Assessing the effectiveness of a Department of Conservation procedure for training domestic dogs to avoid kiwi

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ABSTRACT

An experiment assessed the effectiveness of a procedure used by Department of Conservation (DOC) conservancies to train domestic dogs (*Canis familiaris*) to avoid kiwi (*Apteryx* spp.). That procedure involves fitting a dog with a collar that delivers a brief electric shock the moment the dog contacts either a stuffed kiwi or a kiwi carcass placed in an open field. Thirteen dogs representing a range of breeds, sex and ages were sourced from a local pound. Each dog was initially trained to approach a manufactured burrow while being alone and attached to a modified retractable lead, the handle of which was fixed to a pole adjacent to the burrow. Each then received test trials where food, a stuffed possum (*Trichosurus vulpecula*), rabbit (*Oryctolagus cuniculus*), ferret (*Mustela furo*), or kiwi was driven into view from within the burrow, and a carcass of that animal was presented immediately outside the burrow. Those 12 dogs that ate the food and contacted each stuffed animal or carcass then received the DOC procedure, but in a different site to that used for testing. When the test trials were repeated, only one dog (8%) behaved in a manner suggesting that the DOC training had been effective. This failure of most dogs to avoid the very stimuli that had been associated with electric shock logically precludes a dog's avoidance of live kiwi in their natural habitats. Possible reasons why the DOC procedure is unreliable are considered, as are alternative practical techniques for training kiwi avoidance, such as inducing illness in a dog after it ingests food that has a strong kiwi flavour and/or odour.

Keywords: kiwi, *Apteryx* spp., conservation, depredation, domestic dogs, aversion training, electric shock, taste-aversion conditioning

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1. Introduction

It is now widely accepted that the mainland populations of all four species of kiwi (*Apteryx* spp.) have declined significantly since human settlement in New Zealand. McLennan et al. (1996) estimate that kiwi abundance in most North Island forests has probably declined by at least 90% over the last century. Unfortunately, this decline appears to be continuing at a similar rate. For example, McLennan et al. estimate that the population of northern brown kiwi (*Apteryx australis mantelli*) is currently declining at 5.8% per annum. Although habitat destruction might seem to be the primary cause of population decline, various researchers (McLennan & Potter 1992, 1993; McLennan et al. 1996; Pierce & Sporle 1997) have shown that predation by introduced mammals accounts for most of the decline. In particular, introduced pests such as ferrets (*Mustela furo*) and possums (*Trichosurus vulpecula*) prey on eggs, while stoats (*Mustela erminea*) and cats (*Felis catus*) prey on young birds. However, predation of adult kiwi by domesticated dogs (*Canis familiaris*) contributes significantly also. For example, Pierce & Sporle (1997) reported that 194 kiwi deaths (78% of all reported deaths) in Northland between 1990 and 1995 were attributable to dogs. The threat posed by small numbers of dogs was also highlighted by Taborsky (1988) who reported that a single dog killed about 500 kiwi (around 50% of the local population) in Waitangi State Forest over a six-week period.

Given the threat that dogs pose to kiwi, measures to keep dogs out of kiwi habitats seem to be justified and necessary for the protection of kiwi. However, James (2000) argues that the prohibition of dogs from those habitats may impact negatively on kiwi conservation if an authority's approach is perceived by dog owners as rigid or inconsistent. In addition, such measures are often impractical for a number of reasons. First, kiwi frequently inhabit privately-owned land, or protected areas that are immediately adjacent to either private land, or public areas where dogs are permitted. Some overlap of the habitats of kiwi and dogs is, therefore, probably unavoidable. Second, dogs have proven to be extremely useful for hunting feral pigs (*Sus scrofa*), deer (*Cervus* spp.) and goats (*Capra hircus*) and measures to control these populations undoubtedly also benefit kiwi. Third, given the geography of most kiwi habitats, enforcing dog restrictions is likely to be extremely difficult, especially in rural areas where recreational hunting is popular.

An alternative strategy has been attempted by at least six Department of Conservation (DOC) conservancies in partnership with the Bank of New Zealand Kiwi Recovery Trust. This has involved DOC staff and contractors providing dog owners with information about dogs and kiwi, and a training session in which they attempt to train their dogs to avoid kiwi. The procedure involves attempting to train an aversion to the sight and/or odour of kiwi by associating a brief period (0.5–1.5 s) of electrical stimulation (hereafter referred to as an electric shock) with a kiwi carcass and a stuffed kiwi prepared by a taxidermist. These 'baits' are positioned next to each other in an open field where it may be assumed that the dog can see and smell them. The dog is fitted with a commercially available collar that delivers an electric shock when operated by a remote

control held by the trainer. The owner leads or accompanies the dog to the field and, if it is on a lead, releases it in such a way that it will be likely to approach the baits. The trainer activates the electric shock the moment the dog touches either bait[1]. The owners of dogs receiving this training are told that the training does not guarantee that the dog will not attack kiwi, but are then issued with a certificate as evidence that the training took place. Although dog owners are not legally obliged to have this certificate, there has been considerable demand for kiwi-avoidance training from professional and recreational hunters, farmers, and pet-dog owners. In addition, some DOC conservancies, forestry companies, and private-land owners have begun making it a requirement for access to kiwi habitats under their jurisdiction (e.g. East Coast/Hawke's Bay and Waikato conservancies). Since 1997, employees of the Hauraki Area Office, Waikato Conservancy have provided approx. 1000 dogs with this training session (A. Smaill, BNZ Kiwi Recovery, pers. comm. 2005).

Although a number of published studies have claimed that response-contingent electric shock can, under some conditions, eliminate predatory behaviour in canid species (e.g. Linhart et al. 1976; Andelt et al. 1999; Christiansen et al. 2001), the training methods reported in those studies differ significantly from the method adopted by DOC. Information suggesting that the DOC training results in kiwi avoidance has come only from anecdotal reports by dog owners, from observations of a dog's behaviour immediately after receiving the shock, and from informal tests arranged by reinstating the training environment between one hour and one year following the training session. Each of these sources is, however, likely to involve factors that bias the information toward supporting the effectiveness of the training. For example, dog owners may be more likely to report cases of dogs avoiding kiwi than cases of dogs attacking them; a dog fleeing from the kiwi baits upon receiving the shock is more likely to be fleeing as a direct effect of the shock than a result of having learned an association between kiwi and shock; and prior research suggests that the behaviour of dogs in the informal test may be influenced more by the environment in which testing takes place (i.e. the degree to which it resembles the training environment) than by the re-presentation of the kiwi bait used in training. There is, therefore, a clear need for a rigorous, empirical, and objective assessment of the effectiveness of this training. The experiment reported here involves one such assessment.

The logic applied in the design of this experiment was as follows: The most ecologically valid assessment of this training would involve facilitating near-natural encounters between a dog and a kiwi in an environment (and under those conditions) where dogs and kiwi are most likely to interact in the future, and monitoring closely but discreetly the behaviour of the dog at these encounters. One such encounter would be arranged before the dog received the avoidance training, and another identical encounter would follow the training. In this way, a dog's behaviour before the training is equivalent to a control condition, and comparing this behaviour with that after training would provide an evaluation of the effectiveness of the training; an experiment in its own right. The experiment could then be repeated with a number of dogs

[1] Occasionally, a dog will promptly re-approach the kiwi baits after receiving the shock. If it touches either bait a second time, it receives another shock and verbal reprimands from its owner.

(perhaps of different breeds or experience in bush settings) to show that any behaviour change was reliable and attributable only to the training. Thus, if pig-hunting dogs were being studied, on both pre- and post-training encounters, the dogs could be presented with a live moving kiwi while those dogs were in normal kiwi habitats, out of their handler's sight, and engaged (perhaps with other dogs) in searching for a pig on an otherwise regular hunting trip. Such an assessment, however, involves numerous practical difficulties and ethical issues, not the least of which is how a dog's behaviour could be monitored without affecting that behaviour. As well, there seems little justification for attempting to claim this degree of validity before simpler, albeit less valid, assessments have been conducted. The present experiment was, therefore, designed to provide a more preliminary assessment and ask whether dogs would at least avoid contacting the very stimuli that had previously been associated with shock; namely, the kiwi carcass or the stuffed kiwi. Only once avoidance of these 'training stimuli' had been demonstrated could it be possible that that avoidance had generalised to live kiwi encountered in more natural circumstances, in which case more ecologically valid assessments would then be warranted. Furthermore, evidence that the essentially-kiwi features of the baits (e.g. their odour and distinctive physical features) were being avoided after training would be provided in two ways. Firstly, site avoidance could be eliminated as an alternative explanation of a dog not contacting the kiwi by conducting training and testing in different settings. Secondly, avoidance of dead animals generally could be discounted by demonstrating that dogs would avoid contacting the kiwi baits but continue contacting carcasses, and/or stuffed models, of other animals.

Another practical difficulty confronting us involved establishing how to facilitate a dog's approach to, and contact with, the baits on test trials given that the baits are static (albeit aromatic) features of the environment. This problem is also sometimes faced in DOC's field training and is usually solved by having dog owners position themselves close to the baits and then command their dogs to approach them if they do not approach independently. However, this solution did not seem appropriate for the test trials because dogs vary considerably in their behaviour toward people and one could not easily control the interactions between a dog and its handler. (The presence of a handler would add a further source of variability to the dogs' behaviour.) Instead, we attempted to facilitate bait approaches while minimising effects of a handler by using a combination of techniques. Firstly, on all test trials, a dog was clipped to an extended retractable lead, the handle of which was attached to a pole beside the baits. Once the dog was released on this lead, the handler could then retreat behind a hide and the lead would gently pull the dog toward the baits and define a maximum area in which it could travel. Secondly, this lead operated like a ratchet so that a dog could approach the baits beside the pole but never move further away at any point in that approach. Thirdly, before and after the presentation of the animal baits on test trials, approaches to the bait site were rewarded by providing trials where food appeared there. Providing dogs with a history of finding food at the bait site was also an attempt to simulate 'hunting' opportunities for the dog and increase the likelihood that the movement of a model animal into view at the bait site would elicit a 'chase'.

In summary, this experiment was a preliminary investigation of the effectiveness of that method of kiwi-avoidance training for dogs that has been offered by DOC staff and contractors. Although we worked with a small group of dogs (n = 13), each dog individually received repeated test trials before and after a training trial where electric shock was delivered for touching kiwi baits. Consequently, each dog provided control (or baseline) data against which the effect of this training could be judged. (This research design is known as single-subject or small-n design and is common in a practice of Psychology called Applied Behaviour Analysis.) Specifically, before and after training, each dog was attached to a retractable lead and presented with an opportunity to approach a manufactured burrow and contact either food or one of four different animal baits (possum, rabbit, ferret, kiwi—a stuffed animal and carcass of each) located there. The need for subjective judgements about a dog's behaviour on these test trials was eliminated by adopting a simple operational definition of avoidance. That is, avoidance of a bait was deemed to have occurred if the dog did not touch that bait within 7 min of being released on the site. Furthermore, should this avoidance occur, the degree of avoidance could be quantified objectively by measuring a dog's minimum distance from the bait over the course of the trial. (A record of this distance would be provided by the length of lead remaining at trial end.) The attempt at training kiwi avoidance would be deemed effective if a statistically significant number of dogs contacted all the baits prior to the training trial, and contacted all except the kiwi following the training trial.

2. Method

2.1 SUBJECTS

Sixteen domesticated dogs were procured from the Manukau City and Papakura City animal shelter and transported to a privately-owned boarding kennel nearby where they were housed individually in standard kennel cages. The dogs had been captured by animal-control officers in urban areas of the cities because they had been found wandering and were not registered. Each dog had been kept at the animal shelter for at least seven days since capture and none of the dogs had been claimed by an owner, if anyone indeed owned any of them. Consequently, no information regarding each dog's prior learning experiences (and training) was available, and its age and breed had to be estimated from its physical appearance. These estimates were provided by the animal-control officers and kennel staff.

Five criteria were applied by the animal shelter staff when selecting dogs to serve as subjects:

- The dog showed no signs of illness or significant injuries that could impair its ability to run or be led on a lead.
- The dog showed no evidence of aggression toward people.

- The dog weighed more than 10 kg (in order that the retractable lead did not drag along the ground) but less than 60 kg (in order that the equipment would withstand any attempts to escape).
- The dog was judged to be at least six months of age.
- If the dog was female, it was not in that part of the estrus cycle when it was fertile and therefore attractive to males.

Table 1 details the given names, sex, estimated breeds and ages of those 13 dogs that served as subjects. (The remaining three dogs were excluded from the study and returned to the animal shelter because two of them displayed extremely submissive behaviour in the presence of people, and the third consistently chewed through leads attached to its collar.) Table 1 shows that only one of the dogs (Sparky) is likely to have been of a single known breed. The remaining dogs were obviously a mix of several breeds. Although a range of breeds were represented in the sample, six dogs clearly had bull terrier in their lineage, and six probably had Labrador retriever. The nine male dogs showed no signs of having been neutered, and the four females showed no signs of having been spayed. The estimated ages of dogs varied considerably and ranged from around 10 months to more than five years.

TABLE 1. GROUP ASSIGNMENT, ESTIMATED BREED, SEX, AND ESTIMATED AGE OF THE 13 DOGS USED AS SUBJECTS.

NAME	GROUP	BREED	SEX	AGE (y)
Dumas	1	Labrador retriever × bullmastiff	M	2
Nash	1	Labrador retriever × border collie	M	3
Shep	1	Border collie × German shepherd	F	5 +
Snoopy	1	Bull terrier × beagle	M	5 +
Sparky	1	Short-haired border collie (NZ heading dog)	M	3
Trike	1	Staffordshire bull terrier × rottweiler	M	3
Princess	2	Bull terrier × whippet	F	3
Axel	2	Labrador retriever × bull terrier	M	1
Bruiser	2	Boxer × Labrador retriever	M	4
Ocean	2	Bull Terrier × Staffordshire bull terrier	F	5 +
Jet	3	Labrador retriever × bullmastiff	M	3
Patch	3	Bull terrier × fox terrier	F	1.5
Puppy	3	Blue heeler × Labrador retriever	M	0.8

2.2 APPARATUS

The apparatus consisted of two retractable dog leads, a digital video camera, a remote-controlled car, a remote-controlled electronic dog collar, stuffed models of four different types of animal, and freshly-frozen carcasses of those same four animals.

Both retractable dog leads were Flexi™ Classic Long 3–8-m leads purchased from a pet store. A spring inside the cases of these leads wound up as the lead was extended and so applied a force that kept tension on the lead and gently pulled the dog toward the lead case. This force measured 4.22 N (equivalent to lifting 0.43 kg) when the lead was at maximum extension, and 2.45 N (equivalent to lifting 0.25 kg) when it was at minimum extension. One lead (shown in the left panel of Fig. 1) was used only in preliminary training and was left un-

modified except that a short (20 cm) length of PVC tube was fixed to the handle so that the lead handle could be supported on, and swivel around, a pole. This was called the Unmodified Lead (UL). The line on the UL was a heavy nylon cord that, when fully extended, allowed a dog to be a maximum of 8.3 m from the pole. The braking mechanism controlled by a button on top of the lead case was never engaged, so that a dog could increase and decrease at will its distance from the pole but with tension always on the lead line.

The other retractable lead (shown in the right panel of Fig. 1) was significantly modified, and was called the Modified Lead (ML). A length of PVC tube was also attached to the handle of this lead so that it could be supported on a pole. Additional features of this lead were as follows:

- An extension spring was added to the braking button so that the brake was normally engaged. This brake was, however, uni-directional. The lead could be extended (and was at the beginning of each trial) only by manually disengaging the brake. Once extended, the lead line could automatically retract and build up inside the case, but could never extend more than 83 mm, because this was the distance between teeth on the spool. Consequently, when this lead was extended and a dog was attached to its end, the dog could decrease, but never increase substantially, its distance from the pole.
- A small steel tube was fixed to the lead case adjacent to the button, and a metal hammer was fashioned and attached to the top of the button. This hammer struck the tube on each downward action of the button and, consequently, produced an audible high-pitched click. Each such click therefore signaled that a further 83 mm of line had been retracted into the lead case.

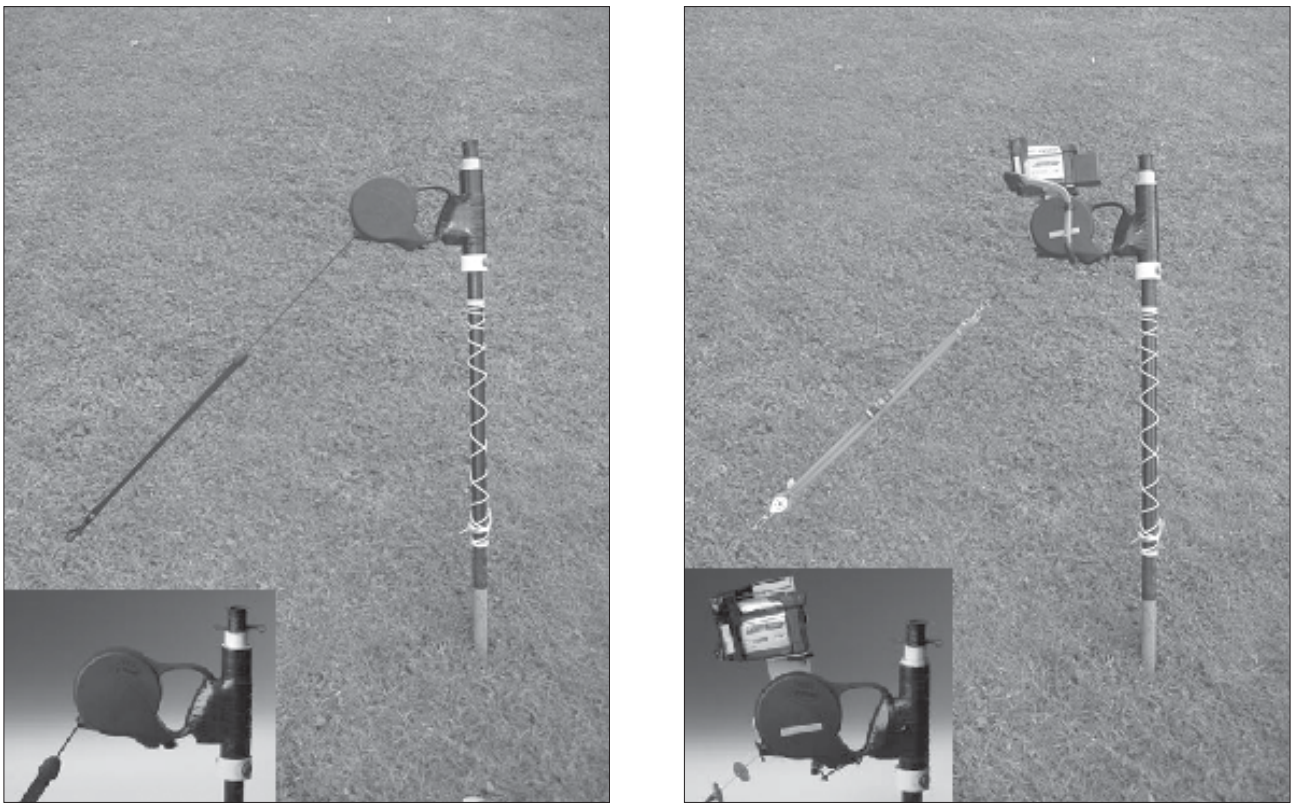

Figure 1. Photographs of the unmodified retractable lead (UL, left panel) and the modified retractable lead (ML, right panel). The UL was used on Trials 1, 2, 3, 4, 10, 12, and 13; the ML was used on all other trials. See text for further explanation.

- The diameter of the spool onto which the lead line could wind was increased, and the nylon cord was replaced by a thin braided wire (used for sports fishing), to increase the carrying capacity of the spool and provide fairly constant measurement intervals.
- A 50-cm-long heavy rubber cord was attached to the end of the lead line and terminated with a clip that could be attached to the dog's collar. This cord served to keep the lead wire a safe distance from the dog, remove the rigidity from the lead, and allow a dog to increase slightly its distance from the pole at any time. When the lead line was fully extended, a dog could be a maximum of 10.9 m from the pole without stretching the rubber cord.

A cradle was fashioned to hold a small digital video camera and attached to the case of the ML. This cradle positioned the lens of the camera 15 cm directly above the lead case and, because it was attached to the lead case, swiveled around the pole with the lead case to keep a dog in view in all areas of the Testing Site. The only times when a dog was not in view were when the lead line had completely retracted, the rubber cord was slack, and the dog was within 80 cm of the pole. The video camera recorded video images at 25 frames per second, and sound as an analogue signal in real time. Video data and graphical representations of clicks on the soundtrack were analysed using Windows™ Movie Maker and Sony™ Sound Forge on an IBM-compatible notebook computer.

A radio-controlled car was modified so as to carry either a food bowl or a stuffed Australian brushtail possum (*Trichosurus vulpecula*), European rabbit (*Oryctolagus cuniculus*), feral ferret (*Mustela furo*), or North Island Brown kiwi (*Apteryx australis mantelli*). A frozen carcass of each species was also presented, but instead of a ferret carcass, that of a stoat (*Mustela erminea*) was used. Each carcass was intact, had no obvious blood on it, and had been frozen within 12 h of the animal dying. The stuffed model and the frozen carcass of each animal were always presented simultaneously in all training and testing trials to simulate the DOC training procedure and present both visual and odour cues.

The electronic training collar was a model known as SmartAid™ produced by Agtronics Ltd. This collar delivered a brief period (approx. 0.5 s but never more than 1.5 s) of electric shocks at a rate of three 10-microsecond pulses per second to the underside of a dog's neck via two steel studs. At the setting used here, each pulse is estimated to be 11 000 volts and extremely low amperage, although the exact current is difficult to verify because it depends in part on the resistance between the electrodes and the dog's skin (B. Carruthers, Agtronics Ltd, pers. comm. 2005). The collar was controlled by a hand-held remote-control device, and a tone oscillating between two frequencies sounded at the collar whenever a shock was being delivered. This collar was developed in accordance with the 'Code of Recommendations and Minimum Standards for the Welfare of Dogs' prepared by the Animal Welfare Advisory Committee in 1998 for the New Zealand Ministry of Agriculture and Fisheries.

2.3 FIELD SITES

Three sites were selected at the boarding kennels: one for use during preliminary training and testing (testing site) and two for use during training (Training Sites 1 and 2). Figure 2 illustrates the main features of the testing site. A paddock measuring approx. 21 m wide by 37 m long was contained by a hedge along one boundary, a fence along another, and buildings or wire-mesh cages along the remaining two. (The key in the Fig. 2 caption identifies the main features of this site.) A burrow was manufactured at the centre of the paddock. This burrow consisted of a hole about 45 cm wide and 1.2 m long, and positioned so that its

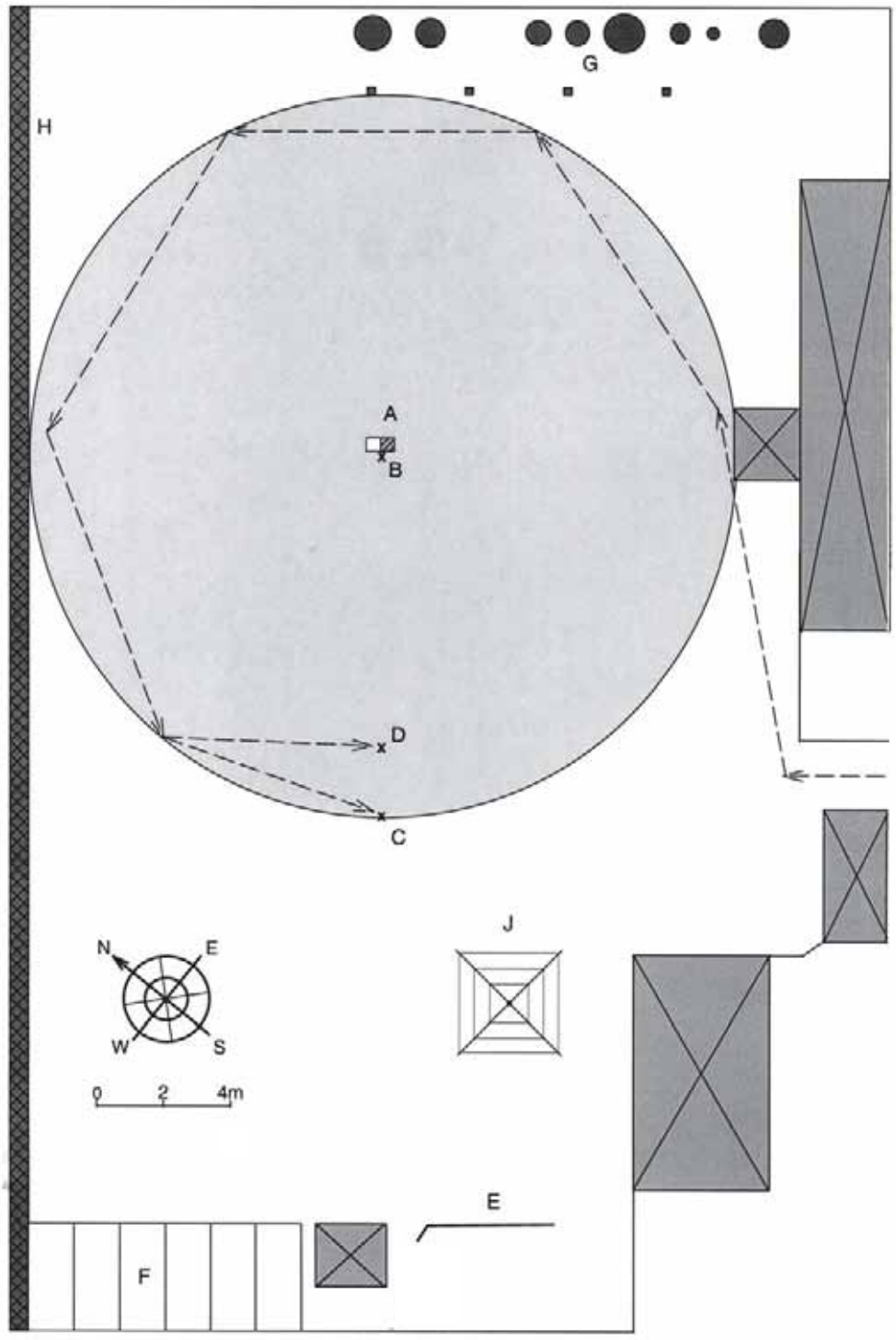

Figure 2. A schematic diagram of the physical features defining the testing site used in preliminary training, pre-training testing, and post-training testing. A = the burrow, B = the pole supporting the handle of either retractable lead, C = the release point when the ML was used, D = the release point when the UL was used, E = a screen serving as a hide for the researchers, F = a row of concrete-floored and caged kennels, G = a row of large trees, H = a hedge, J = a rotary clothesline. Rectangular objects shaded dark grey represent buildings, and all other solid lines represent fences. The dashed lines terminating in arrows depict the path along which a dog was led prior to being attached to a retractable lead at C or D.

long edge was at 90° to the points (C and D in Fig. 2) where dogs would be released on trials. Half of the length of the burrow was covered by plastic netting and fern leaves (see Fig. 3). The hole was ramped at one end to enable the radio-controlled car carrying a food bowl or a stuffed animal to be driven from within the burrow where it was out of view up to ground level where it was clearly visible. A steel pole was hammered into the ground immediately adjacent to the long edge of the hole. This pole supported the handle pieces of the two retractable leads and was disguised by fern fronds. A screen serving as a hide was built approx. 22.4 m from the pole.

Figure 4 illustrates the two training sites. Both sites used a kennel compound in which a set of cages built of wire-mesh fences on concrete floors surrounded a grassed exercise yard. The perimeter of the compound was defined by 1.8-m-high corrugated-iron sheets. In Fig. 4, the concreted areas of this compound are indicated by shading, fine lines indicate mesh fencing, and heavier lines show the iron-sheet fence. The two doors that were used in training are indicated by dotted lines, and the positions of the training stimuli (a kiwi carcass and a stuffed kiwi) and trainer on the two sites are indicated by K1 and T1 respectively (Training Site 1), and K2 and T2 respectively (Training Site 2). K1 was located 5.6 m from a solid door through which a dog was released, whereas K2 was located 2.5 m from a wire-mesh door used for release. Dogs could not see the training site until they were put through the solid door, and they were given access to this site only for the time taken to conduct training.

The training site was sheltered from wind by the high solid fence around the kennel compound. However, the testing site was quite exposed to wind. Consequently, wind direction and wind speed were measured by a hand-held anemometer at the burrow immediately before, and midway through, each session of testing. Wind direction varied between westerly and south-westerly within and across days, and wind speed ranged between 0 and 4 km/h, with no one day having consistently stronger winds than another. Only one 15-min rain shower occurred over these four days. This rain occurred on the morning of the final day of testing and some 3 h before testing started that day.

Figure 3. A photograph of the manufactured burrow and disguised lead assembly after a stuffed kiwi had been driven from within the burrow and up to ground level.

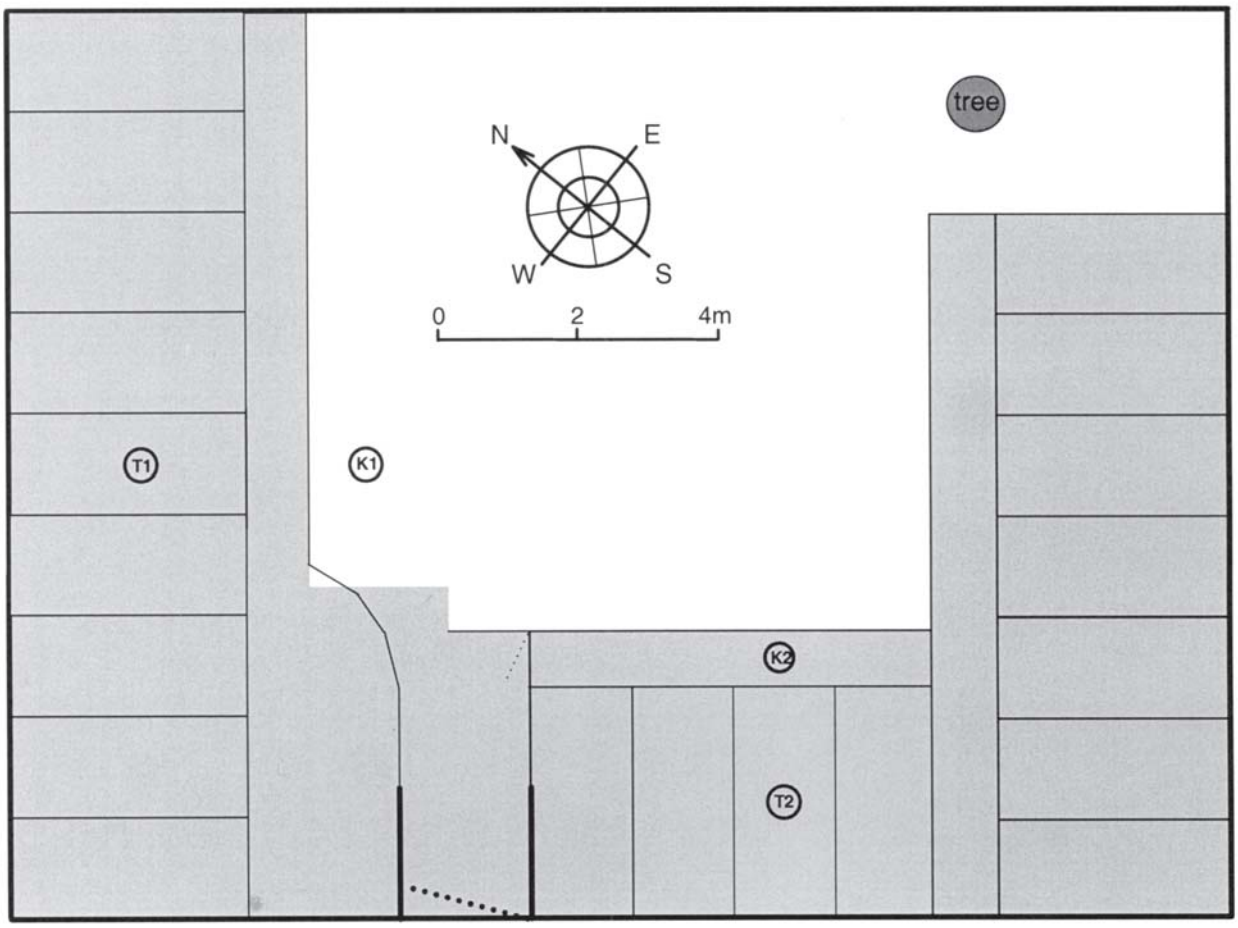

Figure 4. A schematic diagram of the physical features defining the two sites used in the aversion-training phase. Areas of concrete flooring are shaded; the unshaded areas are grass. T1 and K1 indicate the positions of the trainer and the kiwi baits respectively in Training Site 1. T2 and K2 indicate these positions in Training Site 2. Eleven dogs were trained at Training Site 1, and only one (Bruiser) at Training Site 2. Dotted lines depict enclosure doors that were used in the training trial.

2.4 PROCEDURE

Dogs arrived at the kennel facility in three groups over three successive days. (Table 1 identifies the dogs in each group.) Dogs in Groups 1 and 2 received preliminary training on the first day they arrived (Day 1), pre-training testing on Day 2, training on Day 3 and post-training testing on Day 4. Dogs in Group 3 received preliminary training **and** pre-training testing on Day 1, training on Day 2, and post-training testing on Day 3. All dogs were fed a substantial meal at the end of each day of testing or training. Table 2 shows the sequence of trials conducted in each of the four phases.

2.4.1 Preliminary training

In preliminary training, each dog received three sessions lasting around 30 min each and spread across the day. In each session, a dog on a 1.5-m lead was led on a circuit that included two areas: a large tree-lined paddock, and the site that was later to be used for testing (see Fig. 2). These sessions had the following aims:

- To provide the dogs with opportunities to habituate to the sights, sounds and odours of this rural setting.

- To establish the sound of a hand-held clicker as a signal for food delivery (small dog biscuits).
- To train appropriate behaviour on a lead and in the presence of people.

Each dog received approx. 20 clicker-food pairings in each of the three sessions. On each pairing, the clicker was sounded and food was immediately presented to the dog's mouth via the trainer's hand. Clicker-food pairings were presented at random times but contingent on the absence of inappropriate behaviour such as pulling on the lead and rearing on the trainer. Each dog sampled many odours (including those produced by horse, sheep, rabbit and domestic-hen faeces) and encountered live domestic hens in these sessions.

On each of the three occasions that dogs were taken to the testing site, they were led on a pre-determined path that included the paddock's perimeter and approaches to the burrow from three points on this perimeter. Upon arriving at the burrow each time, the handler sounded the clicker and delivered food into a bowl mounted on top of the radio-controlled car. After three burrow approaches and retreats, a trial on the UL was conducted. A second person entered the testing site and placed a small portion of food into the bowl on the car. This person remained at the burrow until the handler had attached the dog to the extended UL (Point D in Fig. 2). The person at the pole then walked past the handler and retreated behind the hide. On a verbal cue from the hidden person, the handler released the dog and then also retreated behind the hide. Both people remained out of sight and silent until the dog had approached the burrow and consumed the food. The dog was then retrieved, transferred back to the 1.5-m leash, and returned to its home cage some 70 m away. The time taken from release until a dog had begun eating at the burrow was recorded on each of these three trials.

TABLE 2. DISTINGUISHING FEATURES OF TRIALS CONDUCTED IN EACH PHASE OF THE EXPERIMENT FOR ALL DOGS EXCEPT OCEAN.
UL = unmodified lead, ML = modified lead, * = extra trials arranged for Axel, Patch, Puppy and Shep.

TRIAL No.	PHASE	LEAD	BAIT AT BURROW
1	Preliminary training	UL	Food
2	Preliminary training	UL	Food
3	Preliminary training	UL	Food
4	Pre-training testing	UL	Food
5	Pre-training testing	ML	Food
6	Pre-training testing	ML	Rabbit
7	Pre-training testing	ML	Mustelid
8	Pre-training testing	ML	Possum
9	Pre-training testing	ML	Kiwi
10	Training	UL	Food
11	Training	none	Kiwi in training sites
12	Training	UL	Food
13	Post-training testing	UL	Food
14	Post-training testing	ML	Food
15	Post-training testing	ML	Rabbit
16	Post-training testing	ML	Mustelid
17	Post-training testing	ML	Possum
18	Post-training testing	ML	Kiwi
19*	Post-training testing	ML	Food
20*	Post-training testing	ML	Kiwi

By the third trial on the UL (the third session of preliminary training), most dogs ran into the burrow and consumed the food immediately upon being released by the handler. Two dogs (Puppy and Snoopy) received a fourth trial on the UL because they did not behave this way. One dog (Nash) received a fifth trial involving the same. Snoopy was the only dog that never consistently ran to the burrow and ate from the bowl on these trials. Instead, he always walked to the burrow and then usually climbed inside it, eating only when he came out of the burrow upon being approached by the handler.

2.4.2 Pre-training testing

All 13 dogs received six discrete trials separated by approx. 20 min. These trials were numbered 4 through 9 (see Table 2). Trials 4 and 5 both involved the provision of food at the burrow, but differed in two respects: the UL was used in Trial 4 (as per Trials 1 through 3) and the ML plus recording camera were used in Trial 5. Trial 6 involved presenting the stuffed rabbit at the burrow with the rabbit carcass lying on a plastic tray beside the burrow and between the stuffed rabbit and the release point. Trial 7 involved presenting the stuffed ferret with the stoat carcass; Trial 8 involved the possum baits, and Trial 9 involved the kiwi baits. A different plastic tray was used for each carcass to minimise the degree of cross-contamination of odours. Handling of the carcasses was also reduced by conducting a set of successive trials involving the same baits but different dogs.

One dog (Ocean) received two additional trials in pre-training testing. Trial 10 involved presenting food at the burrow as per Trial 5, and Trial 11 re-presented the kiwi baits and so replicated Trial 9. These additional trials were conducted because this dog avoided the kiwi on Trial 9 (see Fig. 5).

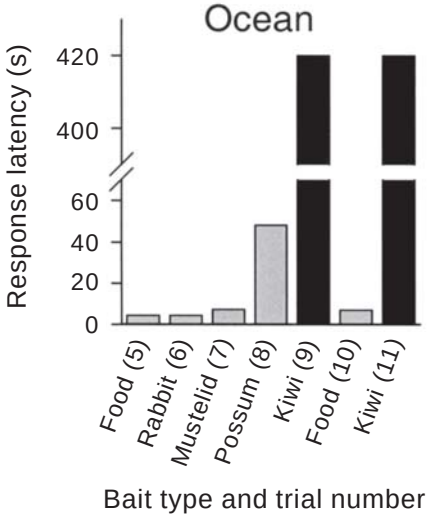

Figure 5. The time taken (in seconds) for one dog (Ocean) to touch the bait at the burrow on Trials 5 through 11. Shaded bars represent trials where the bait was touched; solid bars represent trials where the bait was **not** touched. Note that for all solid bars, the response latency is assigned a value of 420 s (7 min) because a trial was halted if the dog had not touched the bait by this time. This dog did not receive the training trial because he avoided the kiwi on two occasions (Trials 9 and 11) before the training was scheduled.

The following procedure was used with all dogs on all trials in pre-training testing. First, a trial was prepared by securing either a food bowl or a stuffed animal on the car, lowering the car into the burrow, and placing the appropriate carcass on a tray outside the burrow. A dog was taken from its home cage and led around the testing site by the handler. A second person was standing at the burrow. The dog was led along the path shown as the dashed

line in Fig. 2 (this path was consistently downwind of the bait provided at the burrow) and to the location where the end of the extended lead was attached to a peg in the ground. (On Trial 4, the UL was used, so the lead end was at Point D in Fig. 2. On Trials 5 through 9, the ML was used, so the lead end was at Point C in Fig. 2). The dog was then transferred from its leash to the lead, turned so that it was facing the burrow, and restrained by the handler. The person at the burrow then started the camera recording (if that was scheduled), spoke trial details, and then walked past the dog and handler to behind the hide. The now-hidden person then operated the remote control to drive the stuffed animal out of the burrow, or pulled a string attached to the car for the same effect. The burrow was situated so that a dog positioned as detailed above could see the profile of a stuffed animal appearing from the burrow and moving approx. 60 cm from right to left. As soon as the handler saw the stuffed animal cease moving, she released the dog and retreated behind the hide also. Both people behind the hide then served as observers, along with a third person who also served as time-keeper. The dog was allowed to move around the testing site until either of two conditions had been met: either a dog was judged by the three observers to have 'touched' the stuffed animal, the carcass, or the food, or 7 min elapsed since the dog was released, whichever occurred sooner. 'Touching' baits was deemed to have occurred if:

- The dog began eating when food was the bait.
- The dog put its mouth around either the stuffed animal or the carcass.
- The dog put its nose within 3 cm of either the stuffed animal or the carcass.

The moment all observers agreed that any of these conditions was met, the reward clicker was sounded and the trial ended. Two people then reappeared on the testing site, the camera was stopped, and the dog was transferred back to the leash and returned to its home cage until its next trial. If, at any time during or after the trial, a dog urinated or defecated on the testing site, further trials were delayed until the piece of turf under the urine or faeces had been removed from the site.

2.4.3 Aversion training

Twelve of the 13 dogs were given a trial that replicated the DOC procedure designed to establish an aversion to the kiwi baits[2]. (The dog which failed to touch the kiwi on two trials in pre-training testing (Ocean), was excluded from this training and further manipulation because any later avoidance of the kiwi could not be attributed to the training.)[3] This session involved three trials numbered 10, 11 and 12. Trials 10 and 12 involved the UL and food at the burrow (i.e. they were identical to those in preliminary training and Trial 4 in pre-training testing). Trial 11 involved delivering electric shock for touching a kiwi in the training site (see Fig. 4). Another dog (Patch) received two additional trials on the UL after Trial 12 because he took considerably longer than previously to eat at the burrow on that trial.

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[2] This procedure was approved by the University of Auckland Animal Ethics Committee on March 9 2005 (Approval Notice AEC/02/2005/R336).

[3] This exclusion of Ocean from the training and post-training testing allowed us to avoid a false-positive result for the effectiveness of the avoidance training for this dog. This was only made possible by employing a single-subject repeated-measures design rather than a large-number between-group comparison.

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