Comparative importance of training stimuli in avian aversion training for the domestic dog (*Canis familiaris*)

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Abstract

Dogs are the most significant threat to adult kiwi (*Apteryx* spp.), and kiwi aversion training (KAT) has been developed to reduce the likelihood of dogs harming and killing kiwi. In KAT, dogs are presented with a range of kiwi-related stimuli, which attempt to emulate live kiwi. The kiwi stimuli used can vary between trainers and may affect the overall efficacy of KAT. Thus, there is a need to assess the innate 'interest' of dogs in relation to kiwi stimuli to evaluate the potential relevance of different kiwi stimuli for KAT.

In this study, I assessed three groups of dogs with differing experience with kiwi: kiwi conservation dogs, KAT dogs, and kiwi naïve pet dogs. I presented dogs with four kiwi-related stimuli: a kiwi carcass, a taxidermy kiwi, kiwi feathers, kiwi scats, and a blank stimulus using a single-choice preference assessment. Within each trial, dogs were presented with a single kiwi or blank stimulus and were allowed two minutes with the stimulus. The amount of time the dogs spent within the experimental area as well as the behaviour of dogs were videoed throughout the experiment. I used the amount of time the dogs spent investigating a stimulus, as well as their latency to approach the stimulus, as measures of 'interest' from the dogs to each stimulus.

I found that, on average, dogs in all three groups spent more time investigating the kiwi carcass and taxidermy kiwi stimuli. However, the KAT dogs showed the lowest mean duration of investigating each stimulus, while the kiwi conservation dog group had the highest duration. For dogs in the naïve and kiwi conservation dog groups, there was a significant difference in the amount of time they spent investigating each stimulus, with the dogs spending significantly longer investigating the kiwi carcass and taxidermy kiwi in comparison to the scats, feathers and blank stimulus. There was no significant difference in the time the dogs spent investigating the different stimuli in the KAT dog group. Despite the decreased duration of investigation behaviour, dogs within the KAT dog group did not show fear-related behaviour in response to the kiwi stimuli presented. When the duration of time that the dogs spent investigating the different kiwi stimuli was compared across all three groups, no significant difference was found. This indicates that dogs across groups spent similar amounts of time investigating each stimulus.

The lack of obvious learned avoidance behaviours towards kiwi stimuli by KAT dogs in this study suggest that dogs did not show a generalised avoidance toward kiwi stimuli that were not used in their initial KAT. Dogs may still show avoidance toward the stimuli used in their initial training but learned avoidance may not generalise to other kiwi stimuli even if these stimuli are the same type. This poses an issue as each trainer uses different stimuli during KAT, and if dogs are not learning to avoid all kiwi stimuli, dogs may not adequately learn to avoid live kiwi. The kiwi carcass and taxidermy kiwi were of the greatest 'interest' to dogs across groups and so these may be useful stimuli for use in KAT, more so that kiwi scats and feathers. From this study, it seems that visual cues provoke an initial 'interest' in the dogs to investigate a stimulus. I suggested to use several conspicuous items such as taxidermy kiwi models during KAT to ensure generalisation across different stimuli and increase the efficacy of KAT.

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Introduction

1.1 Kiwi: A national icon

New Zealand's fauna is comprised of a unique array of native vertebrates, largely dominated by birds. Throughout the history of human colonisation, many bird species that were once prevalent across New Zealand islands have become extinct or are at risk of extinction. The arrival of the Māori led to significant habitat loss through deforestation, as well as reducing bird populations through hunting (Anderson, 2002). In addition, colonisation by Europeans led to the introduction of numerous mammalian predators, including stoats (*Mustela erminea*), ferrets (*Mustela putorius furo*), weasels (*Mustela nivalis*) and cats (*Felis catus*) (Horn, 1983; Parkes & Murphy, 2003). In the absence of terrestrial mammalian predators, New Zealand's native species had evolved anti-predator traits that were specific to large diurnal avian predators, such as the Eyles' harrier (*Circus teauteensis*) and the Haast eagle (*Harpagornis moorei*), which were the largest birds of their kind that ever existed. However, these defences were not effective against introduced nocturnal mammalian predators (Holdaway, 1989).

Kiwi (*Apteryx* spp.) are a group of flightless bird species, the smallest of the ratite lineage that is endemic to New Zealand. Kiwi possess a suite of characteristics that when placed together are unusual among extant birds. These characteristics allow kiwi to be well adapted to their niche as nocturnal ground insectivores, a niche they now share with some small mammals, lizards and frogs, but no other birds. For example, as a genus *Apteryx* is the only extant bird group to have i) nostrils at the end of their bill, ii) long modified feathers or bristles suggested to help them navigate in the dark (Cunningham et al., 2011), and iii) a bill tip organ that allows detection of prey underground through the sense of touch (Cunningham et al., 2009). All kiwi species nest and roost in burrows and have low metabolic rates (Calder & Dawson, 1978). And importantly, kiwi are considered tāonga for Māori, something that should be treasured culturally, as well as being the national icon for all people in New Zealand.

Along with other native bird species, kiwi numbers have been devastated by predation. Kiwi taxonomy is still under review, but currently five species and 11 taxa are accepted (Weir et al., 2016). Brown kiwi (*Apteryx mantelli*), Rowi (*A. rowii*), Tokoeka (*A. australis*), and Roroa or Great Spotted kiwi (*A. haastii*) adults

range from 2-4 kg, while Pukupuku or Little Spotted kiwi (*A. owenii*) adults weigh up to 2 kg (Castro & Morris, 2010). The size and growth rate makes all species' young susceptible to depredation by introduced stoats, ferrets, and cats; and the adults are vulnerable to ferrets, cats (dependent on size) and dogs (*Canis familiaris*) (McLennan et al., 1996). It is this depredation which has largely lead to threat classifications for kiwi species varying from 'gradual decline' to 'nationally critical' (Robertson et al., 2016). The brown kiwi has the widest distribution, while other remaining species of kiwi are reduced to a few or smaller areas from larger distributions prior to the arrival of mammalian predators (Germano et al., 2018). The little spotted kiwi, for example, survives only on offshore islands or within sanctuaries, and the Rowi exists in a small area at Okarito in the South Island (Germano et al., 2018). It has been estimated that kiwi numbers decline 2% per year in unmanaged populations, largely attributed to predation of both young and adult birds by mammalian predators (Innes et al., 2015). Efforts to preserve what is left of the five species of kiwi is of paramount importance to individuals all throughout New Zealand. However, despite the best efforts of conservation workers, the numbers of some kiwi species are predicted to continue to decline if management remains unchanged (Germano et al., 2018).

Kiwi are attacked and killed by introduced predators at all stages of their life cycle, from hatching to adulthood. Depredation by stoats and ferrets is most prevalent during the juvenile stages (Butler & McLennan, 1991). Many organisations have worked extensively to alleviate the depredation pressure on the kiwi populations with trapping and organised poison drops, focussed largely on reducing populations of stoats, possums (*Trichosurus vulpecula*) and rats (*Rattus* spp). Other programmes such as Operation Nest Egg, run through the Department of Conservation (DOC), involve hatching and rearing kiwi chicks in captivity before they are released into wild populations when they reach a specific weight. This programme is used to assist with kiwi survival by focussing on increasing the number of chicks reared to adulthood (Colbourne et al., 2005). Kiwi eggs are laid in the wild, but eggs are collected, incubated, hatched and raised in sanctuaries or on créche islands. When chicks are large enough (>1 kg) to be able to defend themselves against their most important introduced predator, the stoat, the chicks are released into areas where predator control is undertaken (Bassett, 2012; Colbourne et al., 2005).

The survival of adult kiwi is paramount to the continuation of the species, as the adults are the main contributors to the kiwi breeding population. For this reason, predation at the adult stage of the kiwi life cycle can have the most devastating effects on the species as a whole (Holzapfel et al., 2008; Pierce & Sporle, 1997). The removal or absence of breeding individuals in a population will prevent population growth and re-establishment in these areas. Therefore, the main predators of adult kiwi, ferrets, cats and particularly dogs, are a significant threat to the survival of kiwi populations. It has been estimated that the adult brown kiwi lifespan in Northland has been reduced to less than half of other brown kiwi populations due to predation by dogs (Robertson et al., 2011). The current kiwi recovery plan states as a goal of management (Management goal 1.6), to reduce the number of kiwi killed by dogs (Germano et al., 2018). This acknowledges the importance of dogs as an agent for the decline of kiwi.

1.2 Dogs and kiwi: The problem

The decline of the kiwi has been considered largely caused by introduced predators such as stoats, ferrets and rats, through either predation or competition with kiwi young. However, another key predator that these native birds face is much closer to our homes, our dogs.

The origin of the dog remains under investigation (Freedman & Wayne, 2017), however, dogs have diverged into many phenotypes and spread across the globe. Although, they are considered loveable pets, dogs are also used to help humans in many areas, including conservation. For example, in New Zealand dogs have been used for conservation work for over 100 years. Dogs have been used to locate endangered or protected plants (Dahlgren et al., 2012; Goodwin et al., 2010) and animals (Duggan et al., 2011; Smith et al., 2003; Savidge et al., 2011), as well as locate pest species (Reed et al., 2011; Gsell et al., 2010). Their assistance continues to make a significant contribution to the field of conservation, including efforts to assist kiwi populations (Robertson et al., 2009). However, dogs can also have a negative impact on wildlife.

Along with cats, dogs are considered the most abundant mammalian carnivore (Silva-Rodriguez & Sieving, 2011) and are classified as the third most damaging mammalian predator in terms of impact to other species, after cats and rodents (Doherty et al., 2017). The presence of dogs in many countries has significantly reduced populations of native fauna, and dogs are a threat to 156

different species worldwide (Doherty et al., 2017). For example, the number of mountain gazelle (*Gazella gazella gazella*), an endemic species in Israel, has declined significantly with 23% of young being killed by free-roaming dogs (Manor & Saltz, 2004). Countries with densely populated areas and limited resources for hygiene, commonly have a high number of free-roaming dogs; under these conditions, the spread of disease, such as rabies and Canine Distemper Virus (CDV), by dogs to other animals and humans is significantly increased (Meek, 1999). For instance, more than 39 lions (*Panthera leo*) were killed in Serengeti, Tanzania due to contraction of CDV, which was suspected to be spread by dogs within local villages (Roelke-Parker et al., 1996). A similar study found CDV to cause illness and death in the endangered maned wolf (*Chrysocyon* brachyurus) in Brazil, which was spread by dogs on local farms (Curi et al., 2012). Dogs have also had a severe impact on native fauna on small islands. Barnett (1986) found wild dogs had decimated many populations of tortoise (*Geochelone elephantopus*), iguana (*Amblyrhynchus cristatus*) and penguins (*Spheniscus mendiculus*) on the Galapagos Islands, requiring extensive breeding programmes to help the species recover. In many countries, dogs have been known to destroy bird nesting sites (Van't Woudt, 1990), displace birds and large rodents in native bush (Banks & Bryant, 2007; Mainini et al., 1993). Dogs are the cause the of extinction of up to 11 species of birds (one being the Macquarie Island parakeet, *Cyanoramphus erythrotis* (Taylor, 1979)), and species of mammals and rodents worldwide (Doherty et al., 2017). The impact of dogs on native fauna has, therefore, been seen throughout the world, and New Zealand is not excluded.

The kuri, a domesticated Polynesian dog, was brought to New Zealand with the arrival of the Māori, approximately 1,000 years ago (Holdaway, 1989; Parkes and Murphy, 2003). Although there are few records of the impact of kuri on native wildlife, bones from fur seals (*Arctocephalus forsteri*), pilot whales (*Globicephala* spp.), moa (*Dinornithidae* spp.) and other bird species, including kiwi, have been found with teeth marks from the kuri (Anderson & Clark, 2001; Clark, 1997). The evidence from bones with kuri teeth marks found in middens suggests that the kuri assisted humans in hunting native wildlife.

Presently, over 550,000 dogs are registered on the New Zealand National Dog Database, while approximately 20% of dogs are estimated to be un-registered (Department of Internal Affairs, 2017; New Zealand Companion Animal Council Inc., 2016). Dogs are one of the most popular pets in New Zealand, second only to

cats, and their numbers have increased steadily over the last 15 years, but with a marginal net decrease over the last five years. With the large number of dogs within New Zealand, the impact these animals have had on the native wildlife, particularly on bird species, has also become more widely recognised.

Nesting shorebirds have been significantly impacted by dogs in New Zealand. Dog disturbances can be observed throughout New Zealand estuaries and sand spits that are regularly visited by pet dogs (Bridson, 2000). For example, dogs negatively affect the nesting success and adult survival of New Zealand dotterels (*Charadrius obscurus*) due to their presence at nesting sites (Lord et al., 2001). One of the birds that is most at risk of harm or predation by dogs is the kiwi. Dogs are regarded as the most significant threat to adult kiwi (McLennan et al., 1996) in comparison to other introduced predators, particularly within large parts of the Northland region (Robertson et al., 2011; Miller & Pierce, 1995).

Of the number of adult kiwi deaths reported over a five-year period in Northland, 78% (135 of 173 total deaths) were caused by dogs (Pierce and Sporle, 1997). Feral, stray, and loose pet dogs were the primary culprits of the large number of kiwi deaths, while farm and hunting dogs also contributed to the death toll. Taborsky (1988) estimated that over 500 brown kiwi were killed over a six-week period by a single dog within Waitangi State Forest. Many of the carcasses that were discovered showed no signs of being eaten, but their bodies were crushed and partly mangled. Kiwi with transmitters had been released into the area previously; however, 56% of these birds were also killed by that one dog. It was estimated that this population would take 10 to 20 years to recover from this loss of birds. Miller and Pierce (1995) also noted several reports of kiwi death by dogs in Northland between 1986 to 1992, which involved single stray dogs or feral packs of dogs. For example, on numerous occasions a dog in Taipa, Northland would return home with dead kiwi, while a subsequent survey revealed that no kiwi could be found in the area. This suggests that many incidences of dog attacks on kiwi may go unnoticed if no evidence is found. However, to prevent the reoccurrence of such events, pest management tools, such as the release of toxins to target pest mammals (i.e., stoats, cats and wild dogs) (Murphy et al., 2007), and programmes that involve training dogs to avoid native species have been developed.

1.3 Aversion training: Protecting prey species

Training to protect wildlife has been implemented widely for both prey species (termed anti-predator or predator avoidance training) and predators (termed aversion or avoidance training). Most forms of predator avoidance training involve subjecting the prey animal to a species-specific event that is unpleasant, such as stimulated chase or capture, paired with a model (e.g., taxidermy figure) of the potential predator. The goal of this training is to change the prey animal's future behaviours by eliciting avoidance behaviour in the presence of the target predator. Thus, the prey animal will hopefully learn to evade predatory animals when confronted by them in the wild. However, predator avoidance training has been implemented with varying success. For example, captive bred greater rhea (*Rhea americana*) were trained to avoid puma (*Puma concolor*) via pairing with simulated capture, however, none survived eight months following release. Individuals were killed largely by dogs and poachers, with only one rhea being killed by a puma, which suggested the need to consider other sources of depredation (Vera Cortez et al., 2015). A number of small mammals have also undergone a form of avoidance training against introduced predators. Greater bilby (*Macrotis lagotis*) were found to avoid cats and other predators following avoidance training (Moseby et al., 2012) and captive reared prairie dogs (*Cynomys* spp.) were found to successfully avoid rattlesnakes (*Crotalus* spp.) and hawks (*Accipiter* spp.). Learning and survival were shown to increase when prairie dogs were trained with experienced conspecifics (Shier & Owings, 2007).

Other methods have been used to train predator species to avoid prey animals; these are commonly used to reduce attacks on livestock or other species, including wildlife. For example, coyotes have been given lamb laced with lithium chloride to associate consumption of lambs with illness (Gustavson et al., 1974). In these cases, live prey animals were used in a preliminary trial and the coyotes' latency to attack was measured. Following the ingestion of lithium chloride, the live animal was presented again and the coyotes' latency to attack was measured once more and other behaviours were also recorded. The use of lithium chloride reduced the likelihood of the coyotes attacking live prey, but it was suggested that the presence of displacement behaviours (i.e., eating grass) indicated that motivation to attack is still high but suppressed (Gustavson et al., 1974). Coyotes have also been given an electric shock in the presence of live prey to teach them to avoid lambs, sheep, and rabbits (Andelt et al., 1999; Linhart et al., 1976). Electric shock collars

were found to eliminate coyotes' chasing and attacking live prey, suggesting that pairing the shock (via an electric shock collar) with the attack of a live lamb can lead to learned avoidance by coyotes (Andelt et al., 1999). The use of electric shock collars has also been used on domestic dogs to train them to avoid snakes, prevent them harming livestock (Christiansen et al., 2001) and to avoid native ground-dwelling birds (Dale et al., 2013). Overall, the success of predator and prey avoidance training is varied and may be dependent on a number of factors. Arguably, the most important factor is the effect of evolutionary history in shaping individuals' behavioural responses toward predators and prey (Sih et al., 2011), thus highlighting the importance of choosing the appropriate stimuli to be used during training.

In New Zealand, aversion training is used in an attempt to reduce the likelihood of dogs harming native ground-dwelling birds, such as weka (*Gallirallus australis*), blue penguin (*Eudyptula minor*) and particularly kiwi. Exclusion of dogs from kiwi areas has proven difficult with kiwi species being found on private land, and many dogs used for hunting (e.g., pigs, deer) on conservation land where kiwi may be present (Fraser, 2000). Individual trainers, contracted by the organisation Kiwis for Kiwi or by DOC, carry out kiwi aversion training (KAT) for dogs that may enter kiwi populated areas (Kiwis for Kiwi, 2018). The purpose of this training is to reduce the likelihood of dogs causing kiwi fatalities, through the dogs learning to avoid kiwi and thus, not causing them harm. This aversion training involves presenting dogs with a range of kiwi-related training stimuli that are used to provide olfactory, visual, or auditory stimulation that emulate a live kiwi (for details of the stimuli, refer to section 1.3.2). When a dog approaches a stimulus or shows 'interest' in the object by sniffing or moving in the direction of the stimulus, the dog receives an electric shock via a shock collar, controlled by the trainer. This method of training was established in 1997 (Dale, 2014) and has been used within New Zealand since its establishment for the protection of kiwi.

1.3.1 Learning and stimuli use

For the process of KAT to be considered effective, the association between the kiwi stimuli presented and the aversive shock needs to be established and that aversion needs to generalise to live kiwi and to contexts in which kiwi would naturally be found. Learning is defined by the changing of behaviour as a response to environmental events (Pierce & Cheney, 2013). Operant conditioning is

commonly used in dog training. This involves either reinforcement, when a consequence that follows a behaviour increases the likelihood of that behaviour occurring again, or punishment, when a consequence follows a behaviour and decreases the likelihood of that behaviour reoccurring (Blackwell et al., 2008). Aversion training uses positive punishment, where an aversive stimulus is added (i.e., electric shock) following an undesirable behaviour (e.g., investigating kiwi stimuli). In this case, classical conditioning is likely to be occurring concurrently, as unconditioned responses are consequently elicited during this interaction (e.g., increased heart rate, vocalisations) (Pierce & Cheney, 2013). As a result, responses such as a dog moving away from the stimulus or a lowered posture, which are often indicative of fear, can be observed during subsequent encounters. Avoidance behaviours replace the previous behaviour, such as investigating kiwi stimuli (Dale et al., 2013).

The types of stimuli used in aversion training can be highly variable and can be dependent on the goal of the training. Where aversion training is used to deter depredation of livestock by wolves, coyotes, and dogs, live animals (Shivik & Martin, 2000; Andelt et al., 1999; Gustavson, et al., 1974; Christiansen et al., 2001) and animal carcasses (Conover & Kessler, 1994) have been used as training stimuli. Aversion training has been demonstrated as being effective with wolves (Shivik & Martin, 2000), coyotes (Gustavson, et al., 1974; Andelt et al., 1999) and dogs (Christiansen et al., 2001). However, Conover & Kessler (1994) found that animal carcasses laced with lithium chloride were largely ineffective at deterring predation of livestock by coyotes. Gustavson et al. (1974) used a similar method with lithium chloride packs on live lambs, showed a reduction in attacks by coyote. Pairing electric shock with live animals, via electronic collars, was shown to be effective for learning in wolves to avoid calves (Shivik & Martin, 2000) and dogs to avoid sheep (Christiansen et al., 2001). This would suggest that the types of stimuli used, and the method of aversion application would be significant for dogs, and other canid species, to generalise avoidance to a live prey, including kiwi.

Some research has found KAT to be ineffective in developing avoidance in a natural setting. Jones (2006) presented carcasses and stuffed models of several animals, including a possum, rabbit, ferret or stoat as well as North Island brown kiwi, to 13 dogs. Dogs were sourced from shelters and their histories, including any prior interaction with kiwi, were unknown. In a pre-training trial, the stuffed models were affixed to the top of a modified radio-controlled car, paired with a carcass, and

presented to the dogs individually. The models were moved in front of or coming out of a man-made burrow, which was made to resemble an animal structured burrow, within a 21-m x 37-m paddock. All dogs approached all of the animal stimuli presented at this stage of the study, with the exception of one dog which was not included in further trials. Then, in a concrete enclosure, dogs underwent the aversion training process with a static taxidermy kiwi and frozen kiwi carcass, which were placed on the ground side-by-side. An electric shock was delivered via an electronic collar when dogs made contact with either stimulus. Following the aversion training procedure, the dogs were presented with all of the animal stimuli used in the study. The methods used at this stage replicated the pre-training trial, with the addition of four observers hiding behind the man-made burrow when kiwi stimuli were presented. The observers were present to observe the dogs' responses to the stimuli and thus determine the effectiveness of the training. Half (6/12) of the dogs continued to approach all animal stimuli, including kiwi stimuli, following the aversion training. Seventeen percent (2/12) of dogs showed avoidance behaviours toward possum and kiwi stimuli, thus suggesting that the dogs did not distinguish kiwi stimuli from the other animal stimuli, or that the training was not effective at learning avoidance toward kiwi. Only 25% (3/12) of dogs showed behaviour considered to be consistent with learning avoidance toward kiwi in this study. However, more recent research findings, albeit using different methodology, suggested that KAT is largely successful at developing aversion towards the training stimuli (Dale et al., 2013).

Dale et al. (2013), worked with DOC trainers to conduct a KAT study in native bush along a walking track. Dogs were presented with stuffed kiwi and a partially thawed kiwi carcass and were given an electric shock via an electronic collar when they made contact with one of the stimuli. If dogs undergoing their first training session did not make contact with the stimulus, they were encouraged by the trainer to make contact with the stimulus, who then delivered an electric shock. Another group of dogs was retested 1-month following their initial training, and another group retested 1-year following the initial KAT session. Dogs that were retested 1-month later were not fitted with electronic training collars, while dogs retested 1-year following KAT were fitted with electronic training collars. Across these groups, dogs continued to express avoidance behaviours for at least 1-year following KAT sessions, and this response was independent of wearing shock collars and the location in which the training was conducted. It was also found that

aversion towards the kiwi stimuli decreased as the dogs' age increased, with certain breeds (e.g., non-sporting dogs) showing less avoidance in comparison to other breeds (e.g., terriers), which showed significant avoidance (Dale et al., 2017). These differing outcomes on the research related to KAT suggests there is need for further research in this area with a particular focus on the types of stimuli used in trainings.

1.3.2 Stimuli used in kiwi aversion training

Kiwi aversion trainers make use of many stimuli to train dogs to avoid kiwi, however, the types of training stimuli used varies across practitioners. For example, trainers may use kiwi taxidermy figures, metallic or wooden kiwi-shaped models, with an additional component that mimics kiwi movement (e.g., movement along a string line, or electronic motorisation of the model). Odorous stimuli can also be used, including kiwi roosting material, feathers and scats (of varying freshness). Auditory stimuli of male and female kiwi calls are also used, as well as noises to simulate a kiwi moving through forest debris. Dead kiwi that have been frozen and thawed are also used commonly in this training; the same stimuli are often reused for many years by refreezing and re-thawing the carcasses following each training period. The types of stimuli used in aversion training can vary depending on specific practitioners' preferences, location, and availability of stimuli. Often practitioners use a combination of items that attempt to capture the scent, sight, and smell of a kiwi. The combination of different stimuli, paired with electric shock, are used to establish aversion toward these kiwi stimuli in the trained dogs. From this training, the likelihood of dogs learning to generalise aversion responses toward live kiwi is expected to increase.

Previous research on KAT in dogs has focused on the ability of dogs to learn avoidance towards the stimuli used (Dale, 2014; Dale et al., 2017). However, the question remains whether dogs that have undergone KAT have learnt to avoid kiwi. Testing the effectiveness of KAT in terms of dogs' later avoidance of kiwi has not been done because of welfare concerns preventing the experimental presentation of live kiwi to dogs. To circumvent this, Dale (2014) carried out an experiment where dogs were trained to avoid chickens using similar stimuli used in KAT but including live chickens. Dale found that the use of a live chicken stimulus used in the KAT procedure resulted in a greater avoidance response from dogs to subsequent presentations of live chickens than other stimuli, such as static images of chickens or odorous stimuli such as nesting material and feathers. Therefore, it may be

possible that in order to train a dog to avoid live kiwi, training may need to use live birds rather than other kiwi-related stimuli. However, nothing is known about the innate 'interest' of dogs toward kiwi stimuli, or even whether dogs display similar or varying behaviours when presented with different kiwi stimuli. It is currently unknown whether dogs' responses to kiwi-related stimuli presented during KAT are the same or if responses vary across naïve dogs (i.e., those that have never encountered kiwi or kiwi-related stimuli) and dogs that have been in contact with kiwi or kiwi-related stimuli. It is also unknown whether these possible differences result in varying avoidance responses towards kiwi and kiwi stimuli across these different dogs after having been through the KAT process.

Dogs that have never been in contact with kiwi stimuli and have not undergone KAT can provide us with information on the influence of kiwi and kiwi stimuli on dogs' behaviours and their intrinsic responses to these stimuli. The response of dogs that have been trained to find kiwi, to the stimuli used in KAT, can tell us about the possible link between stimuli and the real bird. The reaction of naïve and 'kiwi-experienced' dogs towards different kiwi stimuli may provide information on the usefulness of a particular stimulus in KAT.

1.4 Measuring preference in animals

A preference assessment is a feasible method for investigating any potential variation in dogs' responses to training stimuli, and therefore, if certain stimuli may be comparatively more or less useful for KAT. Preference assessments involve presenting items of interest (e.g., in a paired-choice or single stimulus presentation format) and assessing the resulting behaviour of the animal. Often an item is considered to be 'preferred' when an animal spends more time with that item or attends to that item first, which allows us to compare different stimuli and observe changes in the animals' behaviour (Rashotte & Smith, 1984; Thompson et al., 2016; Vicars et al., 2014). It is common for preference assessments in animals to involve multiple items being presented simultaneously. For example, young silver foxes (*Vulpes vulpes*) were presented with five different enrichment objects simultaneously for a 10-day period. The objects were then removed for 7-days, and then reintroduced. Following reintroduction, the foxes' latency to contact and manipulate an object as well as amount of time they spent interacting with an object were measured (Hovland et al., 2016). In another study, Araujo and Milgram (2004) completed a preference assessment using five beagle dogs to establish preference

toward a specific food. The dogs were presented with three different objects, where two objects were placed over wells filled with 1 g of food (i.e., moist dog food and dry dog food) and one without any food in the well. This was repeated over 12 trials, and the placement of each object and associated food type was randomised between trials. An object was regarded as preferred based on the number of times it was chosen by the dog throughout the trials. All dogs learnt to ignore the object that was not associated with food, while all dogs showed a similar preference to the object associated with the more palatable moist food type. By presenting three objects at a time, at least six trials were required to account for any possible position bias. Because the assessment also involved delivery of food items, the repetition of the preference procedure was possible while maintaining subject engagement. However, in the case of repeatedly presenting stimuli without any food reinforcer, there may be some difficulty in maintaining subjects' attention.

Kirkden and Pajor (2006) advise against presenting several items at a time because one item is likely to influence an animal's behaviour towards another item. Some studies have employed several stages of preference assessment, for example, Payne-Johnson et al. (2007) tested 46 dogs on their preference for one of two anti-inflammatory oral tablets (one being a palatable tablet and the other a chewable tablet). One stage of this research involved presenting each tablet type singularly over two days, with the order of tablet presentation randomised. Dogs were given 60 s access to the tablet, and their latency to consume the tablet was measured. This initial single-choice test gave information on the dogs' willingness to consume the tablets. The second stage involved a paired-choice test to determine comparative preference between the two tablets. Each tablet was presented and randomly allocated to the left or right position and the study was repeated on three separate days. This allowed the researchers to determine the dogs' preference for the palatable oral tablet in comparison to the chewable oral tablet.

In the case of assessing dogs' preference for kiwi stimuli used in KAT, a paired-choice test would require multiple sequential pairings to allow comparisons between each stimulus whilst controlling for any position bias. Allowing for these different factors would require an extensive amount of time and would likely pose challenges in terms of keeping dogs engaged in the task, particularly as no food would be involved. A single-stimulus presentation can elicit behavioural responses and allow assessment of preference related to the individual stimulus presented,

without the requirement of an excessive number of repeated trials over an extended period.

1.5 Aims of this study

In this study, I used a single-stimulus preference assessment to compare the responses of dogs to four different kiwi-related training stimuli that are commonly utilised in KAT. I assessed preference in three groups of dogs: naïve pet dogs (that had no prior experience with kiwi or kiwi-related stimuli), dogs that had undergone KAT, and dogs that were trained to locate kiwi (kiwi conservation dogs). My hypothesis was that the different kiwi stimuli used in this study would evoke different behavioural responses in dogs, and that these would vary across groups of dogs with different training and experience in relation to kiwi. I predicted that the response of both groups of dogs with previous experience with kiwi would be representative of the dogs' prior interaction with kiwi and kiwi stimuli. Along with this, dogs that had undergone KAT previously would show signs of avoidance learning, measured as fear-based behaviours (e.g., shaking, moving away from kiwi stimuli). I hypothesised that the kiwi conservation dogs would show 'interest' in the kiwi stimuli that most resembles a live kiwi, due to their prior interaction with live kiwi and signs of the presence of kiwi. I predicted that naïve dogs would be highly varied in their behaviour towards kiwi stimuli. As dogs are generally neophilic, I hypothesised that naïve dogs would show 'interest' in all kiwi stimuli presented. I predicted that the kiwi stimuli of most 'interest' for dogs' would vary for naïve dogs and those with previous experience with kiwi and kiwi stimuli. Through comparing behavioural responses, we may gain a greater understanding of what stimuli may be most effective for the aversion process, and their usefulness in a practical setting.

Methods

2.1 Subjects

This project had approval from the University of Waikato Animal Ethics Committee (protocol approval number: 1027). Dogs (N = 70) were recruited through advertisements on social media outlets, newspapers, flyers and word of mouth. To develop methodology, several stages of pilot studies were conducted, involving 32 dogs (refer to Appendix A for details of these dogs and method development). The remaining dogs (N = 38) were chosen from three groups of dogs, with different experience with kiwi or kiwi stimuli. These groups included dogs that have been through the KAT previously (N = 13), dogs that had been trained to locate kiwi (kiwi conservation dogs, N = 7), and pet dogs that had no prior experience with kiwi (kiwi naïve, N = 19). Within these groups, the breed, sex and location where the experiment was carried out varied (Table 2.1). All dogs were tested without equipment related to the possible presence of kiwi; for example, I did not use muzzles and vests that kiwi conservation dogs wear when in the process of locating kiwi, or shock collars worn by dogs during the KAT process. Throughout the study, all owners were given information regarding what the project entailed, and consent forms were signed by owners prior to their dogs participating.

Table 2.1. *List of dog subjects including breed, sex, prior training and location of experiment.*

Group	Breed	Male	Female	Location
Naïve	Greyhound	1		Te Awamutu
	Siberian husky x	1		Te Awamutu
	Border collie x		1	Te Awamutu
	German pinscher	2	1	Te Awamutu
	Mixed breed		2	Te Awamutu, Hamilton
	Pembroke corgi	1	1	Te Awamutu
	Schnauzer	1	1	Te Awamutu
	Silky terrier	1		Te Awamutu
	Rottweiler x		1	Te Awamutu
	Staffordshire terrier	1	1	Te Awamutu

	Labrador retriever	1	2	Te Awamutu, Hamilton
Aversion	Border collie		2	Te Awamutu
	Golden retriever	1	1	Cambridge
	Beagle	1		Thames
	Miniature poodle		1	Thames
	Great Dane x	1	1	Thames
	Cattle dog x	1	1	Thames
	Huntaway x	1		Thames
	German shorthaired pointer		1	Thames
Kiwi	Labrador retriever x		1	Hamilton
	German shorthaired pointer	3	2	Opotiki, Opononi, Kaikohe
	Heading/eye dog		1	Kerikeri
TOTAL		17	21	

2.2 Experimental area and equipment

As dogs were located throughout New Zealand (Table 2.1), particularly the kiwi conservation dogs, the study area was designed to be portable to maintain consistency in the experimental setting, but possible to set up in different locations. I used a 3-m x 3-m gazebo, with three white polyester walls attached to the legs of the gazebo and pegged to the ground, as the experimental area for all trials. Pet fencing was used to surround the open entrance of the gazebo to keep dogs secure within the experimental area, and to allow them to move freely within the space without the use of leads. The fencing was solid wire mesh, 60 to 120-cm high, and was attached to the sides of the gazebo, in a 'U' shape approximately 2-m from the gazebo entrance at its widest point (Figure 2.1). A ground screw was driven into the ground, approximately 30-cm to the right of the maximum arch point of the fencing. Between trials, dogs were secured to the ground screw via a thin rope that was attached to their collars; this location was the starting point for each trial.

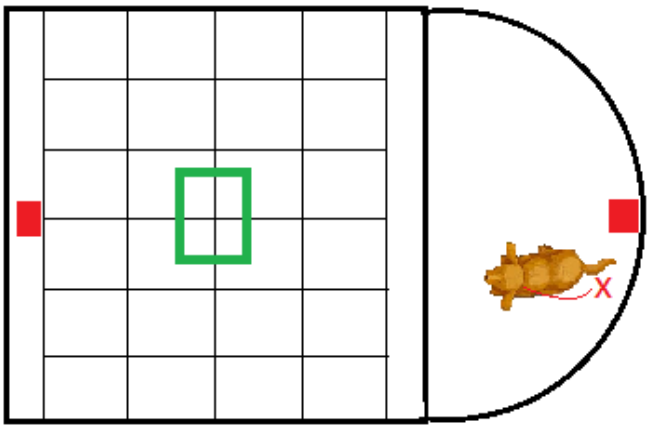

Figure 2.1. Set up of experimental area with position of test stimulus (green outline) and floor-level cameras (red squares) indicated. The red 'x' indicates the position where dogs' were secured between trials.

A grey tarpaulin was used as flooring in the experimental area and was marked with 50-cm grid lines using red insulation tape. Green insulation tape was also used to mark out the area where stimuli were placed to enable consistency between stimuli presentations.

2.2.1 Video recording – Placement and use

Three cameras were used to film the dogs' behaviour within the experimental area (Figure 2.2). Two GoPro Hero3 cameras were used; one was secured to the centre beams of the gazebo framing above the experimental area, capturing footage of the entire floor space in the gazebo; the second camera was secured on a small wooden box placed on the floor at the centre back of the experimental area, pointing towards the open entrance of the gazebo. A Sony Handycam® Camcorder DCR-SX65 was used on a tripod outside the experimental area but within the fenced area, also facing into the gazebo. Video recordings were taken throughout all experiments and with all subjects. The aerial camera view allowed for measuring the dogs' position within the experimental area, as well as the number of times they investigated the stimuli. The other two camera angles were used to observe behaviours and behavioural changes throughout the course of the experiment; these were recording continuously during the trials and footage was reviewed following the experiment.

Figure 2.2. The position of all cameras used in the experimental set up; cameras indicated by red outline.

2.2.2 Kiwi stimuli

Four kiwi-related stimuli were selected for this experiment: kiwi feathers, kiwi scats, kiwi taxidermy, and a kiwi carcass (Figure 2.3). All stimuli were presented in wire pet cages, 50-cm long by 42-cm wide and 35-cm high, which allowed the stimuli to be visible and the scent to be released, but prevented the dogs making direct contact with the stimuli. An additional cage was used and presented as a control, containing no stimuli. The feathers and scats were held in disposable aluminium dishes 21-cm long by 15-cm wide and 5-cm high, with the feathers being covered by mesh to keep them in place during trials (Figures 2.3a and 2.3b, respectively). Each stimulus had their own dedicated cage to avoid mixing smells from various stimuli. Kiwi feathers and kiwi scats were sourced from the Auckland Zoo kiwi enclosure and collected by Auckland Zoo staff. Two taxidermy kiwi (Figure 2.3c) were used in this study; one taxidermy kiwi was sourced from the DOC Opotiki office and had been used regularly in KAT, while the other was a display model from Massey University, Manawatu campus. The kiwi carcass (Figure 2.3d) was sourced by the DOC Hamilton office and kept frozen. The kiwi carcass and taxidermy were placed in the cages without any additional materials. Kiwi scats and kiwi feathers were stored in plastic containers and the kiwi carcass was stored in a polystyrene container, and all were placed in a freezer between sessions.

(a)  (b) 

(c)  (d) 

Figure 2.3. Kiwi-related stimuli used during experiment; (a) kiwi feathers, (b) kiwi scats, (c) kiwi taxidermy from Massey University and (d) kiwi carcass.

2.3 Experimental procedure

Experiments were conducted in a variety of locations that were convenient for owners; this included individuals' homes, dog day care centres, public parks and reserves, as well as DOC offices. The experimental area was set up in positions aimed to reduce external distractions (e.g., excessive foot and vehicle traffic) by ensuring that the gazebo faced toward a side wall of a building or toward a tree covered area of a public space. Owners were out of sight of the testing arena completing a questionnaire while the experiment was conducted, so as not to influence the dogs' behaviour. This separation between the dog and owner was done as previous studies have suggested that dog behaviour is affected by the presence of the owner (Prato-Previde et al., 2008; Schwab & Huber, 2006).

Prior to trials commencing, the dogs were given up to 2-minutes for habituation in the experimental area, where they could investigate the area off-lead without the presence of any stimuli. These sessions were recorded, and I was present, standing to the right-hand side within the fenced experimental area adjacent to square 'A6' (Figure 2.4), facing away from the dog.

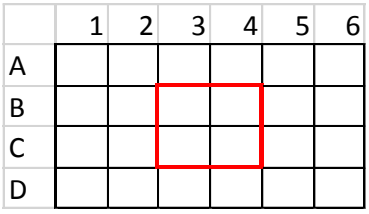

Figure 2.4. Numbering of each quadrat within experimental area to measure location.

The dogs participated in a single-choice assessment where different training stimuli were presented sequentially. A single stimulus was presented during each trial to avoid any location bias that could occur with presentation of paired stimuli and to reduce the number of presentations that would have been required with paired stimuli. Kiwi feathers, scats, a taxidermy kiwi, a partially-thawed frozen kiwi carcass and an empty cage were presented. To reduce any order effect, the order of stimuli presentation was randomised between dogs using a random number generator in Microsoft Excel. The random number generator would assign a number to each stimulus and I then arranged the stimuli in numerical descending order using these generated values.

Following the 2-minute habituation period, the dog was secured by a lead to the ground screw, within the fenced area (Figure 2.5). I placed one test stimulus in the centre of the floor of the gazebo, in the marked-out area. I then returned to the dog and released it from the lead, which indicated the beginning of a trial. Throughout the trial, I stood near the edge of the gazebo, facing away from the gazebo and ignoring any behaviour from the dog. The dog had access to the experimental area and the test stimulus for 2-minutes, which I measured using an electronic cell phone timer. At the end of the trial, the dog was secured by lead again at the starting position and the stimulus was removed and replaced with another stimulus. This entire process was repeated for each of the five stimuli included in the study. Up to 2-minutes were allocated to allow me to swap the stimuli between trials.

Figure 2.5. Example of a dog secured to the ground screw, adjacent to tripod, between trials.

At the conclusion of each session (i.e., after all five stimuli had been presented), the final stimulus was removed, and the dog was placed back on the lead and walked back to their owner by me. For hygiene purposes and to reduce the presence of extraneous cues for following sessions and subjects, the experimental area was cleared of any debris and cleaned with 70% isopropyl solution. Latex gloves were worn while handling stimuli and stimuli were placed outside the experimental area between trials and covered using tarpaulins or stored within vehicles as much as possible.

For welfare reasons, sessions were terminated if a dog showed signs of persistent stress, e.g., continual whimpering/whining that increased in volume. Trials were also terminated if the equipment was at risk of damage by the dog, or if the dog escaped the experimental area.

2.4 Video analysis

In this study, the most preferred stimuli were categorised as the stimuli that the dogs spent the most time investigating during the trials and those stimuli that the dogs approached in the shortest time. Data were extracted from the video footage to calculate duration and frequency of investigation of stimuli, and latency to first approach the stimuli.

Overhead video footage was used to assess the frequency of visitations and duration of time spent in each quadrat of the marked-out grid on the ground. A dog was considered to have entered a quadrat when 50% or more of their head (e.g., the tip of the nose to the top of the head behind the eyes) crossed a line on the floor. I

did not use the position of front paws as a measure of the dogs' location in the grid because the size difference between dogs made this an unsuitable measure.

The video footage was watched using VLC Media Player 3.0.3. Locations where dogs were present within a trial were manually counted and recorded in Microsoft Excel (2016), and the amount of time spent in each quadrat within a trial was totalled in seconds.

An ethogram was developed to determine the dogs' behavioural responses to stimuli (Table 2.2). The amount of time the dogs spent engaging in each behaviour within trials was measured and recorded in Microsoft Excel. Descriptive statistics were calculated and graphed using STATISTICA™ version 8. Behaviours were categorised into four groups: survey, transition, movement, and stationary behaviours. These separations were based on the form and function of the behaviour. The transition behaviour group contained discrete event behaviours, of which are typically measured in frequency rather than duration due to their nature. They were performed regularly but were only seen in short durations, thus categorised as discrete behaviours.

Table 2.2. *Ethogram of locomotor-based behaviours observed by dogs*

Behaviour	Description
	Movement behaviours
Digging	To break up and move ground with the front paws.
Pawing	Using one paw (can alternate between left or right front paw) to make contact with an object or surface at least two times.
Rear up	Hind legs remain in contact with ground while the front legs make contact with an object or person above the ground.
Walking	Three feet are supporting the body at all times, while the other is raised and extended forwards; each paw lifting from the ground one at a time in a regular sequence.
	Transition Behaviours
Paw lift	A single front paw is lifted from the ground and held toward the chest. May or not be in contact with the chest.
Scratching	Raising a hind leg to the body and repeatedly moving the foot/paw back and forth, while remaining in contact with a portion of the body, e.g., head, side, leg etc.

Shake	Rock the head and/or body very rapidly back and forth, in a standing position - often the tail will be whipped back and forth.
Shuffle	To raise and lower the feet singularly or simultaneously while maintaining sitting, standing, or lying position. Can result in a slight forward, sideways or a backwards movement.
Stretch	To extending lower limbs by keeping feet in contact with ground and the body is moved away from the position of the lower limbs.
Roll	Rolls onto back, legs elevated, moving the body side to side while back is in contact with the ground.
	Stationary Behaviours
Lying	The underside or side of the body is in contact with the ground, front legs extended forwards and rear legs positioned on either side of the body. Head can be raised or lowered to be in contact with front legs.
Sitting	Rear lowered to the ground, while front legs remain straight with paws in contact with ground; weight resting mainly on its hocks.
Standing	All four legs are rigid with feet in contact with the ground for at least one second. Body and limbs are stationary, while the direction and position of the head can be altered
	Survey Behaviours
Defecate	To evacuate solid waste.
Face Rub	The side of the face is in contact with an object, wall or ground and is repeatedly moved backwards and forwards at a moderate pace.
Investigating	Head directed toward stimulus, within 10 cm of the stimulus; head is often lowered below the shoulders, with apparent sniffing behaviours occurring (can also include visual investigation) directed toward the stimulus
Licking	The surface of the tongue repeatedly comes in contact with an object with an up and down motion of the tongue observed.
Sniffing	The head is lowered, and the nose is within 10 cm from the ground or wall. Movement of the nostrils may be observed.
Urinate	To evacuate urine.

2.4.1 Data analysis

A power analysis was conducted to determine the total number of dogs to be used throughout the study. This was carried out using latency and duration of investigation, using G*Power software. Based on a single group of dogs, it was determined that eight dogs would be sufficient to obtain statistically relevant results. The majority of the preliminary data were available from the naïve group of dogs, with data from one kiwi conservation dog and two KAT dogs. With limited data on two of the three groups to be used in this study, the ability to calculate 'between group' variance was restricted. A conservative estimate was generated by changing inputs, and numbers were based on 'within group' variance. An appropriate sample size (N = 18) was calculated to compare data between three groups of dogs that would obtain statistical significance at the α-level $p < 0.05$.

Heat maps were constructed to indicate which areas were visited regularly and the amount of time that was spent in each quadrat of the experimental area for each trial for each dog. Heat maps were generated using Microsoft Excel through conditional formatting based on the numbers within squares. Three thresholds of low duration (0 – 10 s), medium duration (11 – 20 s) and high duration (> 21 s) were indicated by colours that varied from yellow to green. This provided a visual representation of the amount of time spent in each square of the experimental area. Heat maps were also generated for the frequency data with low frequency (0 – 4), medium frequency (5 – 8) and high frequency (> 9) thresholds represented by yellow to green coloured squares. Thresholds for both the duration and latency data were based on the average data throughout trials. Long durations or high frequencies of visitations within particular areas of the experimental area were averaged to the nearest whole even number. The medium threshold was calculated by halving the high duration threshold. The duration and latency data were used for further analysis (see section 2.4.1).

STATISTICA™ version 8 was used to complete a within-subject ANOVA with latency and duration of investigation as dependent variables. This was done to determine the effect that each stimulus had on behaviour of the dogs (Table 2.2). A one-way ANOVA was conducted to identify whether there was a difference between the latency and duration of investigation between the three groups of dogs (i.e., naïve dogs, kiwi dogs, and KAT dogs).

Tukey and Fishers post-hoc tests were carried out to determine where the variation was found within the data and to give information on which stimuli were

preferred by each group of dogs. However, the Tukey post-hoc test is more conservative and has greater control for type 1 errors, so this was the post-hoc test reported. Tests with a p-value < 0.05 were considered significant.

2.4.2 Reliability testing

An inter-observer reliability test was conducted to determine potential variation in the measures of the dogs' behaviour between observers. Another individual was trained to use the ethogram. This second observer had not taken part in the study but had basic behaviour analysis knowledge. This observer watched and analysed 10% of the video recordings as per methods described above. The videos were chosen randomly using a random number generator in Microsoft Excel, described previously. The degree of agreement between observers' measures (i.e., the amount of time the dogs engaged in behaviours, behaviours observed, location and duration spent in quadrats) was calculated using Cohen's Kappa coefficient, which also measures the likelihood of matching occurring by chance.

3 Results

3.1 General results

The enclosed testing area worked well for dogs and allowed the collection of behavioural data in response to the kiwi stimuli. However, separating dogs from their respective owners caused some stress in a number of dogs and resulted in the termination of at least one trial for three different dogs. Throughout the trials, only male dogs, both intact and desexed, urinated. It regularly occurred in the same areas within the experimental area for all dog groups. For dogs in the KAT group, urination was only observed during the presentation of the kiwi carcass, the taxidermy kiwi and the kiwi scats.

I recruited different numbers of dogs for each group, due to the location and availability of dogs and owners. I was able to recruit a greater number of dogs for the naïve group as many dogs fit the criteria for inclusion in this group. Therefore, nineteen dogs were tested in the naïve group. Dogs in the KAT group were more difficult to find compared to naïve dogs, with thirteen dogs having been recruited. I attended a KAT course in order to recruit the majority of dogs within this group (N = 10 out of the 13 dogs in the KAT group); dogs were tested prior to undergoing the KAT procedure on the recruitment day. The number of previous KAT sessions and the time since the previous KAT varied between dogs in this group. Seven dogs were recruited in the kiwi conservation dog group. Dogs within this group were the most difficult dogs to include in this study because of a smaller population of dogs (25 dogs in the North Island). The kiwi dogs used in this study were located throughout the North Island, largely in or surrounding areas where kiwi are located.

3.1.1 Reliability

Interobserver reliability scores showed 86.7% matching between observers' scores. Cohen's κ showed there was a substantial level of agreement between both observers ($\kappa = 0.755$).

3.2 Analysis of location

The amount of time the dogs spent in each quadrat of the experimental area varied between individuals. However, on average, dogs across groups showed similarities in the amount of time spent in each quadrat, which also varied depending on the stimulus presented (Figure 3.1).

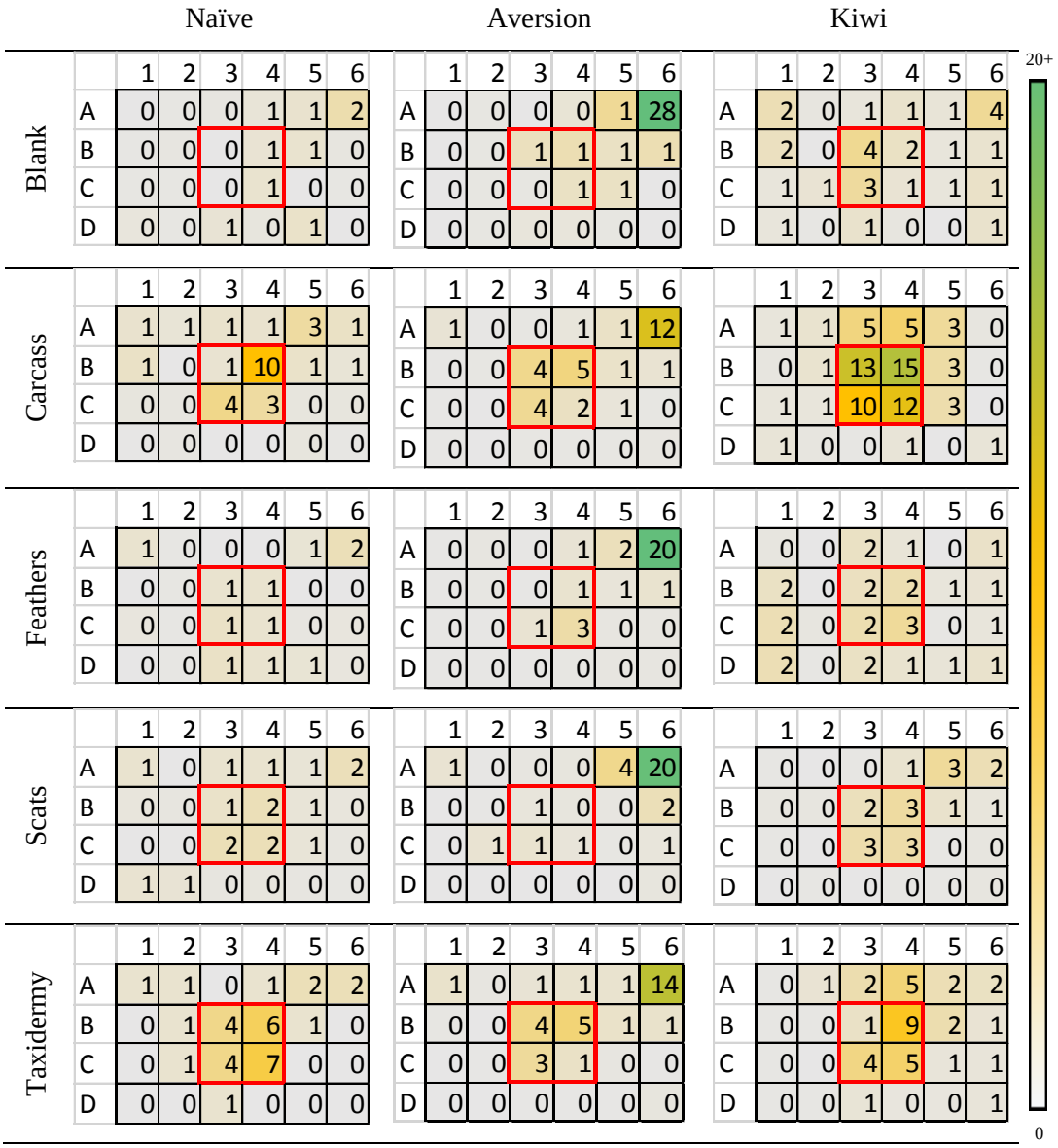

Figure 3.1. Average duration (seconds) spent in each quadrat of the experimental area across all dog groups, in relation to the stimuli presented. Red outline indicates where the stimuli were placed and colours of quadrats indicating variation of duration.

I considered that the amount of time the dogs spent within close proximity of the stimulus would indicate the amount of time spent investigating it. On average, dogs across groups spent a greater amount of time in the quadrats of the red outlined area (see Figure 3.1), in close proximity to the stimulus, in comparison to time spent in other quadrats, showing that all dogs had some degree of 'interest' in the stimuli presented. However, quadrat 'A6' (located on the top-right corner of the experimental area; Figure 2.4) was used regularly, and the dogs in the KAT group in particular, spent a greater portion of time in this area. I was standing adjacent to quadrat 'A6' throughout trials, facing away from dogs, and this may be the reason for the amount of time spent in this quadrat by dogs.

The quadrats that dogs spent the greatest amount of time in varied between dogs and between stimuli presentations. The amount of time that was spent in the red outlined area was greatest when dogs were presented with the kiwi carcass (up to 15 s in a single quadrat), and secondarily, the taxidermy kiwi (up to 9 s in a single quadrat). This behaviour was observed across all groups (Figure 3.1).

One kiwi dog moved toward the stimulus displaying sniffing behaviours but would not enter the squares immediately surrounding the stimulus. This could be inferred as 'interest' in the presented stimulus but it did not meet the criteria for investigation so was not measured as such. In general, dogs would regularly move as close as possible to the stimuli of interest, with some dogs pawing and pushing the cage to such an extent as to almost removing the stimulus from the cage. Three dogs displayed this type of behaviour, but I terminated the trial only on one occasion to prevent damage to the stimulus.

3.3 Analysis of dog behaviour toward kiwi stimuli

For most dogs, with the exception of three (one kiwi dog and two KAT dogs), each trial was run through to completion (120 seconds). Dogs spent, on average, less than 30 seconds (25%) of the total 120 seconds available in the experimental area (refer to Figure 3.1).

3.3.1 Naïve dog group

Dogs in this group spent most of their time in each trial engaging in behaviours classified as movement and stationary behaviours relative to motion-based and surveying behaviours (Figure 3.2). Naïve dogs spent the most time

engaging in investigatory behaviour in response to the kiwi carcass (an average of 17% of the trial time) and taxidermy kiwi (16%). Less time (<6.5% of trial time on average) was spent investigating the other kiwi stimuli and the blank stimulus. 73.7% (14/19) of dogs did not investigate the blank stimulus, while 63.2% (12/19) did not investigate the kiwi feathers. 31.6% (6/19) of the dogs did not investigate the kiwi scats, 26.3% (5/19) did not investigate the kiwi carcass and 21.1% (4/19) did not investigate the taxidermy kiwi. One dog showed 'interest' in the taxidermy kiwi only, which it investigated for 32-seconds.

Three dogs within the naïve dog group showed no 'interest' in any stimuli presented and did not enter the experimental area at all. These same dogs had a limited behavioural repertoire and performed a smaller number of behaviours throughout all trials, in comparison to other dogs within this group.

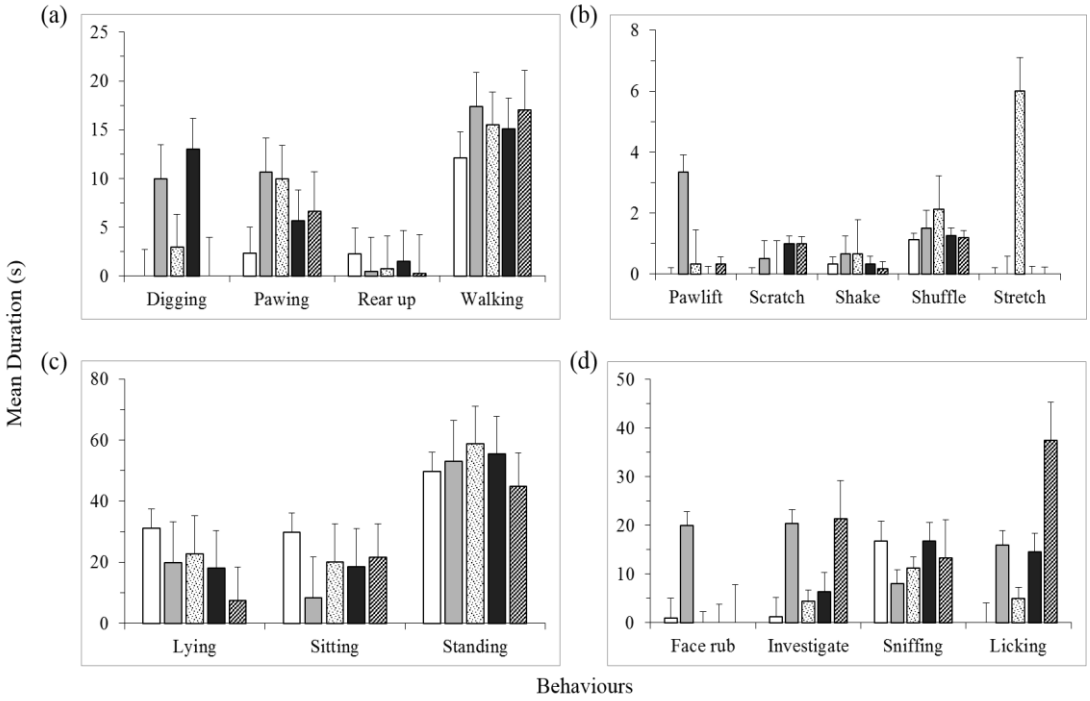

Figure 3.2. Mean duration (seconds) of (a) movement behaviours, (b) transition behaviours, (c) stationary behaviours, and (d) surveying behaviours observed by naïve dogs (N = 19), in relation to the kiwi stimuli presented (+1 SE). NOTE: differing values on y and x-axes. Blank = □; Carcass = ▒; Feathers = ⁙; Scats = ■; Taxidermy = ▨ .

There was a significant difference between the amount of time the dogs within the naïve group spent investigating each stimulus (Table 3.1; Figure 3.3). More investigative behaviour was seen during the presentation of the taxidermy

kiwi (an average of 21.4 s) and the kiwi carcass (an average of 20.4 s) as compared to the other stimuli (Figure 3.3). Dogs in the naïve group investigated kiwi feathers and kiwi scats for similar times, but for significantly less time than the kiwi carcass and taxidermy kiwi. The least amount of time was spent investigating the blank stimulus (Figure 3.3).

With the presentation of the kiwi carcass, two dogs performed face rubbing and licking behaviours toward the stimulus. The dogs, one male and one female attempted to rub the side of their face and body on the cage containing the kiwi carcass stimulus and on the ground beside the cage. The male proceeded to lick the head portion of the kiwi carcass through the bars of the cage. These behaviours were included in measurements of surveying behaviour but were considered different to investigating behaviour.

Table 3.1. *Within-subject ANOVA of the interaction between the stimulus presented and the amount of time spent investigating the stimulus by naïve dogs.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	5464.74	4	1366.18	6.85	<0.001
Error	14358.06	72	199.42		

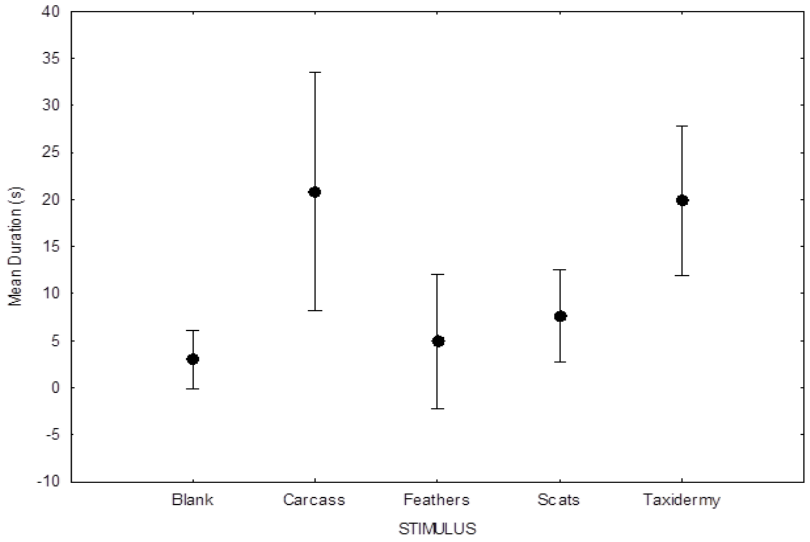

Figure 3.3. Mean duration (seconds, ± 95% confidence interval) that the dogs in the naïve group (N = 19) spent investigating kiwi stimuli.

There were significant differences in the average time the dogs spent investigating the kiwi carcass and taxidermy kiwi (Tukey Post-hoc test (TPHT), *p*

< 0.001) as compared to the blank stimulus, kiwi feathers and kiwi scats (Table 3.2). There was no significant difference between the time the dogs spent investigating the taxidermy kiwi as compared to the kiwi carcass (TPHT, $p = 0.84$), and no significant difference between the average time dogs spent investigating the blank stimulus, kiwi feathers and kiwi scats (Table 3.2). However, there was also no significant difference between the average time the dogs spent investigating the taxidermy kiwi and the kiwi scats (TPHT, $p = 0.07$; Table 3.2).

Table 3.2. *The relationship between each stimulus related to the mean amount of time spent investigating each stimulus, as indicated by the* p*-value output from the Tukey Post hoc test. NOTE: Italicised values indicate significance at α-level.*

Stimulus	Blank	Carcass	Feathers	Scats	Taxidermy
Blank		*0.0021*	0.9931	0.8496	*0.0040*
Carcass	*0.0021*		*0.0078*	*0.0403*	0.9996
Feathers	0.9931	*0.0078*		0.9768	*0.0142*
Scats	0.8496	*0.0403*	0.97683		0.0676
Taxidermy	*0.0040*	0.9996	*0.0142*	0.0676	

The homogenous groupings indicated that the kiwi carcass was of most 'interest' to naïve dogs, closely followed by the taxidermy kiwi. The kiwi scats were third, followed by the kiwi feathers and blank stimulus. The kiwi scats, kiwi feathers and blank stimulus showed no significant difference in amount of time the naïve dogs spent investigating the stimuli (TPHT, $p = 0.99$; Table 3.3).

Table 3.3. *Separation of homogenous groups based on Tukey Post-hoc test of within-group ANOVA for the naïve dogs group; α = 0.05*

	DV1 Mean	1	2	3
Blank	3.00	••••		
Feathers	4.95	••••		
Scats	7.63	••••	••••	
Taxidermy	19.89		••••	••••
Carcass	20.84			••••

The dogs demonstrated the shortest latency to approach the kiwi carcass (average time of 38.8 s) and the taxidermy kiwi (average of 33.9 s; Figure 3.4), followed by scats, feathers and the blank stimulus. These differences were statistically significant (Table 3.4).

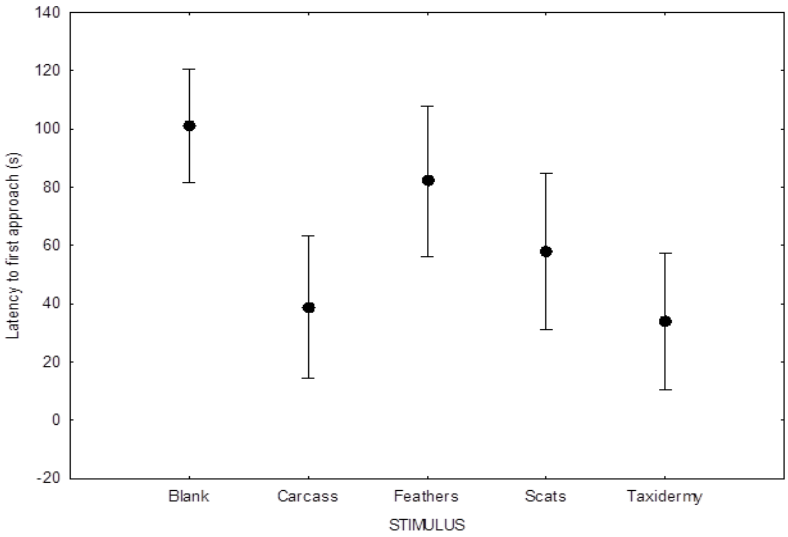

Figure 3.4. Mean latency (seconds, ± 95% confidence interval) for dogs in the naïve group (N = 19) to first approach each kiwi stimulus.

Table 3.4. *Within-subject ANOVA of the interaction between the stimulus presented and the latency to first approach within the naïve dog group.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	61976.70	4	15494.20	11.43	<0.001
Error	97542.50	72	1354.80		

There was a significant difference between the latency for dogs to first approach the kiwi carcass (TPHA; $p < 0.001$), kiwi scats (TPHA; $p = 0.005$), and taxidermy kiwi (TPHA; $p < 0.001$) in relation to the blank stimulus and kiwi feathers. There was also a significant difference between the latency of the dogs to first approach the kiwi carcass (TPHA; $p = 0.005$) and taxidermy kiwi (TPHA; $p = 0.001$) in relation to the kiwi feathers. However, there was not a significant difference between the dogs' latency to first approach the kiwi feathers and the kiwi

scats (TPHA; $p = 0.266$). There was also no significant difference found between the latency to first approach the kiwi carcass, the kiwi scats, and the taxidermy kiwi.

3.3.2 Aversion dog group

Dogs in the KAT group (N = 13) spent the largest proportion of investigation time examining the kiwi carcass (an average of 11.5 s) and the taxidermy kiwi (average of 9.2 s), in comparison to the other stimuli presented (average < 4.2 s; Figure 3.5). Although the proportion of time the dogs spent investigating each stimulus was considerably less in comparison to the values obtained for the naïve group, the stimuli of most 'interest' were the same between these two groups (refer to section 3.4).

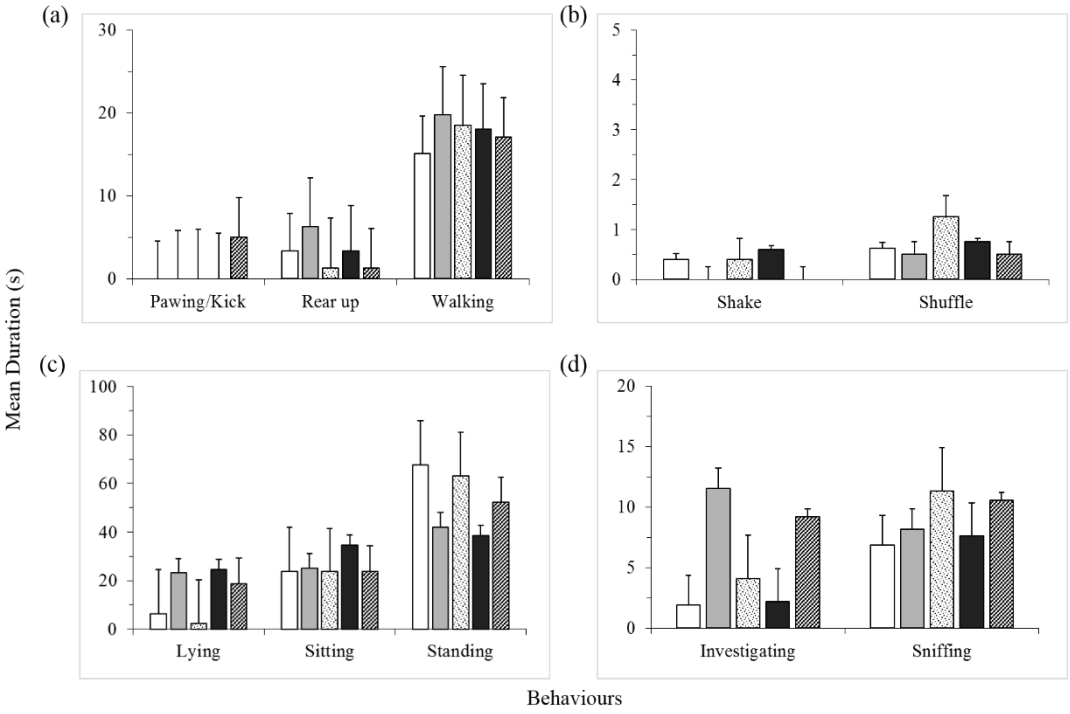

Figure 3.5. Mean duration (seconds) of (a) movement behaviours, (b) transition behaviours, (c) stationary behaviours, and (d) surveying behaviours observed by aversion dogs, in relation to stimuli presented (+1 SE). NOTE: differing values on y and x-axes. Blank = □; Carcass = ▒; Feathers = ⁘; Scats = ■; Taxidermy = ▨.

Dogs within the KAT group, spent a greater proportion of time engaged in stationary behaviours as compared to movement, surveying and transitional behaviours. This was seen across all the different stimuli presented. Transition

behaviours were seen for short durations, one to four seconds at a time within a trial, while movement behaviours such as walking and rear up behaviours were seen for up to 20 seconds on average within a trial. The dogs within the KAT group did not display fearful behaviours (e.g., shaking) in response to the stimuli, but three dogs vocalised for extended periods; in two such cases, the trials were terminated prematurely due to excessive vocalisations. The data from these dogs were still used for this study. The excessive vocalisation did not appear to be related to the presence of the kiwi stimuli but began occurring during the habituation phase, starting when the owner left the area.

The blank stimulus was investigated less frequently in comparison to the other kiwi stimuli (Figure 3.6). 76.9% (10/13) of dogs did not investigate the blank stimulus or the kiwi scats at all during a trial. 61.5% (8/13) of dogs did not investigate the kiwi feathers, while the kiwi carcass and taxidermy kiwi were not investigated by 30.8% (4/13) and 38.5% (5/13) of the dogs within the KAT group, respectively. Two dogs did not investigate any stimuli presented and were observed to have a limited behavioural repertoire (i.e., performed fewer distinct behaviours) in comparison to other dogs within the KAT group. Two other dogs only investigated the kiwi carcass and taxidermy kiwi.

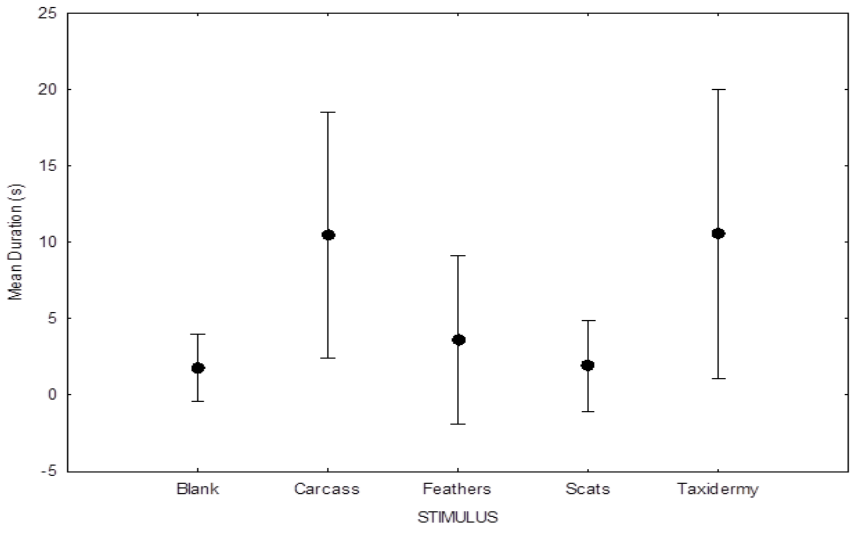

Figure 3.6. Mean duration (seconds, ± 95% confidence interval) that the dogs in the aversion trained group (N = 13) spent investigating each kiwi stimulus.

There was a significant difference in the average amount of time the dogs spent investigating each stimulus within the KAT group (Table 3.5). However, there was no significant difference (TPHT, $p > 0.05$) between the mean duration the dogs spent investigating each stimulus suggesting that the sample size may have been too small to detect significant effects. Latency for the dogs to first approach a stimulus followed a similar pattern to the duration of investigating each stimulus (Figure 3.7).

Table 3.5. *Within-subject ANOVA of the interaction between the stimulus presented and the duration of stimulus investigation by dogs within the aversion trained group.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	1041.79	4	260.45	3.11	0.02
Error	4016.62	48	83.68		

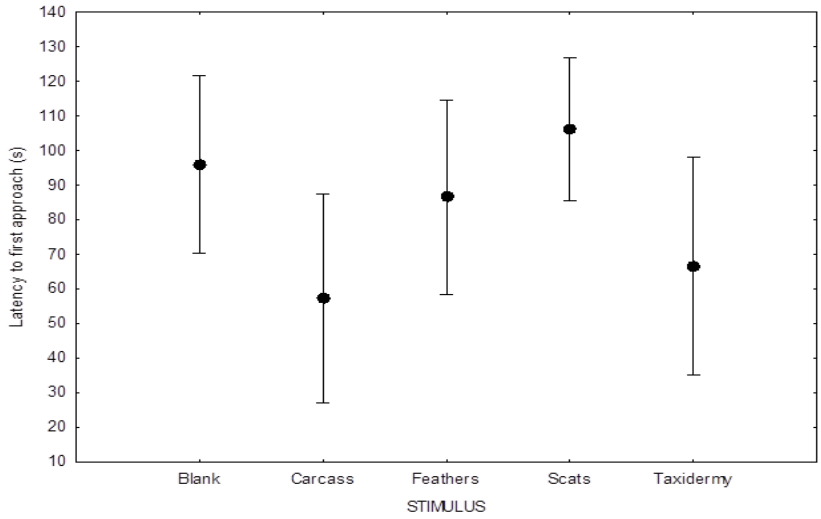

Figure 3.7. Mean latency (seconds, ± 95% confidence interval) of dogs in the aversion trained group (N = 13) to first approach each kiwi stimulus.

There was a significant difference between the latency to first approach each stimulus (Table 3.6). Comparison of the means suggests that the latencies for dogs to first approach the taxidermy kiwi and kiwi carcass were much shorter in comparison to the other kiwi stimuli presented. The longest mean latency to first approach a kiwi stimulus was for the kiwi scats (average of 106.0 s), and the blank stimulus (average of 95.9 s). The latency to first approach the kiwi carcass was the shortest latency (average of 57.2 s). There was no significant difference between

the dogs' mean latency to first approach a kiwi stimulus, with the exception of the latency values between the kiwi carcass and the kiwi scats (TPHT, $p = 0.027$).

Table 3.6. *Within-subject ANOVA of the interaction between the stimulus presented and the latency to first approach each kiwi stimulus by dogs within the aversion trained group.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	21338.2	4	5334.6	3.27	0.02
Error	78329.0	48	1631.9		

3.3.3 Kiwi dog group

The kiwi dog group had less than half the required sample size (N = 7). There were noticeable differences in the behavioural observations of the dogs within the kiwi conservation dog group (Figure 3.8).

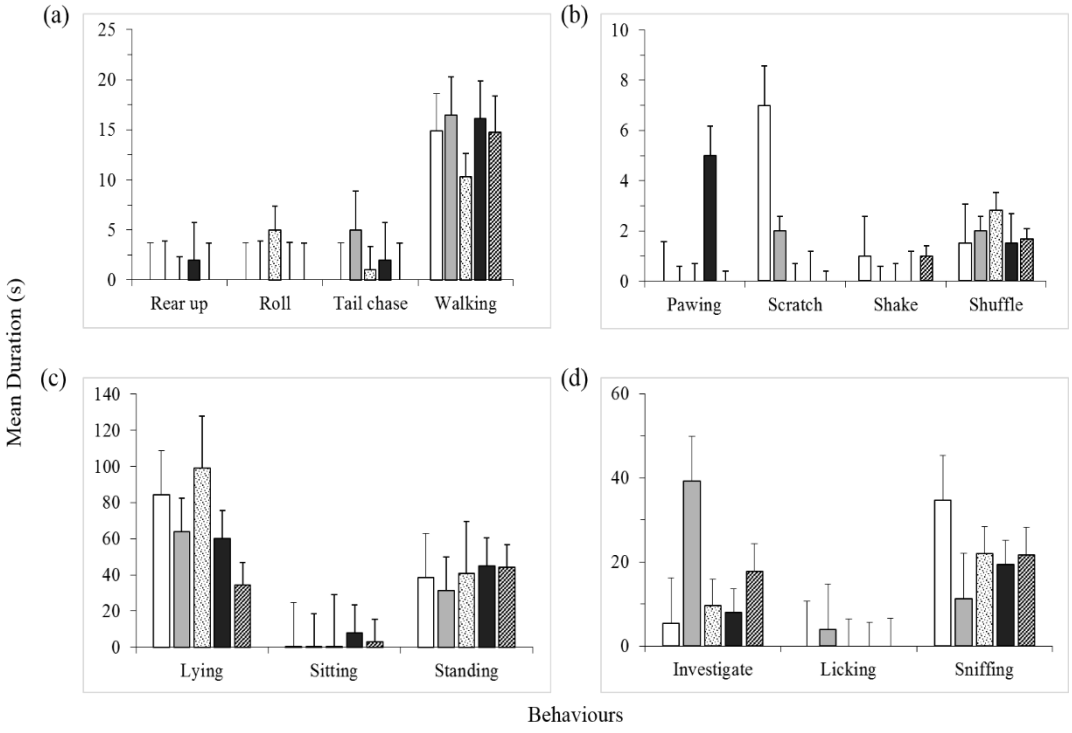

Figure 3.8. Mean duration (seconds) of (a) movement behaviours, (b) transition behaviours, (c) stationary behaviours, and (d) surveying behaviours observed by kiwi dogs, in relation to stimuli presented (+ 1 SE). NOTE: differing values on y and x-axes. Blank = □ ; Carcass = ▒ ; Feathers = ⁙ ; Scats = ■ ; Taxidermy = ▨.

Stationary and surveying behaviours were observed most regularly (lying, standing, and sniffing, respectively). A greater proportion of the dogs' time, on average, was spent investigating the kiwi carcass. Lying and standing behaviours were performed by dogs less during the presentation of the kiwi carcass.

The amount of time dogs spent engaged in stationary behaviours was similar across the presentation of all stimuli, but these behaviours were observed most regularly in response to the blank stimulus, kiwi feathers and kiwi scats. One dog showed no 'interest' in any stimuli presented and did not enter the experimental area except when the taxidermy kiwi was presented, which the dog investigated for 13 seconds before returning to its previous lying position outside the experimental area. One dog investigated only two stimuli: the taxidermy kiwi, for 7 seconds, and the kiwi carcass, for 41 seconds. One dog showed considerable 'interest' in the kiwi feathers, investigating the feathers for 49 seconds. Subsequent discussion with the dog's owner revealed that this dog had been trained to locate feathers.

There were statistically significant differences between group means as determined by one-way ANOVA (Table 3.7). The amount of time dogs in this group spent investigating the kiwi carcass was greater in comparison to other stimuli (Figure 3.9). The mean duration spent investigating the taxidermy kiwi was greater in comparison to the kiwi feathers, kiwi scats and blank stimulus, which had similar values.

Table 3.7. *Within-subject ANOVA of the interaction between the stimulus presented and the amount of time spent investigating the stimulus by kiwi conservation dogs.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	6287.71	4	1571.93	4.4723	0.0076
Error	8435.49	24	351.48		

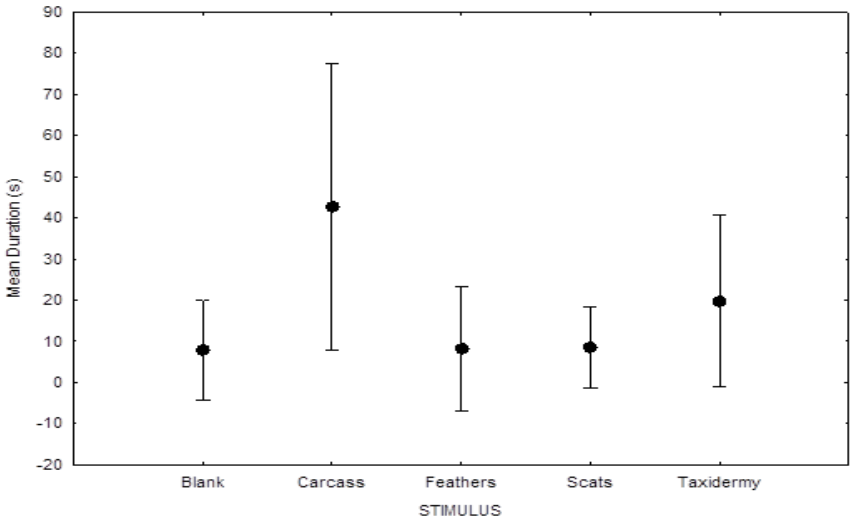

Figure 3.9. Mean duration (seconds, ± 95% confidence interval) that the dogs in the kiwi conservation dog group (N = 7) spent investigating each kiwi stimulus.

There was a significant difference between the amount of time the dogs spent investigating the kiwi carcass (TPHT, $p < 0.001$) when compared to all other stimuli, with the exception of the taxidermy kiwi (TPHT, $p = 0.18$). There was no significant difference between the time spent investigating the taxidermy kiwi and all other stimuli (TPHT, $p > 0.05$). The kiwi feathers and kiwi scats showed no difference in values. This information separates the data into two homogenous groups which displays the differences between the stimuli and the amount of time dogs spent investigating each stimulus (Table 3.8).

Table 3.8. *Separation of homogenous groups (1 and 2) based on Tukey Post-hoc test of within-group ANOVA for the kiwi conservation dogs; α = 0.05.*

	DV1 Mean	1	2
Blank	3.00	••••	
Feathers	4.95	••••	
Scats	7.63	••••	
Taxidermy	19.89	••••	••••
Carcass	20.84		••••

The latency for the dogs to first approach each stimulus showed a similar pattern to the duration of stimulus investigation (Figure 3.10). There were statistically significant differences between average latency to first approach each

stimulus (Table 3.9). However, the mean latency of dogs to first approach the taxidermy kiwi was 14.1 seconds in comparison to the kiwi carcass with a mean latency of 22.4 seconds, which shows that dogs were quicker to approach the taxidermy kiwi but, on average, investigated the kiwi carcass for a greater amount of time. The largest mean latency for dogs to approach a kiwi stimulus was observed for the kiwi feathers (77.0 seconds) in comparison to the blank stimulus (56.6 seconds) and the kiwi scats (42.4 seconds).

Table 3.9. *Within-subject ANOVA of the interaction between the stimulus presented and the latency to first approach each stimulus by kiwi conservation dogs.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	18166.74	4	4541.69	4.2374	0.01
Error	25723.26	24	1071.80		

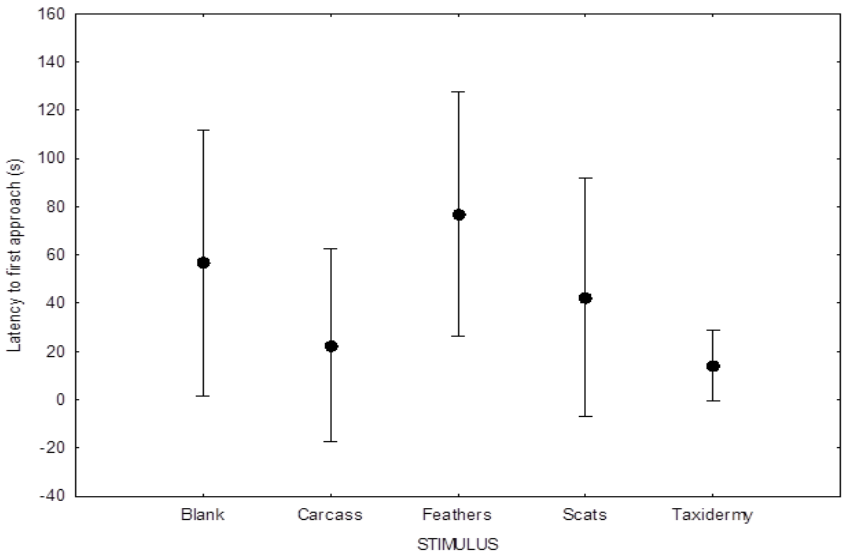

Figure 3.10. Mean latency (seconds, ± 95% confidence interval) for dogs in the kiwi conservation group (N = 7) to first approach each kiwi stimulus.

The latency for dogs to approach the kiwi feathers appear to be considerably different, in comparison to the latency for dogs to approach the blank stimulus (Table 3.10). This was likely to be related to the single dog that showed 'interest' in the feathers due to previous experience.

Table 3.10. *Within-subject ANOVA of the interaction between the stimulus presented and the latency to first approach each stimulus by kiwi dogs.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Stimulus	18166.74	4	4541.69	4.2374	0.0098
Error	25723.26	24	1071.80		

There was a significant difference between the latency to first approach the kiwi feathers and the taxidermy kiwi (TPHT, p = 0.0117). There was also a significant difference between the kiwi feathers and kiwi carcass (TPHT, p = 0.0344). There was no statistically significant difference between the dogs' latencies to approach for the other stimuli presented.

3.4 Comparison of all groups

I found that, in general, the pattern in the amount of time the dogs spent investigating each stimulus was the same across the groups. The stimuli that arose the greatest 'interest' in dogs (i.e., longest duration of investigative behaviour) in all groups were the kiwi carcass and taxidermy kiwi; the lowest 'interest' was seen with the kiwi feathers and kiwi scats, which was the same as the amount of time dogs spent investigating the blank stimulus (Figure 3.11).

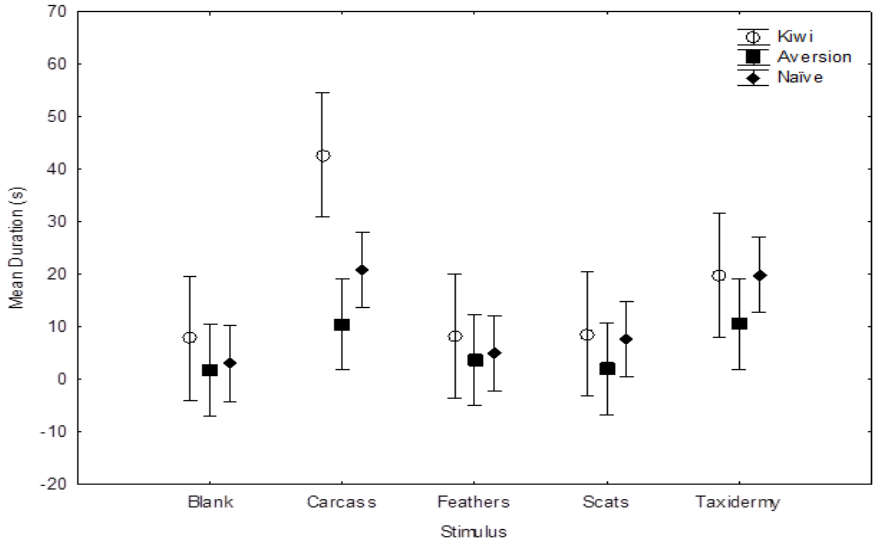

Figure 3.11. Mean duration (seconds, ± 95% confidence interval) spent investigating kiwi stimuli for dogs in the naïve dog group (N = 19),

aversion trained dog group (N = 13) and the kiwi conservation dog group (N = 7).

There were no statistically significant differences between the mean duration dogs spent investigating each stimulus across all groups ($F_{(10,64)}$ = 1.205, p = 0.305). However, there was a tendency for kiwi dogs to spend, on average, a greater amount of time (17.4 seconds) investigating each stimulus, while naïve dogs spent an average of 11.3 seconds investigating each stimulus and KAT dogs spent an average of 5.7 seconds.

There was a significant difference between the mean time spent investigating stimuli for kiwi conservation dogs when compared to the KAT dogs (TPHT, p = 0.0012). The greatest duration spent investigating each kiwi stimulus, on average, was observed with the kiwi conservation dogs, while the lowest duration investigating each stimulus, on average, was observed with the KAT dogs. The mean duration spent investigating the kiwi carcass by the kiwi conservation dogs well exceeded the mean durations for the other two groups of dogs. However, there was no significant difference between the duration spent investigating each stimulus, on average, between the naïve dogs and both other groups of dogs.

The pattern of the latency to first approach kiwi stimuli across the groups of dogs shows an inverse pattern to that of duration of investigation (Figure 3.12). Dogs in all groups approached the kiwi carcass and the taxidermy kiwi with a shorter latency than other stimuli. Dogs in the naïve and kiwi conservation dog group had a shorter latency to approach the kiwi scats, when compared to the blank stimulus, and the kiwi feathers.

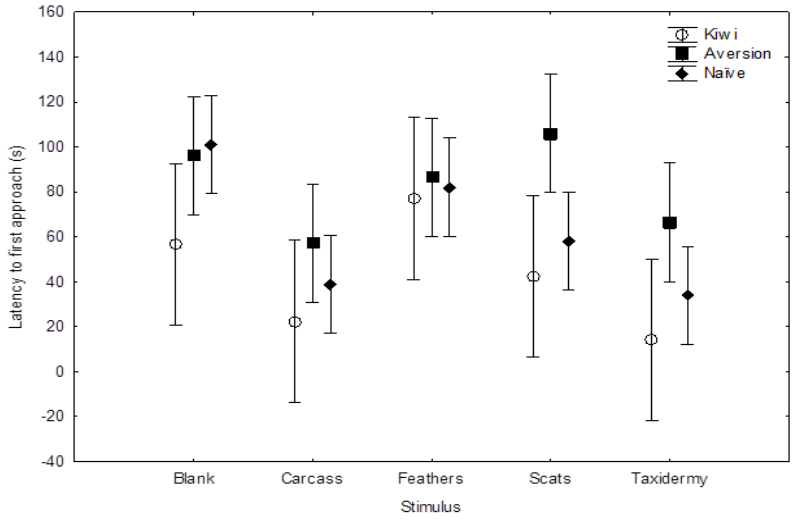

Figure 3.12. Mean latency (seconds, ± 95% confidence interval) to first approach kiwi stimuli for dogs in the naïve dog group (N = 19), the aversion trained dog group (N = 13) and the kiwi conservation dog group (N = 7).

There was a significant difference in the latency to approach each stimulus between groups. Similarly, there was a significant difference in the latency to approach each kiwi stimuli. However, there was no significant difference between the latency to first approach each respective stimulus when compared across groups (Table 3.11).

Table 3.11. *Two-way ANOVA of the interaction between the stimulus presented across groups of dogs, related to the latency to first approach each stimulus.*

Source of Variation	*SS*	*DF*	*MS*	*F*	*p*
Group	37826.30	2	18913.20	8.1303	<0.001
Stimulus	66642.20	4	16660.60	7.1620	<0.001
Group*Stimulus	18331.60	8	2291.40	0.9850	0.449
Error	418723.90	180	2326.20		

There was a significant difference between KAT dogs in comparison to both the kiwi conservation dog group (TPHT, $p < 0.001$) and the naïve dog group (TPHT, $p = 0.030$). There was no significant difference found between the kiwi conservation dog group and the naïve dog group in relation to latency to first approach.

There was no significant difference between the different groups in relation to the mean latency to approach each stimulus (TPHT, $p > 0.050$). This matches the pattern observed for the duration of investigating each stimulus across groups of dogs.

Discussion

4.1 Dogs' behaviour in response to kiwi stimuli

The most important finding of this thesis was that dogs that have undergone KAT did not show complete aversion to kiwi stimuli commonly used in KAT and further investigation on what it means to a dog to have this training is needed. The study also showed that there are some stimuli that are of greater interest to dogs and may be better for KAT than others. However, questions remain in whether dogs can extrapolate between stimuli used in KAT and a real kiwi.

Dogs are a significant source of mortality for kiwi and KAT was designed to discourage dogs from depredating kiwi; however, the results from other studies of this method are conflicting (Dale, 2014; Jones, 2006). When this current project started, there was lack of knowledge regarding dog behaviour towards the different kiwi-related stimuli used in KAT, and whether prior experience with kiwi, or kiwi stimuli, might influence this behaviour. I experimentally presented kiwi stimuli used in KAT to dogs that had previous knowledge of kiwi and to naïve dogs and recorded their behaviour. Dogs with previous knowledge of kiwi were of two types: kiwi conservation dogs, which have a positive interaction with kiwi, and dogs that have undergone KAT, a negative experience that intends to create fear of kiwi in the dog. I expected that the dogs' behaviour would vary between the different groups of dogs with differing experience in relation to kiwi. I expected dogs that had undergone KAT to avoid making contact with the stimuli and to even show fear responses, while kiwi conservation dogs would show 'interest' in certain kiwi stimuli that may most resemble a live kiwi.

The results from this study support the hypothesis that the different types of dogs will display different behaviours in response to different kiwi stimuli commonly used in KAT. I predicted that some kiwi stimuli would be preferred over others and that the stimuli of greatest 'interest' to dogs would vary across groups of dogs. However, this was not supported by the results of this study. I found there was no significant difference between the behaviours of dogs across groups; all dogs were 'interested' in the same kiwi stimuli. Dogs across all groups (i.e., KAT dogs, kiwi conservation dogs, naïve pet dogs) spent more time investigating the taxidermy kiwi and the kiwi carcass, when compared to the other stimuli presented.

The ‘interest’ for dogs in these kiwi stimuli could be attributed to their resemblance to a live kiwi. Both the taxidermy kiwi and kiwi carcass possess the visual characteristics of a motionless kiwi. However, particularly for the kiwi carcass, the substantial olfactory stimulation of a frozen/decaying carcass provided in combination with the visual cues could have increased the ‘interest’ dogs had towards the taxidermy kiwi and kiwi carcass. Forsyth et al. (2014) found that wild dogs were more likely to scavenge on ungulate carcasses shot by hunters in comparison to foxes and feral cats, which suggests that carcasses may be a significant food resource for free-ranging domestic dogs. Based on this information, it is a reasonable assumption that additional olfactory cues have influenced the ‘interest’ demonstrated by dogs towards the kiwi carcass and taxidermy kiwi in this study.

Dogs from all three groups also investigated the kiwi feathers, kiwi scats and the blank stimulus but for significantly less time than the taxidermy kiwi or kiwi carcass. It is possible that the dogs were all ‘interested’ in the larger items and they discovered them by sight, something I did not test for but that is strongly supported by the dogs’ behaviour. Initially, the visual stimulation provided by the kiwi carcass or taxidermy kiwi may be a significant factor in the engagement of ‘interest’ in dogs. This is not to suggest that the olfactory stimulation that is provided by the kiwi stimuli is not an important factor to consider. Gazit and Terkel (2003) found that explosive detection dogs primarily use olfaction to detect explosives in comparison to vision. For trained dogs, olfactory processes are likely to be significant in identifying or locating target objects. In the current study, dogs were anecdotally observed sniffing the kiwi stimuli when investigating it. Overall, it is likely that the visual aspect of the taxidermy kiwi and the kiwi carcass, combined with the olfactory cues from these stimuli, had an influence on initiating ‘interest’ in the dogs.

The single-choice preference test used in the current study helped to determine any significant differences between dogs’ reactions performed in response to different stimuli that are commonly used in KAT. Despite all dogs showing more ‘interest’ in the kiwi carcass and taxidermy kiwi, I found a significant difference in the time spent investigating the stimuli by the different groups. Dogs within the kiwi dog group and the naïve dog group spent significantly more time investigating the kiwi carcass and the taxidermy kiwi. Dogs in the KAT group also

spent a greater amount of time investigating the kiwi carcass and taxidermy kiwi, but their average durations were not significantly different to their durations investigating other kiwi stimuli. The lowered rate of investigating behaviour observed by KAT dogs in comparison to other dog groups gives some evidence to suggest that KAT may have worked to reduce 'interest' in kiwi stimuli; however, this aversion was not sufficient to substantially change the dogs' behaviour in relation to kiwi and kiwi stimuli. 76.9% (10/13) of dogs within the KAT group had investigated at least one kiwi stimulus. This suggests that the KAT was not effective at significantly establishing generalised avoidance toward kiwi stimuli in dogs within the KAT group. Based on these findings, dogs that have undergone KAT are unlikely to show avoidance or fear responses if they were to encounter live kiwi. Thus, it is unlikely that prior KAT would be sufficient to prevent dogs from showing 'interest' or subsequently harming a live kiwi.

As I did not conduct a pairwise comparison of the different kiwi stimuli, I cannot accurately determine the order of preference that the dogs have for the stimuli used. However, I was able to form homogenous groupings which grouped stimuli that were most preferred, and those that were least preferred. This was indicated by the mean time the dogs spent investigating each stimulus and the latency to approach it within each group of dogs. The variation in the times spent investigating each stimulus and the time taken to approach the stimulus by each group of dogs could suggest that if the KAT procedure is carried out with less preferred items (e.g., kiwi scats and kiwi feathers), it may be less effective at developing a fear response toward these items in the dogs, thus reducing the efficacy of KAT in practice.

4.1.1 Olfactory and visual cues related to kiwi stimuli

Some studies have suggested that dogs have a keen sense of smell, being able to detect concentrations of substances as small as 500 parts per trillion, (Johnston, 1999). However, in the current study, two stimuli (the kiwi carcass and the taxidermy kiwi) were larger, more conspicuous, and more closely resembled live kiwi. As such, these stimuli may have offered more in terms of visual stimuli than the kiwi scats and kiwi feathers (refer to 4.1). The size of the stimuli and their resemblance to a live animal may have encouraged dogs to investigate the kiwi carcass and taxidermy kiwi stimuli for a longer period, in comparison to the kiwi

scats and kiwi feathers. In the wild, predators may detect the presence of prey from scats and feathers, but only the view and smell of the prey evokes investigation and eventually a hunt (Conover, 2007). Both the kiwi scats and kiwi feathers were placed in small trays and, in the case for the kiwi feathers, they were covered by a mesh to keep them contained. However, the dogs' preference for larger stimuli may be an evolutionary constraint in regard to the stimuli presented. This may suggest that smaller stimuli used in KAT may not be as effective as larger items. Studies have found that dogs are capable of distinguishing larger from smaller quantities of food (Prato-Previde et al., 2008; Ward & Smuts, 2007), which could also be relevant in the KAT context. The larger items could provide greater olfactory or visual stimulation, encouraging increased investigatory behaviour. Horowitz et al. (2013) also found that dogs showed more 'interest' in covered plates with larger food quantities; however, there was not a significant difference in the differing quantities subsequently chosen by the dogs. It is unknown whether the findings from studies on food choice can be directly compared to object preference related to kiwi stimuli, but I suggest further research to identify the influence size may have on 'interest' towards objects or kiwi stimuli for dogs would be of value to the KAT procedure.

The shorter amount of time that dogs spent investigating the kiwi scats in comparison to other stimuli suggests that kiwi scats were not of significant 'interest' to the dogs. This may indicate that kiwi scats may not be as useful in KAT as other stimuli. Banks et al. (2002) found that dog faeces were not useful in initiating predator avoidance behaviours in the bush rat (*Rattus fuscipes*). This gives evidence to suggest that scats may not be useful in KAT as scats do not appear to be associated with the animal of interest. This could be related to the highly varied nature of the contents of scats, which differ depending on diet, location and population density (Mackay et al. 2008). Scats can indicate that an animal has been present in an area but do not necessarily suggest the animal is still present. Despite dogs showing less 'interest' in the kiwi scats and kiwi feathers, as measured by duration of investigating that stimulus, it is unknown whether dogs still associate kiwi scats and feathers with actual live birds. It is likely that this is dependent on individual dogs' learning experiences and the length of time that the scats have been present in the environment. The freshness of the scats is likely to have some influence on the amount of investigatory behaviour performed by dogs. The

practical limitations in this study in terms of availability and freshness of scats are also likely to apply to and vary across trainers for KAT, thus, mirroring the use of scats in practice of KAT.

In this study, dogs were assessed alone to limit potential influence from conspecifics or owners. It would be interesting to examine the effect of kiwi stimuli on dogs when they are part of a group, as opposed to being on their own. Christiansen et al. (2001) found that dogs were more prone to attack sheep when accompanied by a chasing companion; however, the severity of attacks were reduced in comparison to when the dog was alone. Similarly, Dale (2014) found that dogs showed decreased aversion to kiwi stimuli when they were in their hunting pack (i.e., a group of dogs) as opposed being in the presence of their owner only. However, there was no significant difference found in the behaviour of the dogs toward the kiwi stimuli when in a pack, in comparison to being alone (i.e., without their owner). This leaves room for further research in repeating the current study, using a similar test used by Dale (2014), focusing on the behaviour of dogs in response to kiwi stimuli when tested with a group of two or more conspecifics. This could also be compared with dogs that have both been through KAT and dogs that have not, as well as varying the number of conspecifics present.

4.1.2 Relevance of prior training in dog behaviour

Dogs have demonstrated their olfactory capabilities through the many forms of work in which they are employed, including conservation. In the case of kiwi dogs, the focus of their detection is a live bird. The presence of kiwi scats may indicate the past presence of a bird but may or may not be useful for detecting the bird itself. Based on anecdotal accounts by kiwi dog handlers, dogs trained to locate kiwi do not regularly show ‘interest’ in kiwi scats. As kiwi dogs are trained to locate live kiwi birds, their ‘interest’ in certain stimuli could indicate the relevance of these stimuli for use in KAT as they could more greatly emulate a live kiwi. The average amount of time kiwi dogs spent investigating the kiwi carcass exceeded that of the other two groups considerably, which could suggest its usefulness for KAT.

Dogs in the KAT group were expected to show signs of avoidance in response to the kiwi stimuli presented in this study. Previous research suggests that dogs will continue to express avoidance towards sheep (Christiansen et al., 2001) and kiwi stimuli (Dale et al., 2013) for approximately one year following initial

aversion training using electronic shock collars. However, in the current study, dogs in the KAT group did not show signs of significant aversion to the kiwi stimuli presented in this study, based on behavioural observations (e.g., shaking, increasing distance between themselves and the stimuli). The average duration that the KAT dogs spent investigating each stimulus was less than those observed in naïve and kiwi dog groups; however, this difference was not statistically significant, although this could be due to a small sample size in the KAT dog group. Using this information, as well as reviewing the behaviours observed during each trial, would suggest against learned avoidance to the presented stimuli for dogs in the KAT group. This could indicate that i) KAT was not successful with the dogs tested in the current study; ii) learned avoidance is very stimulus specific (i.e., it does not generalise to other stimuli that were not used in prior KAT sessions); or iii) that the amount of time elapsed since the previous KAT was too long for dogs to recognise the kiwi stimuli as stimuli to be avoided.

KAT in New Zealand is carried out by over 35 trainers across the country with different access to and preference for certain kiwi-related stimuli for use in the training sessions; therefore, the kiwi stimuli that are used during KAT will vary between trainers. As such, dogs that undergo KAT could learn to avoid different stimuli; dogs may learn to avoid the stimuli that they were presented with in their initial KAT session, which might be different to what other dogs were presented with during KAT sessions with other trainers. Gruber (1969) found that when rats were trained to avoid an auditory stimulus (i.e., a buzzer), they were not able to generalise to learn avoidance of a visual stimulus (i.e., a light). In KAT, the initial stimuli used may have influenced the ability of dogs to generalise learned avoidance toward other kiwi stimuli as well as live kiwi. Hypothetically, if dogs were initially trained using an auditory stimulus, such as a kiwi call recording, then dogs may not use the visual or olfactory cues of other stimuli (e.g., taxidermy kiwi, kiwi scats) as stimuli to avoid.

It is also possible that KAT dogs have not completed the KAT a sufficient number of times in order for aversion to develop long-term. In other research, dogs were more likely to express avoidance behaviours when having undertaken more than one KAT session (Dale, 2014). Although I do not know the exact history of dogs within the KAT group, all dogs in this group had been through KAT at least once prior to taking part in this experiment. Dogs did not show signs of avoidance

(e.g., not returning to the area surrounding the stimulus, lowered posture) toward the stimuli used in this study but may show avoidance toward the stimuli used in their prior KAT. Dale et al. (2013) found dogs to show avoidance toward the same kiwi stimuli in different training sites, even when the dogs were not wearing shock collars. This suggests that the dogs within Dale's study showed generalised avoidance toward kiwi stimuli in the environmental setting, but avoidance may not generalise to other kiwi stimuli as seen within this current study.

On the other hand, there are a number of cues which dogs could associate with the positive punisher (electric shock) during KAT. Trainers of KAT and owners of KAT dogs have anecdotally reported instances where dogs that have undergone KAT previously were wary of exiting a vehicle upon arrival at the training site for re-training. This would suggest that a fear response may be associated with the training site or other extraneous cues. In the case of KAT, it is not uncommon for dogs to be with their owner during the training. Owners will walk with their dog through the training site, where the trainer may or may not be hidden from view. Owners will purposefully walk past the kiwi stimuli to increase the likelihood of dogs engaging with the stimuli, or to observe avoidance behaviours (e.g., increasing the distance between themselves and the kiwi stimuli). Dogs may potentially be influenced by their owners and the cues that they may be unconsciously presenting. Gergely et al. (2015) noted that dogs regularly use human cues, even from individuals whom they are not familiar with, recognising slight changes in movement, adjusting their behaviour based on those presented cues. Prior to visiting the training site, owners may communicate to the KAT dog that an unpleasant experience may occur (e.g., the Clever Hans effect). Rosenthal and Fode (1963) found that experimenters could unknowingly indicate to laboratory rats whether they performed well or not in their respective experiments. This could then influence subsequent behaviour when undertaking the test (e.g., rats navigating a maze) and increase performance. In the case of KAT, the owner is aware of the situation and the avoidance behaviour observed by some dogs could be an artefact of this effect, where dogs are capable of identifying cues from owners, or even conspecifics.

There are a number of welfare concerns related to the use of electric shock collars for dog training (Schalke et al. 2007; Cooper et al. 2014). Based on the results of the present study, dogs who have undergone KAT did not show any

statistically significant differences in their behavioural response to the type of kiwi stimuli used in KAT. Thus, KAT does not appear to be effective at producing generalised aversion toward kiwi stimuli long-term. This finding raises concerns for this form of aversion training. Cooper et al. (2014) noted that there is no advantage in using shock collars in dog training (e.g., recall training and avoidance learning) in comparison to training through positive reinforcement. Further, Schilder and van der Borg (2004) suggested that in police dog training dogs can learn that the trainer is responsible for the shock, and this can result in less effective training. Dogs that had been through KAT previously did not express fears behaviours that were consistent with having learned avoidance toward kiwi stimuli through the application of an electric shock (positive punishment). Due to the inconsistencies in learning generalised avoidance toward kiwi stimuli with the current KAT process as suggested by the findings in this current study, this may suggest a need to review KAT practices.

Within the naïve group, the 'interest' of dogs toward the kiwi stimuli is consistent with studies of neophilia (i.e., interest in novel objects; Kniowski, 2012; Kaulfuß and Mills, 2008). Kaulfuß and Mills (2008) suggested that neophilia may be an adaptive trait that has assisted dogs with domestication and is related to their attentiveness towards human signals. As dogs within the naïve group had not been in contact with kiwi stimuli previously, their initial 'interest' or duration of investigation of the stimuli could be attributed to the stimuli being novel to those dogs. However, kiwi conservation dogs are likely to have had the most experience with kiwi and kiwi stimuli in comparison to the other groups of dogs, as well as having received positive reinforcement for finding kiwi. As the kiwi dog group had the greatest average duration investigating any given kiwi stimulus, investigative duration may not be related to neophilia. The long duration investigating the kiwi carcass and taxidermy kiwi by dogs in the kiwi conservation group could indicate that some aspect of these stimuli could be translated to live kiwi. Dogs in the Dale (2014) study were not found to generalise avoidance to a live chicken when trained with chicken stimuli equivalent to kiwi stimuli. The variation in the behaviour of dogs between these studies could be related to kiwi conservation dogs being trained to identify kiwi by seeing and smelling scents from live birds. There were dogs within each group which showed no 'interest' in the stimuli presented. It is difficult to determine whether the prior training or lack of training, regarding the kiwi stimuli,

was a significant factor in the observance of these behaviours. As such, further experiments aimed to clarify this aspect of dog behaviour toward kiwi stimuli are needed.

4.1.3 Personality and individual variation in dogs

There were large variations in the amount of time the dogs spent engaged in certain behaviours, such as time they spent engaged in stationary behaviours and investigating each stimulus. These variations could be attributed to personality types that have been observed in dogs (Svartberg & Forkman, 2002). Svartberg (2002) suggests there is a link between personality type and performance ability in working dogs. He used a behavioural test to establish each dog's shyness-boldness score. Dogs were placed in unfamiliar situations and their behaviours were recorded. Svartberg (2002) found that dogs that obtained a higher boldness score were often higher performing working dogs, and breed or gender did not affect this. Boldness is associated with exploration and fearlessness, which increases a dog's ability to learn and adhere to delivered instructions. In the current study, there were dogs within each group that showed no 'interest' in any stimuli presented, and perhaps this could be attributed to a higher shyness scoring. A higher boldness score in dogs could be related to greater 'interest' towards kiwi stimuli, which could explain the variation in 'interest' or amount of time spent investigating each stimulus. However, further research with larger sample sizes would be needed to confirm this assumption.

In the current study, one male dog attempted to eliminate urine on a floor-based camera, while a number of other dogs were observed urinating on or near the cage in which the kiwi stimuli were placed. Pal (2003) found that male free-ranging dogs would regularly urinate as a means of scent marking in comparison to simple elimination. Dogs were observed marking novel objects or within feeding or courtship areas. In the current study, dogs that urinated during a trial showed similar behaviours characterised in Pal (2003) related to scent marking. The urination occurred in similar places within the experimental area (e.g., the corner edge of the gazebo or near the kiwi stimuli), suggesting that dogs could detect that conspecifics had been present in those areas despite cleaning these areas between dogs. Dogs were also shown to urinate most frequently when the kiwi carcass was presented. This could indicate that the presence of the kiwi carcass may have some influence

on territorial-based behaviours or be a form of resource-based marking signal not observed with the other stimuli presented. Overall, this variation in urination count and the location of urination elimination suggests that urine elimination may be due to other dogs that have been present as well as the type of kiwi stimuli presented.

One kiwi dog and two naïve dogs attempted to gain access to at least one of the kiwi stimuli presented. The one kiwi dog pushed the cage containing the taxidermy kiwi on its side and pawed at the cage to the extent that the cage could have opened. However, in this case, the trial was terminated prematurely to prevent damage to the taxidermy kiwi stimulus. The two naïve dogs were observed pushing the cage containing the kiwi carcass and pawing at the cage and the ground surrounding the cage. These behaviours would suggest a strong motivation to investigate these stimuli.

4.2 Limitations

It is likely that there were non-kiwi scents associated with the stimuli used in this study which could be detected by dogs' highly sensitive noses. For example, the length of time for which the kiwi carcass was kept in the freezer, as well as the cause of death of the kiwi, were unknown. These aspects could result in this carcass smelling dissimilar to a live kiwi, and more closely resembling the scent of the freezer contents or decaying material. Although the kiwi carcass was kept frozen, it would thaw throughout the day when being used in experimental sessions. Thus, it is also likely that the condition of the kiwi carcass would vary between presentations to different dogs. Likewise, the taxidermy kiwi had been handled by many individuals prior to use in this current study, and so it could have retained odours more related to humans than to those of a live kiwi. It is possible that these other odours, in combination with the visual and olfactory cues of the kiwi carcass and taxidermy kiwi, contributed to these stimuli producing greater 'interest' from the dogs across all groups. This is also likely to be the case in KAT sessions.

The varying sample sizes within each group was a limitation. For example, there appeared to be a difference between the mean values for investigating each stimulus by dogs in the KAT group, however, I was unable to find out what groups were different when using the Tukey test (TPHT, $p > 0.05$). We may have gained a more accurate understanding of the 'interest' of dogs that fit the criteria of this

group, as well as the kiwi dog group, if we could have achieved the sample size of 18 dogs per group calculated prior to the start of the study. The results may be similar with increased sample sizes, but we would have greater confidence in the data. The naïve dog group had a sample size (N = 19 dogs) that exceeded that of the preliminary power analysis (N = 18 dogs), so we can have greater confidence in the reliability of the results obtained for this group. Ideally, the current study would be repeated with larger sample sizes across groups to more accurately identify whether there are significant differences in dogs' behaviour toward kiwi stimuli commonly used in KAT.

In the current study, I only collected behavioural data. Physiological measures (e.g., heart rate variability in relation to the kiwi stimuli) would have allowed greater comparisons between the reactions of dogs across groups in relation to kiwi stimuli. However, despite attempts to include these data, I was unable to achieve it (refer to Appendix A).

The experimental area was maintained in the same condition, as much as possible, for all dogs included in this study. However, due to physical constraints, the exact set-up of the experimental area in relation to the surrounding environment varied slightly. The time of day when each session was run was different for each dog, as well as the location of the set-up; these variations could have influenced the dogs' behaviour. For example, it was common for dogs that were assessed later in the day (from 1500 hours onwards) to show no 'interest' in the presented stimuli; behaviours displayed by those dogs consisted largely of stationary behaviours. In many of these cases, the dogs had been active throughout the day (e.g., locating kiwi or engaging in other physical exercise) prior to the experiment. This could have significantly altered the dogs' behaviour and decreased their motivation to engage in certain behaviours (e.g., investigating the kiwi stimuli). However, the behaviour of dogs in the KAT group may have also been influenced by the sparseness of the experimental area or the absence of leaf litter and debris. Although the reduction of extraneous cues allows greater understanding of dog behaviour in relation to a single kiwi stimulus, the absence of natural materials may have altered behaviours that could have been observed during KAT in a natural environment. Similarly, for naïve dogs and kiwi dogs, the absence of other materials could have increased their 'interest' in the kiwi stimuli due to the limited items present to investigate.

4.3 Conclusions and recommendations

Greater awareness of the issues dogs pose to native wildlife in New Zealand has increased steadily over the years. KAT was established to decrease the number of kiwi fatalities caused by dogs. Approximately 180 dogs are trained or re-trained each year in the Coromandel area alone (Dale et al., 2017), which suggests that many dog owners are involving their dogs in the KAT programme. Despite the prospect of decreasing the risk dogs pose to kiwi through KAT, dogs are still a threat and anecdotal information suggests that there are cases where dogs have killed kiwi following KAT. These factors suggest that there is room to increase our knowledge in relation to KAT.

My primary objective was to assess the behavioural responses of dogs toward different kiwi stimuli. Overall, the results of this experiment indicate that there is variation in the 'interest' that different kiwi stimuli hold for dogs, which does not differ with dogs' varying previous experience with kiwi or kiwi stimuli. I found that dogs in the KAT group did investigate kiwi stimuli less, on average, in comparison to both the kiwi dog and naïve dog groups. However, this difference was not statistically significant. The visual cues associated with the kiwi carcass and the taxidermy kiwi may act as an initial indicator that the stimuli are within the area and thus, elicit greater 'interest' toward the stimuli from dogs. This information may assist trainers in their choice of kiwi stimuli and when conducting KAT, serve the purpose of increasing the efficacy of the training process. However, further investigation into the use of punishment to develop effective avoidance is warranted, as well as translating aversion of KAT stimuli to live kiwi.

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Appendix A

A.1 Pilot trials

Several stages of trials were conducted to determine the methodology and equipment to be used in the final stage of the experimental process. This included testing equipment for use in the experimental set up as well as data collection equipment. A varying number of dogs, both naïve and KAT, were tested at each of these stages and video recordings were taken for review.

A.1.1. Experimental area - Trailer

The use of a trailer was tested initially as it enabled travel between various locations, reduced the time involved with the set up, and was a metal surface that was able to be cleaned between dogs (Figure A.1).

Figure 0. Side view of University of Waikato trailer used during the first stages of the pilot trials.

The trailer was semi-enclosed, with dimensions of 2.37 m long, 1.51 m wide and the walls were 0.90 m high. The rear wall of the trailer could be opened and lowered to act as a ramp to allow dogs to enter and exit the trailer. A smaller opening at the front of the trailer, 1.45 m wide by 0.31 m high, allowed access to change the stimulus to be presented at the front of the trailer area. A 0.5 m square grid on the floor of the trailer was made using red insulation tape to determine the amount of time the dogs spent in each area of the trailer. Three GoPro Hero 3 cameras were used, one placed on a tripod pointing into the trailer, one attached to the front of the

trailer, just above the small opening, facing outwards, and one placed above the experimental area facing downwards, attached to a rail above the trailer.

Seven dogs were used in this pilot study to determine the usefulness of the trailer (Table A.1). The dog was held by an assistant near the entrance of the trailer while I put the kiwi stimuli in position. I would make eye contact with the dog to ensure that the dog observed the stimuli was put in place. The dog was then walked to the entrance by me and encouraged and/or prompted to enter the trailer by pointing into the trailer and giving a command. The dog was allowed to walk freely within the experimental area, while the assistant stood to one side and attempted to limit any influence they might have on the dog's behaviour. The trial was ended dependent on meeting one of two criteria, whichever was met first: when the dog left the experimental area, or when the trial reached 2-minutes. The process was repeated once for each stimulus that was being used at this stage of the study. At this stage of the study, only two stimuli were used due to difficulties in obtaining materials for testing. These included kiwi scats and kiwi nesting material that was collected by staff from Otorohanga Kiwi house.

However, dogs would not readily enter the trailer and required prompting and/or luring to move up the ramp into the trailer. The ramp that led into the trailer may have been too steep for a number of the dogs, and thus, restricted their movement into the trailer. As the aim of this study was to determine dogs' innate 'interest' in kiwi related stimuli, the use of the trailer did not allow this aim to be adequately met without undue human prompting and, therefore, the trailer was not used in the final study.

Table A.1.1. *Details of dog subjects used in stage 1 of the pilot study.*

Training	Breed Description	Age	Sex
Naïve	Huntaway x	6	Female
Aversion	Heading Dog		Male
Aversion	Cattle Dog x		Female
Naïve	Jack Russel Terrier	3	Female
Naïve	Labrador Retriever	4	Female
Naïve	Mastiff x	4	Male
Naïve	Terrier x	2	Male

A.1.2. Experimental area - Gazebo

A gazebo set up was then tested as a means to maintain consistency in the experimental setting while still being able to conduct trials in different locations (Figure A.2). Twenty-five naïve dogs were trialled with the use of a gazebo with walls and tarpaulin flooring (Table A.3).

Figure 0. Gazebo with walls and tarpaulin flooring that was used during the pilot stages of experiment.

Table 0 *Details of dog subjects used during stage 2 of the pilot study.*

Breed Description	Male	Female
Rottweiler	2	
Staffordshire terrier x	1	1
Labrador retriever		2
German shepherd	1	
Maltese x	2	1
Fox terrier x	4	
Miniature poodle	1	
Huntaway x		2
Mastiff x	2	
Papillion	1	
Cavalier King Charles spaniel		1
Shitzu x	1	

Brittany spaniel	1	
Basenji		1
Pitbull terrier x		1
TOTAL	16	9

I placed the stimuli in the centre of the experimental area and made eye contact with the dog. The dog was held near the entrance by an assistant and was released at the start of the trial. The end of the trial was marked by the dog either leaving the experimental area, or the trial reaching the maximum 2-minute timeframe. This procedure was repeated for each kiwi stimulus used in the study. At this stage of the study, all stimuli were available and used (i.e., stuffed kiwi, kiwi carcass, kiwi scats, kiwi feathers, and the blank stimulus) which were presented in their respective cages.

During the trialling of this method, many of the dogs were on lead to prevent them leaving the unfenced experimental area. The assistant would hold the dog to one side while the stimulus was placed in position by me. Once the stimulus was in place, I would leave the experimental area and would not observe the dog's behaviour. The leads were held by one of two assistants, but the assistants did not use the leads to direct the movement of the dog within the experimental area. For instance, the assistants would extend or reduce the length of the lead to prevent the lead becoming tangled as the dog investigated the experimental area. In some cases, owners were also present during the experiment. The owners would often encourage their dogs to investigate the stimuli and as such, they could also be a means of distraction for the dog. Some dogs would also wait for their owner to prompt them to investigate the experimental area and stimuli.

At first, each trial was concluded based on one of two criteria as described previously (refer to section A1). However, it was found that dogs would often re-enter the experimental area after leaving which resulted in the 'end of trial' criteria being changed to better suit the behaviour of the dogs. The presence of owners as well as some dogs needing to be restrained on lead during trials posed some issues. Dogs are regularly influenced by their owner's behaviours (Schwab & Huber, 2006) and the use of leads required someone attending to the dogs which could also influence the dogs' behaviour, as well as the possibility of the lead becoming

entangled around the stimuli. These factors influenced the need for re-evaluation of the set-up and methods used to meet the aims of this study.

The gazebo was retained for use in the final experimental set-up, with the addition of pet fencing to keep dogs contained and eliminate the need to use a lead. The methods were also adjusted to meet a single 'end of trial' criterion of the trial reaching a set time of 2-minutes which allowed the dogs to leave and re-enter the experimental area more than once.

A.2 Pilot trials - Heart rate monitoring

Measuring physiological responses alongside behavioural responses was trialled initially to give further information about dogs' reactions toward the different stimuli presented. Polar© heart rate monitors were trialled during the pilot stages (A.1 and A.2, above) of this study. This involved shaving a patch of fur on each dog, approximately 4-cm wide and 14-cm high, on the left-hand side of the dog's chest behind the front leg. A lubricant gel was applied to the heart rate monitor, which was attached to the dog's chest via a strap and further secured using elastic bandaging (i.e., vet wrap). To establish a baseline heart rate, the strap was attached at least 15-minutes prior to beginning the experimental trials.

Many dogs that were used during the pilot study were not able to be restrained for long enough to allow the heart rate monitors to be placed and secured accurately. This limited the amount of heart rate data that could be collected. In addition, some owners were not willing to have patches of their dogs' fur shaved, which was a requirement for the effective use of the heart rate monitors, further reducing the heart rate data that could be collected.

Of the 18 dogs that had the heart rate monitors prepped and secured, the monitors would often only partially collect heart rate data. The Polar© heart rate monitors used were designed for humans to measure sporting and fitness performance. Due to the varying sizes and shapes of dogs, the monitors could not accurately detect heart rate of certain dogs as they moved within the experimental area and between trials. With the number of issues and the significant issue of reliability of the data collected using the heart rate monitors, the monitors were not used in the final experimental procedure.

Appendix B

Table B.1. *Ethogram of behaviours performed with locomotor behaviours.*

Behaviour	Description
Barking	Vocalisation; mouth opens and closes to produce the sound, non-continuous
Panting	Mouth is open, with the tongue clearly visible, while breathing heavily
Whining/whimpering	Low-intensity, often repetitive high-pitched vocalisation with rising or falling frequency modulation, usually executed with a closed mouth.
Yawn	Mouth is opened to full extension for a short duration, without vocalisation.

Appendix C

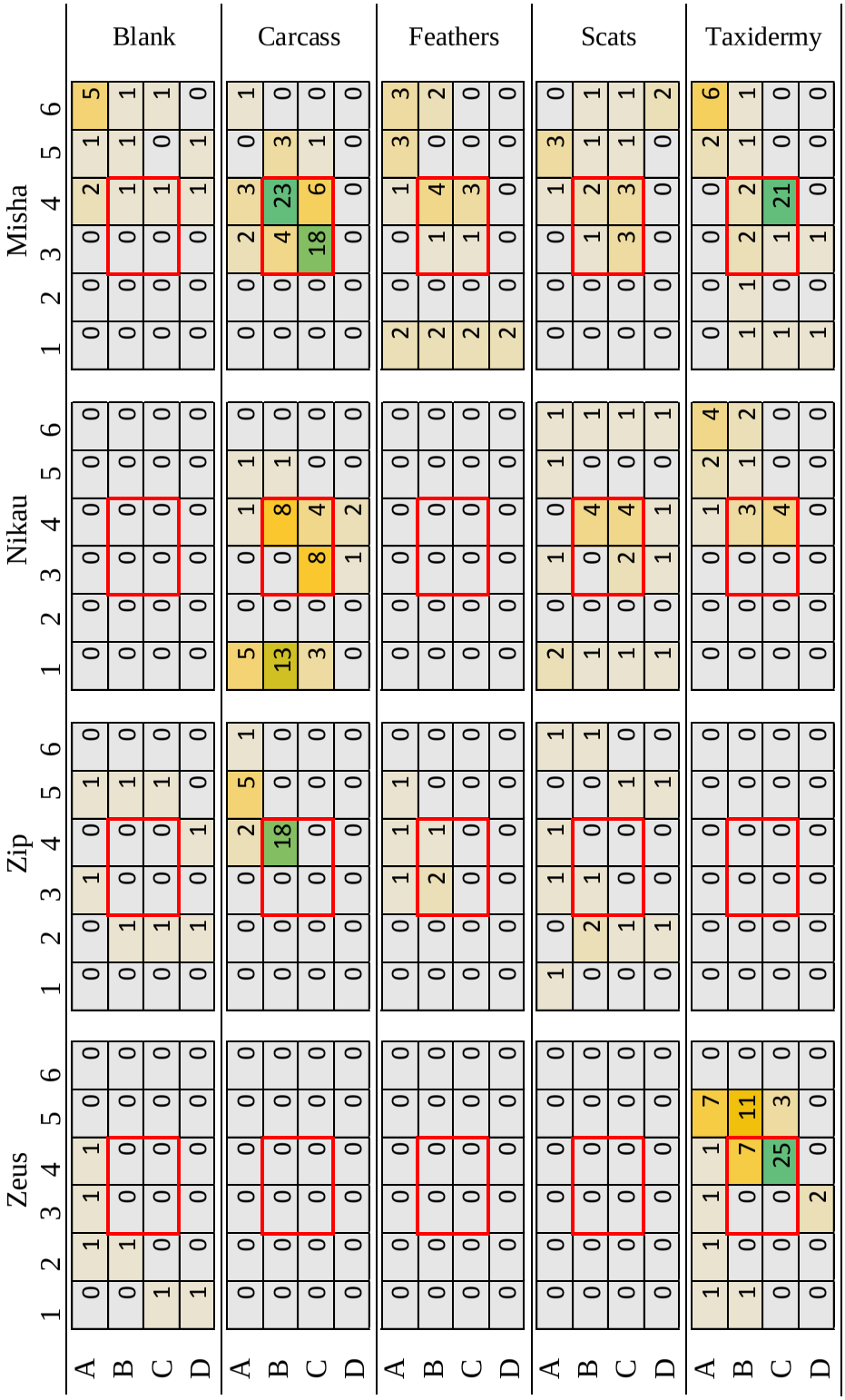

Figure 0. Duration (sec) heat maps indicating the amount of time spent in each quadrat of the experimental area for each naïve (pet) dog, in relation to the stimuli presented. 'Red' outline indicates where the stimuli were placed (continued over following 3 pages)

	Chrissie						Chloe						Preston						Kiri						Fritz						
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
A	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	8	0	0	0	0	0	0	0	2	0	0	0	0	0	Blank
B	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	5	0	0	0	0	0	0	0	1	0	0	0	0	0	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	7	2	0	0	0	0	0	0	0	1	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	2	2	0	0	0	0	0	0	1	0	0	0	0	0	
A	0	0	0	1	1	0	0	0	0	0	0	0	0	2	4	2	1	0	0	0	2	2	0	0	0	0	0	1	42	0	Carcass
B	0	0	2	13	1	0	0	0	0	0	0	0	2	3	0	8	3	1	0	0	3	0	0	0	0	0	0	20	8	0	
C	0	0	11	5	0	0	0	0	0	0	0	0	2	2	11	5	1	1	0	0	12	0	0	0	0	0	0	4	2	0	
D	0	0	1	0	0	0	0	0	0	0	0	0	1	2	3	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0	
A	1	0	2	1	0	3	0	0	0	0	0	0	5	0	2	1	3	2	0	1	1	1	3	1	0	0	0	0	0	0	Feathers
B	1	0	2	1	0	2	0	0	0	0	0	0	0	1	1	2	2	1	0	0	0	0	3	3	0	0	0	0	0	0	
C	1	0	0	1	0	2	0	0	0	0	0	0	0	1	1	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
D	1	0	0	0	1	2	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
A	0	0	2	0	0	0	0	0	0	0	0	0	0	2	2	5	4	0	4	0	0	1	0	0	0	0	0	0	0	0	Scats
B	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	2	0	2	1	0	0	2	0	0	0	0	0	0	0	
C	0	0	2	1	0	0	0	0	0	0	0	0	0	0	10	13	0	0	3	0	0	2	0	0	0	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	0	0	0	0	0	0	0	0	
A	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	4	5	4	0	0	0	4	7	4	3	2	0	2	1	0	Taxidermy
B	0	0	2	3	0	0	0	0	0	0	0	0	0	0	1	13	2	0	0	0	1	15	0	4	0	0	4	10	1	0	
C	0	0	5	12	1	0	0	0	0	0	0	0	0	0	4	12	0	0	0	2	2	13	0	5	0	0	0	4	0	0	
D	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	5	3	2	0	4	0	0	0	0	0	0	

	Mini						Spud						Layla						Mila						Sam						
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
A	0	1	2	5	4	9	0	0	0	0	0	28	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Blank
B	0	1	3	2	8	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
C	0	1	2	9	4	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	1	1	8	1	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	3	8	8	4	4	1	0	0	3	1	1	18	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	Carcass
B	6	3	0	14	4	2	0	1	1	9	0	6	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
C	1	1	4	0	0	1	0	1	2	7	2	3	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	5	1	2	3	2	0	0	0	0	0	0	34	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Feathers
B	4	1	9	19	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
C	3	1	19	18	2	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
D	3	1	19	18	2	0	0	0	0	0	0	2	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	
A	2	1	4	3	3	2	0	0	0	0	2	21	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Scats
B	1	1	7	16	4	1	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
C	1	0	0	15	4	2	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	5	2	1	1	2	1	0	0	0	2	1	21	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	Taxidermy
B	4	4	18	7	0	0	0	0	2	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
C	0	2	13	19	0	0	0	0	0	0	0	0	0	1	8	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	1	2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	

	Kimchi						Jake						Ted						Bella						Gypsy						
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
A	0	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Blank
B	0	0	2	5	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
C	0	0	0	7	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0	0	16	2	0	0	0	0	0	0	0	0	0	0	0	0	
A	0	1	0	0	0	0	0	0	0	0	0	1	9	2	1	1	1	0	0	0	0	1	2	0	0	0	0	0	0	0	Carcass
B	0	0	1	0	0	0	0	0	1	1	0	1	0	1	6	71	2	0	0	0	0	33	0	0	0	0	0	0	0	0	
C	0	1	2	1	0	0	0	0	7	0	0	1	0	0	18	13	1	0	0	0	0	17	0	0	0	0	0	0	0	0	
D	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	Feathers
B	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	
C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	
A	0	0	0	0	0	0	1	1	1	0	0	1	8	0	1	1	0	2	0	0	1	2	0	0	0	0	1	2	1	0	Scats
B	0	0	1	0	0	0	0	0	2	0	0	1	3	1	2	7	0	2	0	0	2	7	0	0	0	0	2	7	0	0	
C	0	0	5	0	0	0	0	0	5	0	0	1	3	0	1	2	0	1	0	0	6	1	0	0	0	0	0	0	0	0	
D	7	7	0	0	0	0	1	1	0	1	0	0	3	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	
A	10	10	0	5	5	0	1	0	1	0	0	0	1	0	1	1	8	0	0	1	1	2	1	0	0	1	0	1	2	0	Taxidermy
B	0	17	13	9	0	0	0	0	11	1	0	0	0	1	22	3	0	0	0	0	8	24	0	0	0	1	0	10	2	0	
C	0	17	14	23	0	0	2	0	9	0	0	0	0	0	15	2	0	0	0	0	0	0	0	0	0	1	1	2	1	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

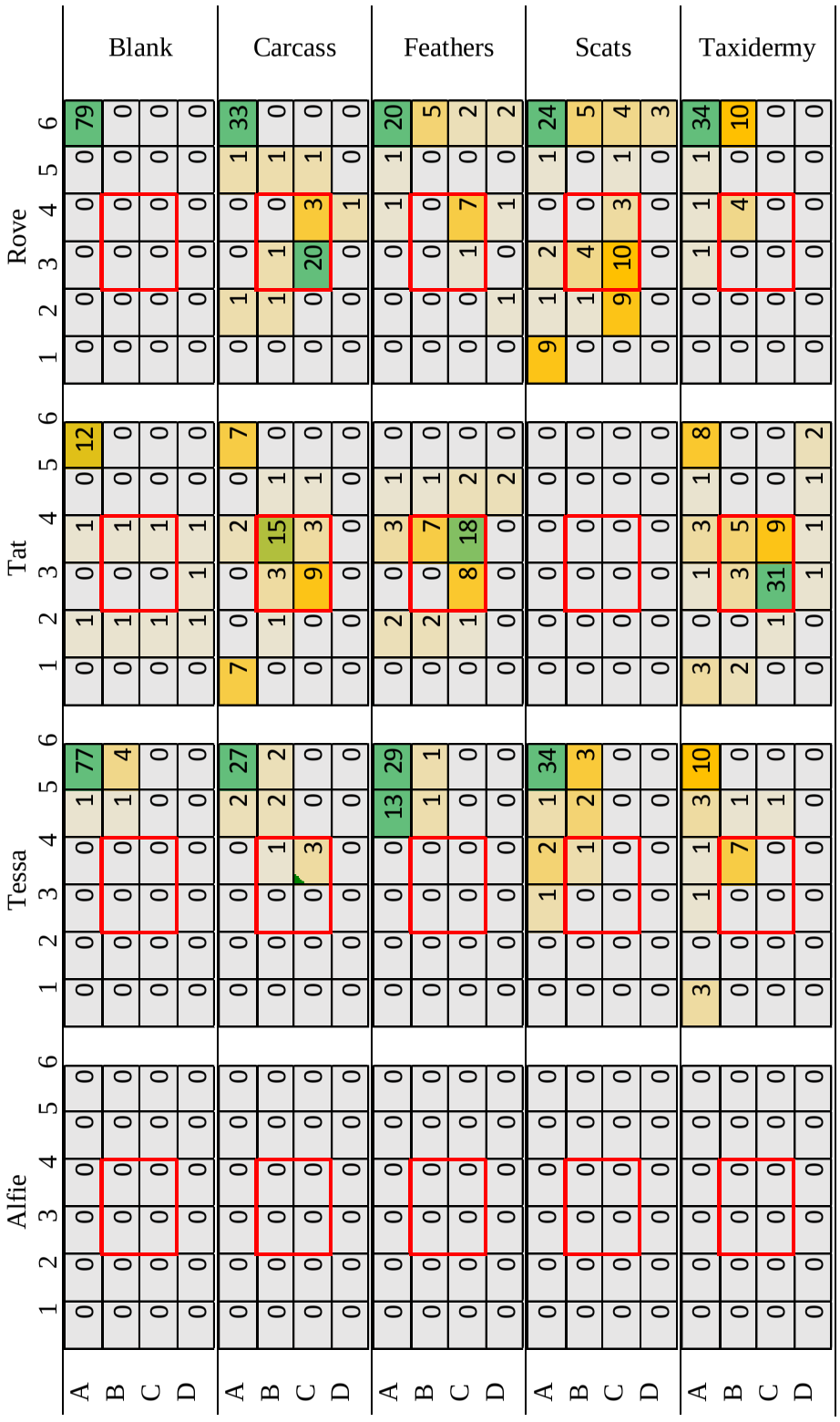

Figure C.2. Duration (sec) heat maps indicating the amount of time spent in each quadrat of the experimental area for each aversion trained dog, in relation to the stimuli presented. 'Red' outline indicates where the stimuli were placed (continued over following 2 pages)

	Pirate						Lexi						Nala						Yort						
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
A	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	1	20	0	0	0	0	0	1	Blank
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	
A	0	0	1	1	1	3	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	1	2	Carcass
B	0	0	5	5	1	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	4	1	0	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	6	0	0	0	4	1	42	Feathers
B	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	1	2	1	4	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
A	0	0	0	0	0	0	0	0	0	2	2	48	0	0	0	0	0	0	0	0	0	0	1	13	Scats
B	0	0	0	0	0	0	0	0	1	3	1	9	0	0	0	0	0	0	0	0	0	0	0	2	
C	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	6	2	4	1	1	28	0	0	0	2	0	13	0	0	0	1	1	0	0	0	0	0	0	24	Taxidermy
B	0	0	22	0	0	0	0	0	0	5	1	0	0	0	0	2	0	0	0	0	0	0	0	0	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

		Mardy						Fay						Rewa						Clutha						Defa						
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
Blank	A	0	0	0	1	7	28	0	0	0	1	4	48	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
	B	0	0	4	6	1	0	0	0	3	2	2	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
	C	0	0	0	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
Carcass	A	0	0	1	0	1	43	1	0	0	2	3	6	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	
	B	0	0	30	4	1	2	1	0	0	4	3	4	0	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	0	
	C	0	0	6	2	0	0	1	0	1	5	1	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	
	D	0	0	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	
Feathers	A	0	0	0	0	2	7	1	1	1	0	1	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	B	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	C	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	D	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Scats	A	0	0	0	0	0	0	0	0	0	0	34	30	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0	0	0	0	
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
Taxidermy	A	0	0	0	0	0	0	0	1	1	0	3	23	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	
	B	0	0	0	0	0	0	0	0	2	3	4	2	0	0	0	0	0	0	0	0	14	23	7	0	0	0	0	0	0	0	
	C	0	0	0	0	0	0	0	0	2	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	D	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

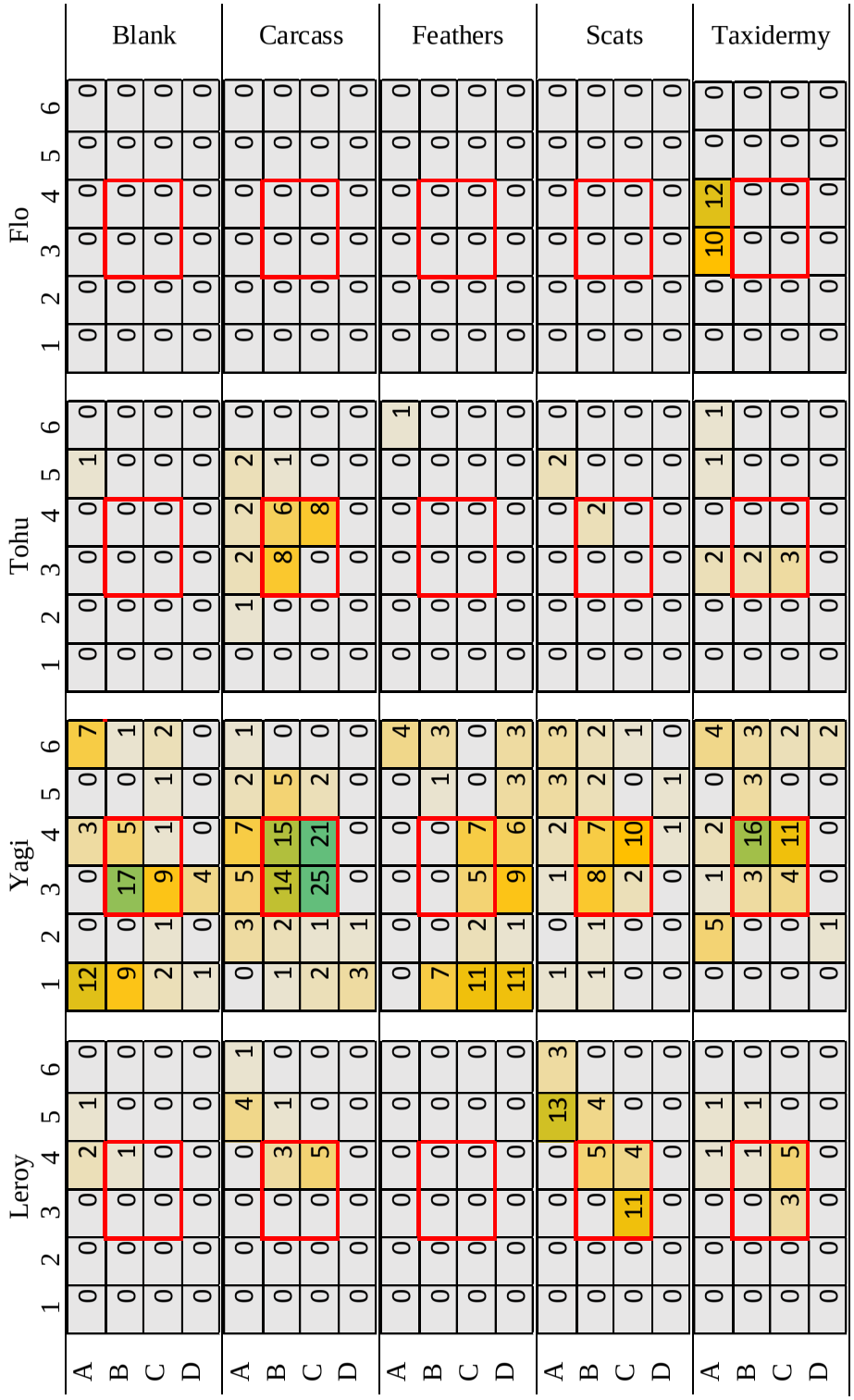

Figure C.3. Duration (sec) heat maps indicating the amount of time spent in each quadrat of the experimental area for each kiwi conservation dog, in relation to the stimuli presented. 'Red' outline indicates where the stimuli were placed (continued over following page)

		Neo						Eko						Beau						
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	
Blank	A	0	0	2	1	1	10	0	0	0	0	0	0	1	2	1	1	1	4	
	B	0	0	1	0	1	2	0	0	0	0	0	0	1	0	4	3	2	3	
	C	0	0	0	0	2	1	0	0	0	0	0	0	1	4	10	4	0	5	
	D	0	0	0	0	0	1	0	0	0	0	0	0	2	1	3	2	0	6	
Carcass	A	2	1	1	1	4	0	0	0	17	17	7	0	1	1	2	8	1	0	
	B	1	3	21	9	2	1	0	0	17	17	7	0	0	2	20	39	1	0	
	C	1	1	2	11	2	0	0	0	0	11	11	0	0	1	33	14	0	0	
	D	1	1	0	0	0	0	0	0	0	4	0	4	0	0	2	0	0	0	
Feathers	A	2	0	0	0	0	0	0	0	0	2	0	0	0	0	9	2	0	3	
	B	2	0	0	0	0	0	0	0	0	2	0	0	0	0	10	12	2	2	
	C	2	0	0	0	0	0	0	0	0	0	0	0	0	0	9	13	1	3	
	D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	
Scats	A	0	0	0	1	1	0	0	0	0	3	0	0	0	0	0	0	1	7	
	B	0	0	0	0	0	0	0	0	0	3	0	0	1	1	3	1	1	1	
	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	1	1	
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	
Taxidermy	A	1	1	3	0	3	1	0	0	3	18	8	0	0	0	0	1	2	6	
	B	1	1	0	3	2	0	0	0	6	35	7	0	0	0	1	5	3	3	
	C	1	0	5	0	2	0	0	0	13	8	0	0	0	0	5	14	1	2	
	D	1	0	1	0	2	0	0	0	0	0	0	0	0	0	4	3	0	2	