforementioned correction procedure was implemented again.

Sessions consisted of 20 trials (10 with the toy on the left and 10 with the toy on the right). Placement of the toys was pseudo-randomized following Fellows' (1967) guidelines with the added constraint that the toy was not placed on the same side in more than two consecutive trials. Training sessions continued until Aero met the criterion of responding at or above 90% correct for 5 consecutive sessions. Any correction trials were omitted from the calculation of percent correct in each session.

Simultaneous Testing

I conducted the test sessions the same as the sessions for discrimination training. I started the trial by tossing a treat behind Aero, placing a toy (or new toy) and a non-toy on a low table while Aero followed the treat. Aero returned to the table and touched one of the objects with his nose. If it was a reinforceable response I clicked and tossed a treat behind Aero so that he moved away from the table and could approach again. While Aero was following the tossed treat, I placed the objects on the table for the next trial. In the test phase I reinforced all trials involving the new pairs of stimuli, as well as correct trials involving the pair trained in the initial discrimination (black dumbbell and blue geometric). Incorrect trials involving the trained pair resulted in a correction trial as previously described.

The transfer test consisted of presenting pairs of objects in which one member of the pair was a toy or new toy (i.e., one of the objects that received common-response training), and the other member of the pair was a non-toy. In Sessions 1 and 2, in addition to the pair of objects used in the discrimination training, three new toys and one toy from the stimulus class test were each paired with the three non-toys not used in the discrimination training (the football was used in two pairings). These pairs were: the KONG (new toy) and football (non-toy); the red ball (new toy) and squirrel (non-toy); and the rope rings (toy) and football (non-toy) (Fig. 1a). In Sessions 3 and 4, along with the pair of objects used in the discrimination training, three toys were paired with the three non-toys. These pairs were: the plush geometric (toy) and flying disc (non-toy); the alligator (toy) and squirrel (non-toy); and the rope rings (toy) and football (non-toy) (Fig. 1b). In Session 5, four toys were presented with two non-toys. The blue geometric was eliminated from the test pairs as Aero could have responded correctly based on exclusion. The football was eliminated from the test pairs as it was physically similar to the dumbbell and I wanted to constrain the test situation to reduce the likelihood that Aero could respond based on physical similarity. The four toys (black dumbbell, plush geometric, alligator and rope rings) and the three new toys (blue tug, KONG, and red ball) were each presented once with the flying disc and once with the squirrel.

Sessions 1-4 consisted of four blocks (five trials in Sessions 1 and 2, and four trials in Sessions 3 and 4). In each block, the first trial was the pair of trained objects (black dumbbell and blue geometric). The remaining trials were the pairs of new toys or toys and non-toys; the sequence of pair presentations in these trials varied between trial blocks. In Session 5 each toy and new toy (total of 7 objects) were tested once with both non-toys (flying disc and squirrel) so that each trial in the 14-trial session involved a unique pair of objects. All sessions were counterbalanced for the side of toy or new toy presentation. Sessions were also constructed so that no more than two consecutive trials had the toy or new toy on the same side. The same trial sequence was used in Sessions 1 and 2, but different sequences were used in Sessions 3 and 4, and all were different from Session 5. Prior to each transfer test session, I conducted a discrimination training session as detailed above.

Probe Retrieval Testing

On the days of two discrimination training sessions, and three simultaneous transfer test sessions (Transfer Test Sessions 1, 2, and 5) I also conducted probe retrieval sessions, some of which were preceded by a probe retrieval training session. On days in which a probe retrieval test session occurred on the same day as discrimination training the probe retrieval training session occurred first (if one was scheduled), followed by a probe retrieval test session, and finally the discrimination training session. On the days of the transfer test that a probe retrieval test session was conducted the probe retrieval training session occurred first (if one was scheduled), followed by a probe retrieval test session, then the discrimination training session, and finally the transfer test session.

RESULTS

Stimulus Class Test

Figure 2 shows the results of the toy and non-toy class test. The cumulative retrieval responses for each object across sessions are graphed. The top six lines graphed depict the results from six objects that Aero reliably retrieved (toys) and the bottom four lines depict the results from four objects that Aero never retrieved (non-toys). Three other objects also were not retrieved, but these were targeted for inclusion in the toy class and their results are plotted in Figure 3 and discussed separately. The arrows indicate in which session the various phases began. A total of 111 full test sessions were conducted, and, although the number of sessions goes to 111 on the graph, one of these was a retrieval trial in which the blue tug was the only object tested, resulting in the graph showing 110 full sessions and the probe trial (Session 20). The last full session (111) is not graphed in Figure 2, but is presented along with transfer test data in Figure 6.

During all the phases of the experiment (baseline, four phases of class inclusion training, and the probe retrieval phase), Aero reliably retrieved the black dumbbell (110 retrievals out of 110 trials), the plush alligator (110 retrievals out of 110 trials), the rope rings (105 retrievals out of 110 trials), the plush geometric (103 retrievals out of 110 trials), the lambswool knot (54 retrievals out of 55 trials), and the plush bear (52 retrievals out of 54 trials). Aero's retrieval behavior with these objects did not vary across experimental phases. The lambswool knot and the plush bear were discontinued and replaced with additional non-retrieved objects (red ball and blue geometric).

Aero never retrieved the flying disc (0 retrievals out of 110 trials), the blue geometric (0 retrievals out of 51 trials), the football (0 retrievals out of 48 trials), or the squirrel (0 out of 33 trials). The blue geometric, football, and squirrel were added in Sessions 60, 63, and 78, respectively. Several other objects were tested for use in the study as non-retrieved objects, but were discontinued if Aero put his mouth on them or retrieved them; these were replaced with new objects.

Adding Objects to the Class

Figure 3 shows the results of the three target objects that were trained as members of the toy class: the blue tug, KONG® (The Kong Company, LLC, Golden CO, www.kongcompany.com), and red ball. The graph plots cumulative retrieval responses for the tug (top line), KONG (middle line) and red ball (bottom line). The arrows indicate where the different various phases began. The data from the nine retrieval sessions (Sessions 103-111) that occurred during the transfer training and testing will be discussed separately.

The blue tug was the first object targeted for toy class inclusion. After 10 baseline sessions during which Aero never retrieved the blue tug, I conducted 4 sessions of tug training (Sessions 11-14), each followed by a test session. Aero did not retrieve the tug in any of these trials. I then conducted 4 sessions of fetch/tug training (Sessions 15-18), each followed by a test session. Aero did not retrieve the tug in any of these trials. In Session 19 I began conducting interspersed training sessions prior to testing. A total of 12 test sessions were conducted during the interspersed training phase, nine of which were preceded by the interspersed training (Sessions 24, 26, and 30 were not preceded by a training session). During the fourth interspersed test session following training (Session 22—overall the 12th session following a training session), Aero first touched the blue tug with his mouth and during Session 23 (probe trial—overall the 13th session following training) Aero first retrieved the blue tug. Including the first retrieval session, he retrieved the tug in 7 out of the remaining 8 sessions in which the tug was the target object. Training for the tug stopped after Session 30. After this, Aero continued to retrieve the tug 39 out of the remaining 81 trials. His rate of retrieval did decline with the time since training had stopped.

The KONG was the second object targeted for class inclusion. After 34 baseline sessions in which Aero never retrieved the KONG, I conducted 29 interspersed training sessions, each of which was followed by a test session. After seven training sessions, Aero first put his mouth on the KONG (Session 42), and after nine training sessions Aero first retrieved the KONG (Session 44). Including the first retrieval session, he retrieved the KONG in 7 out of the remaining 21 sessions in which the KONG was the target object. However, the rate of retrieval was inconsistent: all 7 retrievals occurred in the next 12 sessions, and no retrievals occurred in the last 9 sessions. Training was discontinued after Session 64 and Aero did not retrieve the KONG again until a second training phase was implemented (see below).

The red ball was the third object targeted for class inclusion. The red ball was first introduced during the KONG training phase (Session 58). After 7 baseline sessions in which Aero never retrieved the red ball, I conducted tug/fetch training for 17 sessions. After six sessions of training (Session 63), Aero first put his mouth on the red ball, and after eight sessions of training (Session 65), Aero first retrieved the red ball. Including the first retrieval session, he retrieved the red ball in 9 out of the remaining 10 sessions in which the red ball was the target object. Training was discontinued after Session 81. After training was discontinued, Aero continued to retrieve the red ball in 13 out of 18 sessions.

After training ended for the red ball, I conducted a second training phase for the KONG. Beginning in Session 82, I conducted 18 tug/fetch training sessions with the KONG, each of which was followed by a test session. Aero retrieved the KONG twice, in Sessions 89 and 93. Beginning with the first session in which Aero retrieved the KONG in the first KONG training phase, Aero retrieved the KONG a total of 12 times out of 55 sessions.

I conducted three probe retrieval trials after the second training phase for the KONG ended (Sessions 100-102, Fig. 2 and Fig. 3). In these sessions, Aero continued to retrieve all of the toys (Fig. 2) and not retrieve the non-toys (Fig. 2). For the new toys, Aero retrieved the blue tug in two of the three sessions, did not retrieve the KONG in any of the sessions, and retrieved the red ball in one of the three sessions (Fig. 3).

Between the end of the blue tug training and before the first KONG training phase, I conducted five sessions of interspersed training with the red disc, each of which was followed by a test session, in which Aero did not retrieve the red disc. However, during the training sessions, the red disc fractured into pointed edges, and was deemed unsafe and discontinued as a toy. The more flexible blue flying disc replaced the red disc, but because the flying disc had had no baseline trials, I instead began training the KONG.

Transfer of Function Test 1: Successive Presentations

Aero met the criterion to move from discrimination training to transfer testing by responding at or above 90% correct in five consecutive sessions. Figure 4 shows the results for the first transfer of function test. Aero had been trained to emit a paw touch when I presented the plush geometric (toy) and to emit a sit when I presented the blue geometric (non-toy). I then tested whether Aero emitted these responses to other toys and non-toys in accordance with a toy concept. The first column (a-d) shows the results for the four original toys. The second column (e-h) shows the results for the four non-toys, and the third column (i-k) shows the results for the three objects that were added to the class. The top graphs (a and e) show the results for the two objects used in training the new response for the transfer test (plush geometric and blue geometric). Each graph shows the cumulative paw touches and sits for each object.

Toys

Over four transfer sessions, the plush geometric toy was tested 19 times. Due to experimenter error, it was not tested the 20th time. In the 19 trials, Aero emitted a paw touch 16 times and sat 3 times (Fig. 4a). When I presented the rope rings, Aero emitted a paw touch in all 4 trials (Fig. 4b). When I presented the dumbbell, Aero emitted a paw touch in Trial 2 and sat in the three other trials (Fig. 4c). When I presented the alligator, Aero emitted a paw touch in Trial 3 and sat in the three other trials (Fig. 4d).

Non-toys

Over four transfer sessions, the blue geometric was tested 20 times, and Aero sat all 20 times (Fig. 4e). When I presented the flying disc and the squirrel, Aero emitted a sit in all four trials with each object (Figs. 4f and 4g). When I presented the football, Aero emitted a paw touch in Trial 1 and sat in the three other trials (Fig. 4h).

New Toys

When I presented the blue tug and the red ball, Aero emitted a sit in all four trials with each object (Fig. 4i and 4j). When I presented the KONG, Aero emitted a paw touch in Trial 3 and sat in the three other trials (Fig. 4k).

Probe Retrieval Sessions

During the same time frame that discrimination training and the transfer test occurred, I conducted six probe retrieval trials (Figs. 2 and 3, Sessions 103-108). Sessions 105, 106, and 108 were each preceded by a probe retrieval training session. Aero continued to retrieve the black dumbbell, alligator, and rope rings reliably (Fig. 2). The rate of retrieval decreased for the plush geometric (the toy used in the discrimination training) with four retrievals out of seven sessions (Sessions 103, 105, and 106, Fig. 2). Aero continued to not retrieve the squirrel, football, blue geometric, or flying disc (Fig. 2). Of the new toys, Aero retrieved the blue tug three times out of seven sessions (Sessions 103, 105, and 106, Fig. 3), did not retrieve the KONG in any sessions (Fig. 3), and retrieved the red ball four times out of seven sessions (Sessions 105-108, Fig. 3).

Transfer of Function Test 2: Simultaneous Presentations

Figure 5 shows the results for the five retrieved objects (two original toys, and the three new toys) in the two transfer tests using simultaneous presentations. Each pair of objects was presented eight times. The graph plots the cumulative nose touches to the toy in each pair of objects presented simultaneously. Aero emitted seven nose touches to the dumbbell and one nose touch to the blue geometric in Trial 3. Aero emitted seven nose touches to the rope rings and one nose touch to the football in Trial 7. Aero emitted seven nose touches to the red ball and one nose touch to the squirrel in Trial 6. Aero emitted 3 nose touches to the blue tug in Trials 1, 4, and 5, and five nose touches to the flying disc. Aero emitted two nose touches to the KONG in Trials 3 and 6, and six nose touches to the football.

Probe Retrieval Sessions

During the same time frame that discrimination training and the transfer test occurred, I conducted four probe retrieval sessions (Fig. 2 and 3, Sessions 109-111 and Fig. 6). The last probe retrieval session will be discussed separately in conjunction with Transfer Test Session 5. Sessions 109 and 111 were each preceded by a probe retrieval training session. In these retrievals, Aero continued to retrieve all of the original toys (Fig. 2) and to not retrieve the non-toys (Fig. 2). Aero retrieved the red ball two times out of three sessions (Sessions 109 and 110, Fig. 3). He did not retrieve the blue tug or the KONG in either session (Fig. 3).

Probe Retrieval Session 112 and Transfer Test 5

In the final probe retrieval session, Aero retrieved all of the toys (black dumbbell, plush geometric, alligator, and rope rings, Fig. 6) and did not retrieve any of the non-toys. Of the new toys, he retrieved the red ball, but did not retrieve the blue tug or KONG. Of the five objects that Aero retrieved in the retrieval trial, Aero made both possible nose touches to each of these objects in the transfer test (Fig. 6). Of the two new objects that Aero did not retrieve in the probe retrieval trial, Aero made one nose touch to the blue tug in the second trial involving the blue tug, and he made one nose touch to the KONG in the first trial involving the KONG.

DISCUSSION

The purpose of this study was to test whether or not toys are a natural concept for the domestic dog. The first evidence for toys as a natural concept came from the retrieval test in which Aero responded differentially to two sets of objects (subsequently labeled toys and non-toys). These results were obtained without training the response or differentially reinforcing retrievals vs. non-retrievals in the test sessions. These findings are similar to the results of Herrnstein and Loveland (1964), Herrnstein, Loveland, and Cable (1968), and Cerella (1979), among others, although no differential reinforcement of instances of a concept was used in the current study.

Differential responding has been extensively used as a criterion to identify a concept. For example, Huber (2001), in his review of the concept literature, concluded that the typical usage of concept refers to “the ability to treat similar, but not identical, things as somehow equivalent, by sorting them into their proper categories and by reacting to them in the same manner” (*Introduction section, para. 2).* Using these criteria, Aero’s differential responding demonstrated a concept of toys because he responded to them as objects to be retrieved. Aero reliably retrieved six objects during baseline: the black dumbbell, plush alligator, rope rings, plush geometric, lambswool knot, and plush bear. On the other hand, Aero did not ever retrieve four objects: flying disc, blue geometric, squirrel, and football. Aero showed the concept although the contingencies during testing did not require such differential responding. Aero’s retrieval and non-retrieval were equally reinforced with food. The test captured a stimulus-response relation that Aero already had. Because of this, the concept of toys for Aero can be considered a natural concept.

A natural concept is one that has been formed through contingencies in the animal's day-to-day life, not from differential reinforcement during an experiment. Similar to Herrnstein and Loveland's experiment (1964) wherein pigeons responded appropriately to complex stimuli very quickly (thus suggesting that the pigeons had formed a concept of humans prior to the experiment). Aero's differential responding occurred from the very first session indicating that Aero already had formed the concept when he entered the study. The assessment procedures simply revealed that concept.

The results from Herrnstein and Loveland (1964) and those from the current study beg the question of how a concept is formed in the natural environment—what kind of experience is required for concept formation? While experimental procedures have provided ways in which to train new stimulus classes (e.g., Galizio, Stewart, & Pilgrim, 2008; and Vaughan, 1988), these same procedures (such as the match-to-sample procedures of Galizio, Stewart, and Pilgrim or the rapidly reversing contingencies on whole groups of stimuli of Vaughan), while not impossible, seem unlikely to occur in the natural environment. Thus, an investigation for a more ecologically plausible mechanism is warranted. Sidman (2000) offered a possibility when he suggested that stimulus classes could also be formed through a common response. That is, stimuli involved in separate contingencies, without having any conditional or discriminative stimuli in common, can enter into a stimulus class as long as a common response is evoked in those contingencies. This suggests that a new member of the class could be added simply by evoking the same response to a novel stimulus, even in a novel context, as had served to initially unite the class of interest.

The possibility of adding new members to a class using a common response might offer a useful way of further testing whether an animal has a concept. Typically, concepts have been demonstrated by generalization tests in which a novel exemplar is presented and I records whether the animal responds the same way it does to other members of the class (Bhatt, Wasserman, Reynolds, & Knauss, 1988; Range, et al., 2008). However, such a generalization test may not always be possible; for example, when investigating whether there is a concept or class that is not characterized by any particular stimulus features, such as “toys”, it would be impossible to a priori identify a novel exemplar of the class. Researchers could instead test whether a group of stimuli functioned as a class by adding a new member to it. To do this would require evoking a common response (the response presumed to unite the class) to the stimulus in one context and in a second context testing whether the animal responded the same way to this stimulus as to other members of the class in the second context.

In the case of Aero and a toy concept, Aero played tug-of-war with many objects throughout his life; those that he retrieved in the initial retrieval tests were similar to toys in his daily life (i.e., made of plush fabric or with twisted rope as part of the configuration, except for the black dumbbell) with which he played tug-of-war. Tug-of-war, then, provided a possible common response that united the toys as a class. The next phase of the experiment explored whether the toy concept could be expanded through a common response and the results emerge in the testing context. To investigate this, I used an ecologically relevant response (fetch/tug) in play sessions with three non-toy objects and then tested whether Aero began retrieving those objects in the retrieval test sessions.

The results demonstrated that by playing with the three non-toys—blue tug, KONG® (The Kong Company, LLC, Golden CO, www.kongcompany.com), and red ball—through fetch/tug, Aero began to retrieve all three of them, confirming that concepts may be formed and expanded through a common response. The results are noteworthy because the training took place in a different context than testing and the cue used in testing ("go get it" and a finger point) was never used when playing with the three objects. Additionally, all test trials were reinforced, precluding the possibility that differential reinforcement resulted in the formation of the concept. In fact, this change in Aero's behavior to the three objects runs counter to that predicted by his history of reinforcement with respect to those objects in the testing situation. When I started the common response training for the blue tug, Aero had already been reinforced for ten trials for *not retrieving* or ignoring it. Similarly, he had been reinforced for ignoring the KONG in 34 trials and the red ball in 7 trials at the point at which common-response training started for each of the objects. Yet, after receiving common-response training, all three objects were retrieved.

The experiment employed three types of common-response training (tug, fetch/tug, and interspersed). Although there were small variations in either how the object was presented or whether other toys were played with in the same training session, the same general response topography was used in all three training types (all involved grabbing an object and playing tug-of-war). Aero began to retrieve the blue tug after 12 common-response training sessions (four tug, four fetch/tug, and four interspersed), the KONG after nine common-response training sessions (all interspersed), and the red ball after eight common-response training sessions (all fetch/tug). As noted earlier, Aero actually first retrieved the blue tug in the 13th session of the common-response training phase, but the 13th retrieval test session was not preceded by a common-response training session. Because of the similarity in number of common-response training sessions to first retrieval, the number of sessions in which the animal engages in the common response with the stimulus may be a critical variable for the object to acquire class membership, rather than the type of training (i.e., tug, fetch/tug, or interspersed).

Although, the results showed that the common response of playing was sufficient for initiating the retrieval of the three target objects, the rates of retrieval of the three objects differed: the red ball had the highest overall rate, and its rate approached that of the original toys; the KONG had the lowest overall rate; and the rate of retrieval for the blue tug fell between the first two objects. The variation in rates of retrieval indicates that factors other than the procedures used to include a new member in a class may be responsible for the maintenance of that object in the class. For example, the new member may have to share the same contingencies as other members of that class in more than one context.

Three possible factors within the current experiment may have also contributed to the variation in retrieval rates. One possible factor is the interference from the prior history of reinforcement. This can be seen by evaluating the length of baseline for each object. The rates of retrieval of the three objects were inversely related to the length of baseline for each object, suggesting that the non-retrieval responses reinforced during baseline interfered with the retrieval performance. For example, the 34-session baseline of the KONG was nearly fives times longer than that for the red ball, and the

KONG showed the lowest rate of retrieval. The KONG was also one of the two objects that were familiar to Aero. It had been used as a food-dispensing object; Aero licked food out of the hollow of the KONG. Having emitted other responses to the KONG also may have interfered with the consistency of the retrieval response. A second possible factor is that, although Aero's tug and fetch response in the common-response training sessions looked the same to the human eye for the three objects, the stimulation associated with each might have varied. The KONG, especially, was made of thicker, less pliable rubber so that Aero was not able to close his mouth as much with the KONG as with the red ball and blue tug. The KONG also showed the lowest overall rate of retrieval.

A third possible factor is that longer and more frequent common-response training might be required. This is particularly evident in the blue tug, which had the longest time since training (it was the first object trained) and the rate of retrieval declined with the time elapsed since training. Further support for this comes from the brief resumption of KONG retrievals when a second training phase for the KONG was conducted, as well as an increase in red ball and blue tug retrievals when these objects received additional training in the probe retrieval phase at the end. These potential variables and their effect on the rate of retrieval, and the persistence of retrieval in the absence of common-response training should be explored in future research.

While the experiments of the current study discussed so far demonstrate a toy concept in line with the definitions from Herrnstein and Loveland (1964); Keller and Schoenfeld (1950); and Huber (2001) other researchers require more rigorous criteria be met before a group of stimuli are accorded the status of stimulus class or concept

(Herrnstein, 1990; Lea, 1984). These definitions require demonstration that the set of all stimuli change functions when one member of the set changes function.

To this end, I trained Aero to emit a new response (paw touch) in the presence of a toy (plush geometric) and to emit a new response (sit) in the presence of a non-toy (blue geometric). I then tested whether Aero would respond with a paw touch to all of the original and new toys and respond with a sit to all of the non-toys. The results showed that Aero did not differentially respond along toy class lines. Instead, Aero consistently sat in the presence of all objects (non-toys, toys, and new toys) except for the rope rings to which he emitted a paw touch. This revealed that the discrimination training produced a discrimination not along class membership lines (toy vs. non-toy), but rather along a physical feature-based dimension. Both the plush geometric and the rope rings were multicolored and had ropes as part of their configuration, and it seems likely that one or both of these features are what exerted control over the paw touch response. In other words, the discrimination training and transfer test tapped into a feature discrimination rather than the concept that this study explored.

Interestingly, results like these would have been taken as negative evidence for the presence of a concept if only the percent correct across toys vs. non-toys had been considered. However, by conducting an error analysis and subsequently comparing the trained stimulus (plush geometric) to the only toy to which he reliably responded correctly (rope rings), the relevant stimulus control was revealed. This points to the general utility of analyzing negative results in behavioral studies; in identifying likely variables that have interfered with the desired performance, the researchers can amend their training or testing procedures to better control for those variables.

It is reasonable that Aero's successive discrimination training would have led to a physical feature-based discrimination because the stimulus presentation leaves the control of the response open to all of the features of the stimulus. Perhaps, without further environmental constraint, the feature that takes control is the one with the longest history of reinforcement. Additionally, in the current study, only one exemplar was trained; if multiple exemplars had been trained it is more likely that the response would have come under the control of class membership.

Short of training sufficient exemplars, one way to constrain the stimulus control along the toy/non-toy dimension is by using simultaneous presentations of a positive stimulus (toy) and a negative stimulus (non-toy). By pitting two stimuli against each other in this way, an experimenter can minimize the irrelevant feature differences between the two stimuli and thus increase the likelihood that the animal will respond along the desired class membership dimension.

Accordingly, I conducted a second transfer of function test using a simultaneous presentation format and equalizing as much as possible the physical feature similarity of the positive and negative stimuli used in the discrimination training. Aero was trained to emit a nose touch to the toy object (black dumbbell) when presented simultaneously with a non-toy (blue geometric) so that training involved one toy/non-toy pair. I then tested whether Aero would preferentially emit a nose touch to the toy of each novel pair of objects. The results of this test indicate that Aero did emit nose touches to objects in such a way that his responses fell along toy class lines. When old toys were presented with non-toys, Aero almost exclusively emitted nose touches to the toy object of the toy/non-toy pair. When the pair involved a new toy/non-toy, Aero emitted nose touches to the red ball in 9 out of 10 trials, to the blue tug in 4 out of 10 trials, and to the KONG in 3 out of 10 trials. These results exactly parallel the results from the probe retrieval tests in which the red ball had the highest rate of retrieval and that rate nearly approximated the rate of retrieval of the old toys, followed by the blue tug, and finally the KONG, which had the lowest rate of retrieval. Additionally, the red ball was the only one of the three new toys that Aero retrieved in the probe retrieval tests that were conducted during the same time period as the second transfer tests.

Certain object pairings from the second transfer test offer further insight as to the basis on which Aero discriminated between the two objects in a pair. When presented with two objects that he was not currently retrieving in the retrieval tests (KONG and football), Aero apparently responded on the basis of stimulus features. Aero emitted a nose touch to the football, which was the most similar of all the objects used in the transfer test in its overall dimensions, texture, and color to the black dumbbell. However, when the football was paired with a toy (rope rings) instead of another object that Aero was not currently retrieving, Aero emitted the nose touch to the toy, even when he had been reinforced in an earlier trial for emitting the nose touch to the football (when paired with the KONG). He responded not in accordance with his history of reinforcement for nose touching the football nor along the lines of stimulus feature similarity to the black dumbbell, but instead responded along class membership lines by emitting a nose touch to the rope rings.

The results of this study raise several important procedural points. The first stems from the results of the two types of transfer tests (successive vs. simultaneous presentations). The different results of the two tests demonstrated the influence of testing procedures on the results of those tests and, thus, the conclusions that we as researchers draw about the behavior and abilities of our subjects. Clearly, the conclusions regarding dogs having a toy concept would have been much different if the current study had stopped after the first transfer test, rather than conducting the second test. To understand the utility of this procedural change, as well as to reconcile the results of these two tests, it is useful to remember that any given stimulus, especially a complex stimulus such as a toy, belongs to many stimulus classes, only one of which is the stimulus class being investigated in a study. Considering this, it is remarkable that transfer of function tests produce positive results as often as they do. The task of the experimenter, then, is to constrain the subject's response, by designing a test that will most likely probe the class of interest and that will prevent the subject from responding on the basis of other classes of which the stimulus is a member. In addition to choosing stimuli that minimize irrelevant feature differences for the discrimination training, the simultaneous test also seems to effectively constrain responses (see Siegel & Honig,1969; Zeiler, 1965).

Another procedural variable that is worth noting is that of "reinforce-all" in which all test trials in the study were reinforced. This prevented any differential reinforcement from influencing the formation or maintenance of the toy concept, or the discriminations made during the transfer test. The reinforce-all captured any discriminations Aero had already made, but did not create new discriminations. Other studies often use extinction during testing procedures (e.g., Siegel & Honig, 1969; Zeiler, 1965), again to prevent differential reinforcement from influencing the results, but extinction is much more likely to disrupt any relevant discriminations in the animal's repertoire than a reinforce-all procedure would, and experimenters have to conduct interspersed training sessions throughout the study to maintain the subject's performance (e.g., Siegel & Honig, 1969). Zeiler (1965) argued for the use of extinction as it gave a more stable performance than reinforcement, which Zeiler took to indicate that reinforcement had disrupted the trained discrimination. However, as there was no independent measure of the purportedly disrupted discrimination to compare the results of this test to, his conclusions warrant further investigation. In the current study, two advantages to a reinforce-all procedure were identified. First, the reinforce-all procedure allowed for identification of any stimulus classes with which Aero entered the study, which then permitted further exploration into stimulus classes that are formed in the natural environment and not during the experiment. Second, by using reinforce-all when the results of transfer tests did not match a toy class framework, I was able to identify the likely basis on which Aero was discriminating and conduct a second test that minimized variables that interfered with testing the class of interest. Because of these advantages the reinforce-all procedure has much to recommend it in behavioral studies.

The results of this study demonstrate that Aero does have a toy concept, regardless of the criteria used to evaluate his behavior. The concept of toys is particularly intriguing as the members appear to share no overarching physical features that can be used to discriminate between a toy and non-toy. Instead, whether an object belongs to the toy class depends on the contingencies in which that object has been previously involved, as suggested by Premack (1983). Certainly concepts can be feature-based, but this is not a requirement. A concept, as all of the various criteria noted here have demonstrated, should be functionally defined, and this allows for both feature-based and contingency-based concepts. Not only did this study identify a toy concept but it demonstrated successful addition of new members to the class through a common response. This supports Sidman's (2000) formulation of stimulus class formation and offers insight into concept formation in the natural environment. Finally, this study identified several important procedural variables that researchers might consider when designing experiments, interpreting results, and ascribing abilities to animals.

a SESSIONS 1 AND 2

PAIR	TOY	NON-TOY
1 (trained pair)	Black dumbbell	Blue Geometric
2	Rope rings	Football
PAIR	NEW TOY	NON-TOY
3	Blue tug	Flying Disc
4	KONG®	Football
5	Red ball	Squirrel

b SESSIONS 3 AND 4

PAIR	TOY	NON-TOY
1 (trained pair)	Black dumbbell	Blue Geometric
2	Rope rings	Football
3	Plush geometric	Flying Disc
4	Alligator	Squirrel

c SESSION 5

PAIR	TOY	NON-TOY
1 (trained pair)	Black dumbbell	Flying Disc
2	Black dumbbell	Squirrel
3	Plush geometric	Flying Disc
4	Plush geometric	Squirrel
5	Alligator	Flying Disc
6	Alligator	Squirrel
7	Rope rings	Flying Disc
8	Rope rings	Squirrel
PAIR	NEW TOY	NON-TOY
9	Blue tug	Flying Disc
10	Blue tug	Squirrel
11	KONG®	Flying Disc
12	KONG®	Squirrel
13	Red ball	Flying Disc
14	Red ball	Squirrel

Figure 1. Object pairs used in simultaneous transfer of function test.

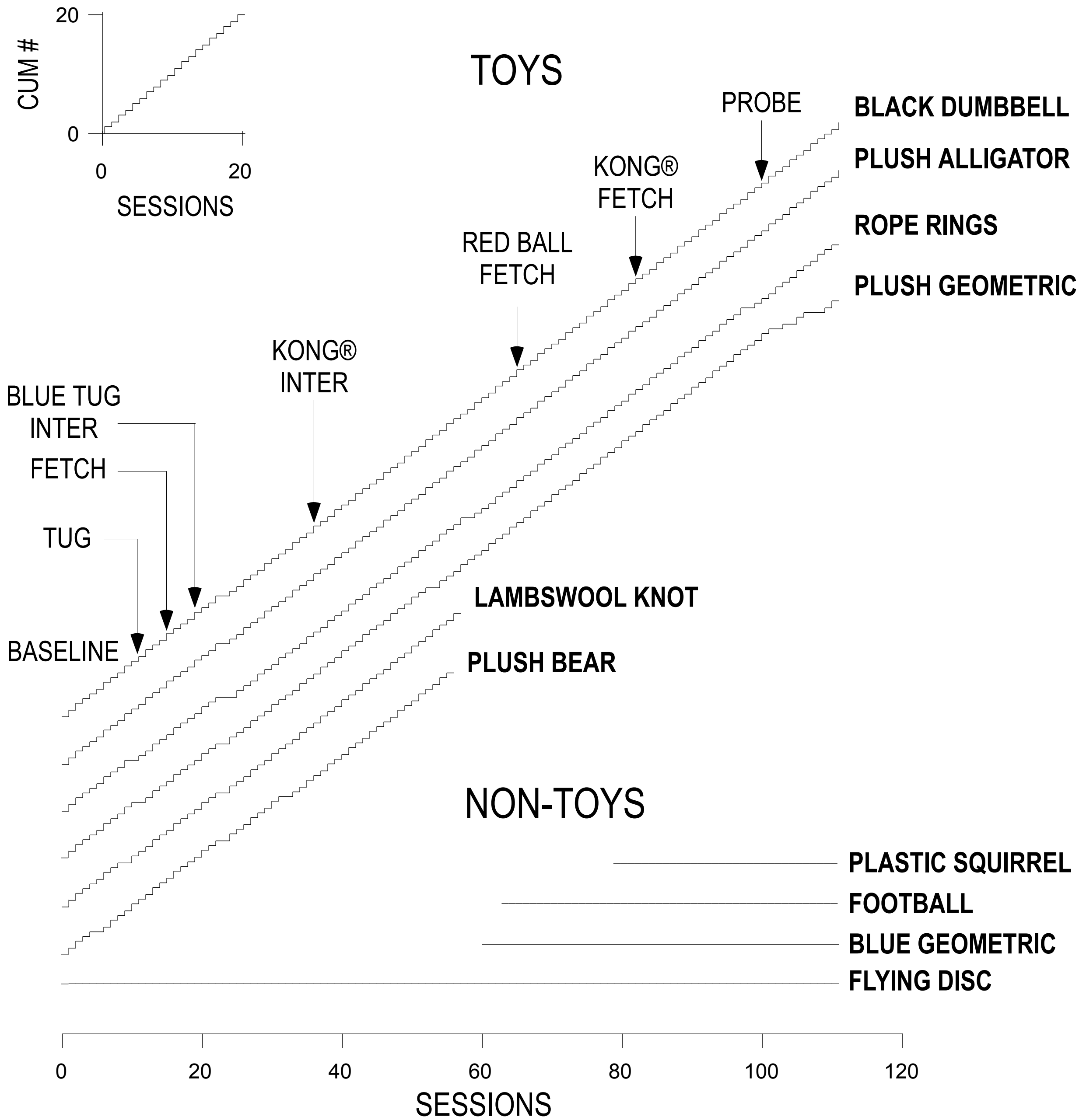

Figure 2. Cumulative retrieval responses across sesssions for six toys (top lines) and four non-toys (bottom lines), none of which received common-response training. Arrows indicate common-response training phases for the three target objects (blue tug, KONG®, and red ball, and are plotted here for reference. “Tug” indicates tug training, “Fetch” indicates fetch/tug training, and “Inter” indicates interspersed training.

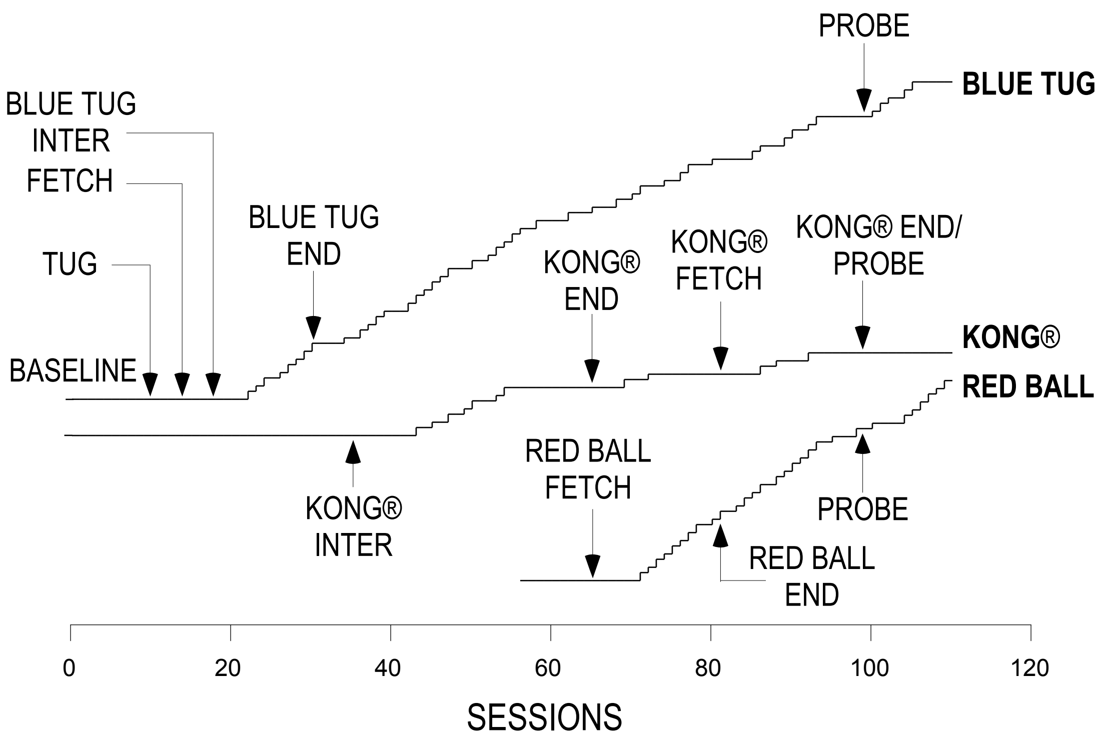

Figure 3. Cumulative retrieval responses for the three target objects that received common-response training. Arrows indicate training phase changes. "Tug" indicates tug training, "Fetch" indicates fetch/tug training, "Inter" indicates interspersed training, and "End" indicates when training for that object ended.

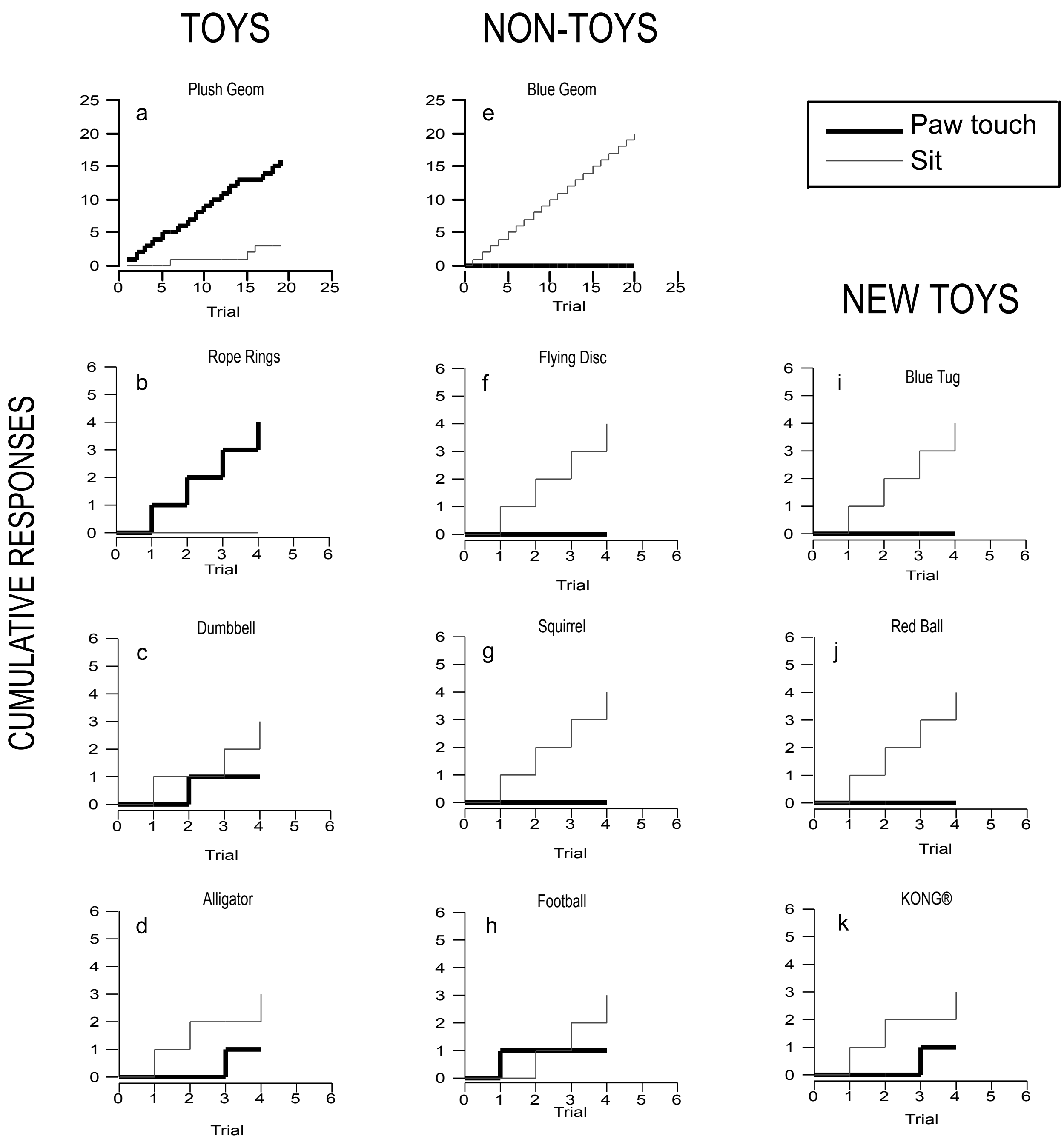

Figure 4. Cumulative paw touch (thick line) and sit (thin line) responses to each of twelve objects across trials in four sessions. Graphs a-d show results of four toys. Graphs e-h show results for four non-toys. Graph i-k show results for three new toys.

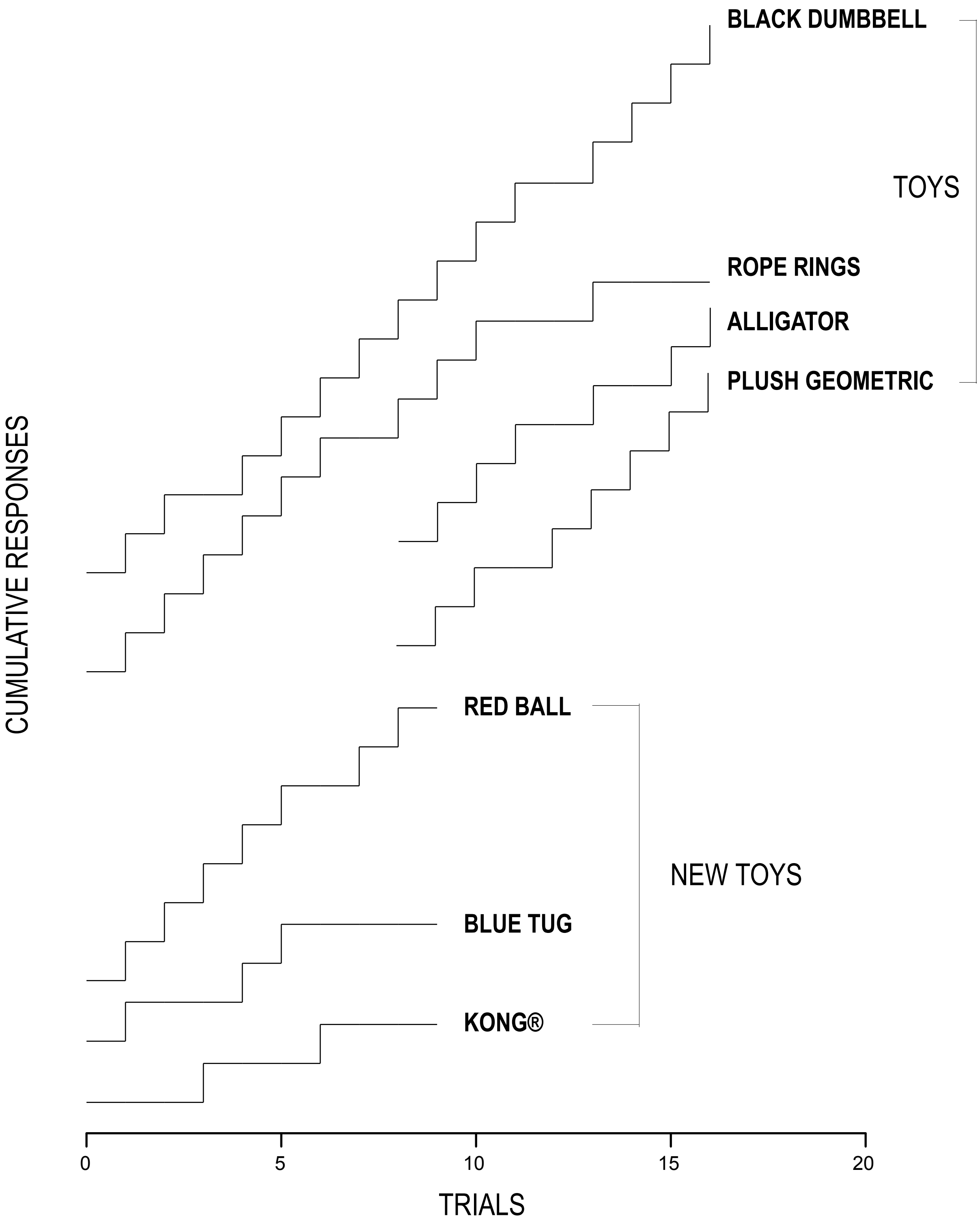

Figure 5. Cumulative nose touche responses to four toys (top lines) and three new toys (bottom lines).

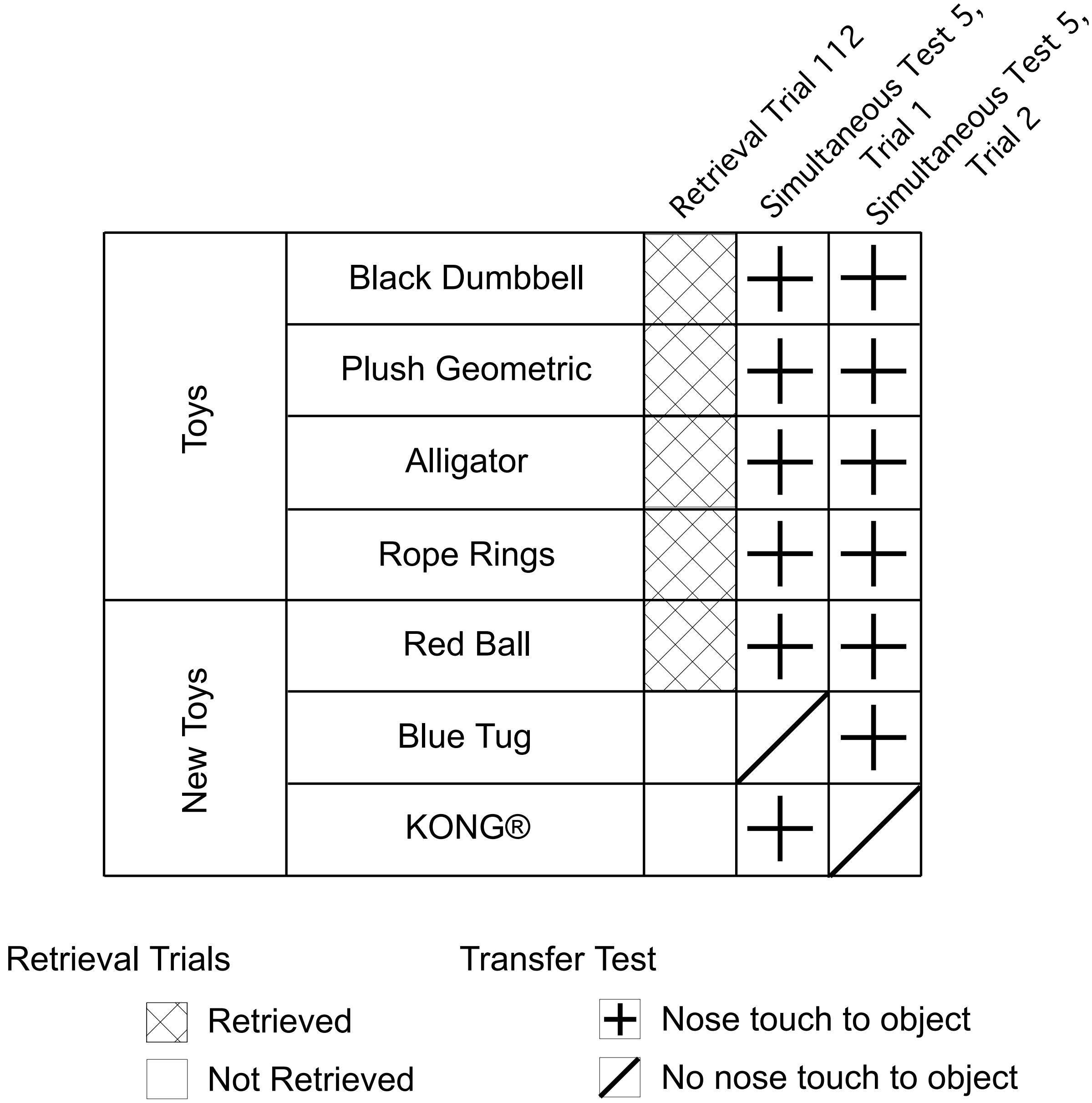

Figure 6. Correspondence between the last retrieval test and the last simultaneous transfer test. Column 1 shows retrieval response to four toys and three new toys. A hatched box indicates the object was retrieved and an empty box indicates the object was not retrieved. Column 2 and 3 show the nose touch responses in the two trials from the transfer of function test. A plus sign (+) indicates a nose touch to that object. A slash (/) indicates a nose touch to the other object (non-toy) of the pair.

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