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The efficacy of the model–rival method when compared with operant conditioning for training domestic dogs to perform a retrieval–selection task

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Abstract

Traditionally, dogs have been trained by operant conditioning techniques; that is, dogs make a desired behavioural response and this response is reinforced by a reward such as food. This type of training is very effective in training dogs to perform basic obedience behaviours (e.g. ‘stay’). However, dogs are social animals and should be predisposed to learn from social stimuli. In the present study, we used a modified version of the model–rival technique that has been extensively used in experiments investigating the cognitive ability of parrots. In this technique, social stimuli are used to create in the animal an interest in the object without the use of food or other rewards. Therefore, the animal learns the name of the object (intrinsic reward) and not that the object’s name means food. In this experiment we compared the learning ability of nine pet dogs to solve the same retrieval–selection task having been previously trained using operant conditioning or model–rival techniques. The retrieval–selection task was the dogs had to correctly select the commanded object to bring to the experimenter from a group of three similar objects. The results show no difference in the speeds with which the dogs solved the test—demonstrating the efficacy of the model–rival method. This is the first time that the effectiveness of the model–rival technique has been experimentally demonstrated with dogs. Furthermore, we believe that the methodology reported in this paper has applications in dog training and in experiments into dog cognition.

Keywords: Dogs; Learning; Operant conditioning; Model–rival; Cognition

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1. Introduction

The training of domestic dogs and indeed other animals to perform behaviours on command is well established using operant conditioning techniques (Pryor, 1999; Chance, 1999). These techniques are commonly used to train domestic dogs to perform obedience commands, such as 'stay'.

Recently, studies into animal cognition have put great emphasis on the 'social brain hypothesis'; that is, intelligence evolved to solve social problems (Dunbar, 1998; see Cooper et al., in press). The genetic ancestor of the domestic dog is the wolf (Serpell, 1995), a species that lives in large, complex social groups—the ideal conditions to promote the evolution of high cognitive abilities. Adler and Adler (1977) established that dogs were capable of observational learning and, recently, Slabbert and Rasa (1997) demonstrated that a puppy could learn a new behavioural task from watching its mother. Given the social nature of dogs and their ability to learn observationally it is surprising that humans have not tried to teach them using social learning methods, which have been employed with parrots.

Using methodology and social modelling theories borrowed from Todt (1975), Mowrer (1960), Bandura (1971) and Pepperberg (1994, 1999) attempted to teach Alex, an African grey parrot how to recognise objects (their name, colour, size, shape and quantity). Pepperberg's modified model–rival method is as follows: Alex, the African grey parrot stands on a perch in front of Pepperberg and an assistant. One of them acts as the trainer whilst the other acts as a model–rival (i.e. a model for the desired behaviour but also a rival for the trainer's attention; Bandura and Walters, 1963). The trainer presents an object to the model–rival asking questions. If the model–rival answers correctly they receive praise and the trainer hands the object to the model–rival. If the model–rival names the object incorrectly the trainer shows their disapproval, scolds them and removes the objects from view, thus giving the model–rival 'time out'. Alex watches this and is allowed to join in with the 'conversation'. When they consider that he is trained sufficiently, he can choose the object he wants and when he says it correctly he is given the object as a reward. In this case, the reward is intrinsic; that is, the label belongs to that particular object. In most training situations, an extrinsic reward is given; that is, you ask the dog to bring you the ball and when he does you give him a food reward. Pepperberg believes that animals trained using model–rival, know what the objects are and know that they want them. She argues that by giving extrinsic rewards the bird may end up 'believing' that the word being taught relates to the food item they receive rather than the object being shown to them (Pepperberg, 1987, 1994).

The trainer and the model–rival change 'roles' so that the bird will respond to more than one person (Pepperberg, 1987). Studies with humans have shown that the words at the end of the sentence are the ones most likely to be remembered (Pepperberg, 1999), therefore the target word always appeared at the end of the sentence in Pepperberg's studies.

It is likely that the model–rival technique has great potential as a tool to allow us to train, and explore the cognitive abilities of other highly social animal species, such as domestic dogs. There has been one notable failure using this method, this involved a lar gibbon (*Hylobates lar*) who attacked the model–rival during training sessions (Heyes and Galef Jr., 1996); this probably occurred due to the aggressive and territorial nature of this species (Preuschoft et al., 1984). Therefore, before we can put this method to use in training or exploring the cognitive abilities of dogs we must first establish the efficacy of the method. In this experiment we compare the learning speeds of nine dogs to retrieve a named object when trained by operant conditioning and model–rival technique.

2. Methods

2.1. Animals

The subjects were a haphazard sample (Lehner, 1996) of pet dogs, six females and three males, of mixed breeds and ages (mean age was 55.20 ± 16.88 months); which were day boarders at the animal care unit of De Montfort University. Prior to all experimentation the consent of all dog owners was acquired in writing (the owners were given an outline of the experimental protocol) and the owners filled in a short questionnaire about their dog (e.g. which toys they had, what was their favourite treat, etc.).

2.2. Objects

The objects used that the dogs had to choose consisted of two groups of rubber toys. One group consisted of three red rubber dog toys, being a boot, a fire extinguisher and a strawberry (mean length = 156.6 mm and mean circumference = 263.3 mm). The other group consisted of three yellow rubber dog toys consisting of a saxophone, a toothbrush and a hammer (mean length = 203.3 mm and mean circumference = 210.0 mm). It should be noted that all toys within a group had a similar physical appearance, this was considered important in creating a real test of the dogs' learning abilities.

After each training session all of the objects were washed in biological washing liquid and wiped over with a cloth that had been dipped in surgical spirit. This was to remove any odour cues. The toys that were not used in that particular trial were also washed to ensure that all of the toys had the same smell.

2.3. Novel labels

The object to be retrieved was decided on a random basis by the experimenter, but regardless of which toy was chosen, the label used for the red toy was ''SOCKS'' while the label used for the yellow toy was ''CROSS''. This was done to make sure that each dog was asked to choose the same 'label', thus eliminating any confounding errors that may have occurred; that is, pronunciation of the word, or any unknown gestures that may have accompanied the word unintentionally. Furthermore, we had confirmed in our questionnaire that these labels were indeed novel to the dogs.

2.4. Training sessions

The dogs were allowed to acclimatise off the leash to the training room for 10 min prior to the study with the experimenter and assistants present, thus reducing observer/experimenter effects. The training methods were alternated between the dogs; for example, if dog number 1 was trained by operant method first, dog number 2 was taught by using model–rival method first, thus providing a counterbalance for using the same subjects in both conditions. This also ensured that the experimenter did not begin enthusiastically and then tail off during the second method.

2.5. Operant training method

Each dog was trained using operant conditioning to locate and bring a named item to the experimenter (this was the only toy available). This was achieved through shaping (without the use of a clicker); that is, rewarding successive approximations to the desired behaviour on a differential reinforcement schedule. For example, if the dog interacted with the toyed it gained a food reward, later the dog only gain a reward if it picked up the toy in its mouth, eventually the dog only gained a food reward for bring the toy to the experimenter. The number of times the name of the target item was said was noted to ensure consistency in the experiment. When the dog could successfully return the toy to the experimenter (from 3 m), after having received a verbal command, and drop it at her feet three consecutive times the dog was considered 'trained' and was put into the trial condition.

2.6. Model–rival training method

The model–rival technique of training consisted of the dog being secured by a lead half a metre away from both the trainer and the model–rival who were sitting in front of the dog. They then discussed the target item (only one toy was present at any time as the target item), the name of which always appeared last in the sentence. This consisted of a dialogue between the trainer and the model–rival.

Trainer: "Can you see the SOCKS?"—hand the object to the model–rival.
Model–rival: "Yes I can, thank you for the SOCKS"—hand to the trainer.
Trainer: "Can you pass me the SOCKS"—hand to model–rival.
Model–rival: "Thank you for the wonderful SOCKS"—hand to trainer.

This dialogue continued and the number of times the name of the object was mentioned was record. After witnessing the conversation the dog as asked to retrieve the object from a distance of 3 m using a verbal command. The training took a total of 2 min (which proved sufficient in a pilot study). If the dog was unable to complete the trial successfully, the training was repeated and the extra time was added on to the total training time.

The dog was not allowed to touch the target item whilst the dialogue was taking place, he was merely observing the interaction of the two people. In order to keep the dog interested, the experimenter and model–rival were speaking in a highly animated way. They both looked at the target object at all times they were discussing it, also ensuring that voice direction and body postures were directed towards the dog.

2.7. Retrieval–selection task trials

The object of the task was to assess if the dog had learnt the name of the object, in the test the dog did this by retrieving the correct object from a group of three similar objects.

To ensure that each dog started the trial from exactly the same distance away from the three objects in the trial, and also ensure that the three objects were exactly the same distance away from each other a measuring stick was used. This consisted of three 2 m lengths of wood being pivoted together at one end. Each piece of wood was joined to the next one at the other end by a 1 m length of cord, thus the whole measuring stick opened like a fan. Chalk marks were then put on the floor for each of the three objects and also the dog's position.

When the dogs were in the trials the experimenter stood behind the dog, the dog facing forwards and they were let off the lead. This did two things, firstly it reduced experimenter bias, and secondly it ensured that the experimenter did not inadvertently push the dog to any particular side, thus reducing the risk of obtaining a side bias. In all cases, when the dog was released, the experimenter said, "Go get the SOCKS" or "Go get the CROSS".

2.8. The trial

The trial was the same for both training methods. It consisted of a group of three same coloured objects being placed 1 m away from each other and 2 m away from the dog. The dog was made to sit in the designated space and was asked to "Go get the CROSS" and was then let off the lead. The trial was completed when the dog had retrieved the target item from the line-up and returned it to the experimenter. This was repeated with the target item in a second position in the line-up and repeated again with it in the third position in the line-up; that is, the dog had to successfully choose the target item from every position in the line-up. This position was randomly assigned for each dog, making sure that if the object was in position one in the operant trial it was not in position one first in the model–rival trial. If the dog failed to choose the correct item three times the training period was repeated. The extra time taken was reflected in the total training time, thus showing the training method that was the most successful.

3. Results

The following data were available for analysis (all timings were recorded using a digital stopwatch; see Tables 1 and 2):

- *A*: Time taken to train using operant training method in seconds.
- *B*: Time taken to choose item three times when trained using operant method in seconds.
- *C*: Time taken to train using model–rival method in seconds.
- *D*: Time taken to choose item three times when trained using model–rival method in seconds.
- *E*: The number of times the object label was repeated in operant training.
- *F*: The number of times the object label was repeated in model–rival training.

The data were checked for normality using the Anderson–Darling test and found not to meet the requirement for parametric statistics. Therefore, we transformed the data using a square-root transformation and re-tested the data for normality and the data now met the

Table 1
Training statistics (in seconds)

Dog number	Operant method	Model–rival (M–R)	Difference between operant and M–R
2	474	136	338
3	855	617	238
5	569	283	286
6	244	117	127
7	520	814	−294
8	629	1210	−581
9	290	224	66
11	388	168	220
15	556	647	−91

Table 2
Trial statistics (in seconds)

Dog number	Operant method	Model–rival (M–R)	Difference between operant and M–R
2	22.3	20.16	2.14
3	14	409	−395
5	224	159.3	64.7
6	15.8	25	−9.2
7	660	466	194
8	745	311	434
9	58	63	−5
11	101	10	91
15	288	346	−58

requirements for parametric statistics. The training time variables (A and C) and the test time variables (B and D) were then analysed using ANOVA (two types of training and two order effects; that is, operant or model–rival training first). We found no significant effects of training method on training times (mean training times and S.E.M. for both methods were: 502.7 ± 61.7 and 468.4 ± 126.0 for operant and model–rival, respectively) or on trail times (mean trail times and S.E.M. for both methods were: 236.4 ± 93.7 and 201.0 ± 61.0 for operant and model–rival, respectively) and no significant effects of order of training method. Thus, for both variables dogs learnt at the same rate and performed the task at the same speed. We then correlated the number of times the object name was said (variables E and F) with the aforementioned three variables used in the ANOVA models. We found no significant correlations between any of the variables.

4. Discussion

The result of this experiment demonstrates that the model–rival technique has similar efficacy as operant conditioning in training dogs to a retrieval–selection task. Thus, we have demonstrated that this method has potential to be used in training and potentially for future experiments into the cognition of domestic dogs. The power of the method lies in the fact that it uses intrinsic rewards (the object itself is the reward), whereas operant conditioning uses extrinsic rewards (food is the reward). Thus, although in our experiment the test behaviour of the dogs appeared identical—the retrieval of a named object—its significance to the dogs depended upon the training method. The model–rival method resulted in the dog knowing what the objects name was, whereas the operant method only resulted in the dogs knowing that retrieving the object results in a food reward.

It should be noted that we found considerable variation in the time for dogs to learn the retrieval–selection task when trained by either method and it is this that accounts for the lack of significant difference between the two training methods (see Section 3). Unfortunately, we only had a haphazard sample (see Lehner, 1996) of dogs available to conduct the experiment with and therefore we had no control over the effects of age, sex, breed or rearing history. However, despite these sources of variation we found that all of our dogs learnt to perform the retrieval–selection task by both training methods. These sources of uncontrolled variation suggest future experiments and perhaps ways of increasing the efficacy of the model–rival training technique.

Pepperberg (1999) believes that one of the factors that created her success in training Alex was that she acquired him when he was young. In many species of mammals gender has been found to influence the speed of social learning (for a review, see Choleris and Kavaliers, 1999). It is likely, that some breeds of dog would learn more quickly the retrieval–selection tasks due to them being bred for specific traits. Gun dogs, for example, are bred to retrieve objects (i.e. game) but also are bred to work with humans and are more sensitive to their signals than non-gun dog breeds (Mckinley and Sambrook, 2000). Studies into the cognitive abilities of dogs have often found dogs with larger brains perform better (Hemmer, 1990). However, brain size is a correlate of body size (Harvey and Krebs, 1990), to avoid this confounding relationship researchers into cognition now use neocortex ratio (the size of the neocortex in relation to the rest of the brain; Dunbar, 1998; Dunbar and Beaver, 1998). It therefore would be interesting to repeat this experiment using dogs bred for different purposes and with different neocortex ratios. It is highly likely that rearing history would affect the ability of dogs in our retrieval–selection task, we knew all of our dogs had been previously trained to retrieve objects but knew little of how this was done and how rigorously each owner enforced correct performance. For example, some owners might insist on an immediate and correct response from their pet dog during a retrieval task for the dog to receive a reward. Whereas, other owners might have less strict criteria for the dog to receive the reward for performing a retrieval task. Thus, it is likely that rearing history would affect the efficacy of the dog's response to a commanded task. In experiments into dog cognition the relationship between the owner and the dog has been found to profoundly influence results (Topal et al., 1997, 1998). In the future it might be preferable to use a novel task and also to conduct observations of owner–dog interactions during training sessions. We believe that by controlling for the aforementioned variables it might well be possible to improve the efficacy of the model–rival technique. Furthermore, this method may be much more appropriate training method to use when their is concern about a dog being aggressive in the presence of food rewards.

We hope that this paper will stimulate more research into dog training using social learning techniques. Already, the methods developed in this study are being employed by a researcher into dog cognition at the University of São Paulo (Alexandre Rossi, personal communication).

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