A review of AW1402A proposal, raw data and methodology into the use of electronic collars on domestic dogs in the U.K

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Abstract:

AW1402A was a research study commissioned by Department of Environment Food and Rural affairs (DEFRA) in 2010 and undertaken by Researchers from Lincoln University. Raw data from the completed study was exchanged between Lincoln University and the Electronic Collars Manufacturers association (ECMA) and DEFRA under a memorandum of understanding agreement. The data was then presented for analysis independently of the research completed by Lincoln University.

Data was proposed to be collected for nine independent variables; video of behaviour, ethograms, data extraction from video, urine cortisol, saliva cortisol, heart rate, cognitive bias, impulsivity trait and PANAS scores. This proposal met with approval from DEFRA and funding was awarded. Five of these variables could not be analysed: heart rate, video of behaviour, ethograms and data extraction from video of behaviour and impulsivity.

Of the original 9 criteria selected for the study, 1 was abandoned shortly after the study commenced and 3 were invalidated through poor methodology management and failure to collect data and 1 was not attempted.

Heart rate results were incomplete and appear to have been abandoned 5 days into the experiment. A blinding protocol was present in the methodology of AW1402A for the video recording, ethogram and data extraction and while the importance of blinding was specified in a protocol, it does not appear to have been followed and this invalidated the behavioural data analysis. An impulsivity assessment was proposed in the research methodology and this appears to have been abandoned with no results gathered or presented. Follow up behavioural data collection has not been completed.

The remaining four criteria were analysed and interpreted and they showed no significant effect with regard to collar condition on urine cortisol, saliva cortisol, cognitive bias or PANAS score.

1. Introduction:

AW1402 was a research proposal funding grant, initiated by DEFRA and undertaken by researchers from Lincoln University, to investigate the behavioural, affective state and physiological effects of using training devices in dogs undergoing training with remote static pulse training collars (e-collars). The original proposal contained 5 objectives with the overall aim to assess the welfare of dogs exposed to these devices. Objective 4 of this original proposal was changed sufficiently after consultation between DEFRA, Lincoln researchers and ECMA to become AW1402 A. Total funding available for the research was £538, 000.

AW1402A aimed to investigate the immediate impact of training with e-collars as well as provide a more focused study of the longer term consequences by follow up investigation. The use of multiple parameters and the relationships between them can increase robustness of the final assessment (Hiby 2006) by adhering to the discrete independent effect (Bailey 2012).

The study chose 9 independent sources of evidence to contribute to 3 discrete criteria (behaviour, physiology and affective state) for investigation into the effects of collars on domestic dog welfare.

These were:

1. Video of behaviours
2. Ethograms
3. Data derived from videos
4. Urine cortisol
5. Saliva cortisol
6. Heart Rate results
7. Cognitive bias testing
8. PANAS (positive and negative association scores) recording
9. Impulsivity score

(Items 1–3: Behaviour; items 4–6: Physiology; items 7–9: Affective state)

Dogs were divided into 3 groups:

1. E-collar group trainers with experience of use of e-collars, using e-collars as part of their training program.
2. Control A: Trainers with experience of use of e-collars, not using e-collars as part of their training program
3. Control B: Trainers who do not normally use e-collars in training, not using e-collars as part of their training program.

Behavioural, Affect and Physiological data were collected over a 5 day period to assess immediate impact of e-collar. Follow-up data was collected at around 3 months post training to assess long term welfare consequences of training methods and their efficacy.

The use of electronic collars as training aids on dogs has been controversial (Schalke et al 2006). Historically, in the U.K there has been opposing views on the best approach to providing training for animals and accurate measurement of animal welfare is notoriously difficult (Hiby 2006). In 1998, following the death of a police dog; Acer (after being suspended over a fence and kicked during training by his handler, a member of the Essex constabulary) the use of any form of punishment to train a dog has received adverse publicity.

In 1998, after the conviction of 3 police officers following the Death of Acer, the use of training devices, methods or techniques that promoted any form of punishment (including pinch collars and electronic collars) received negative attention from the National Canine defence League (NCDL), the Royal Society of Prevention of cruelty to Animals (RSPCA), as well as the British Small Animal Veterinary Association (BSAVA) (BBC 1998). Compared to production animals, the welfare of the domestic dog is a relatively understudied area (Hiby 2006). In 2000 the Association of Chief Police Officers (ACPO) urged all members to suspend the use of such devices until the findings of a country wide review were completed. (BBC 2000). In May of 2000, ACPO banned the use of these devices in police dog training and this attracted the support of the NCDL and RSPCA who responded by considering lifting the ban on rehoming of dogs to British police forces that had been in place since the death of Acer. (BBC- Feb 2000)

Since the ban on the use of electronic training collars on police dogs in the U.K in 2000 there have been progressive efforts to have them removed from all aspects of dog training and to outlaw them in the U.K. (Kennel club 2005-2009). This includes an attempt in 2003 to introduce a private members bill; Animal (electric shock) collars bill, which was unsuccessful. Further lobbying in 2004 and 2005 to have the use of electronic collars included in the review of the animal welfare Act 2006 was unsuccessful. Another private members bill was attempted unsuccessfully in 2006.

Further lobbying lead to a statement by the Welsh Minister for Environment Carwyn Jones to issue a consultation on the use of electronic collars. This began some political momentum with the Scottish executive issuing a consultation in 2007. (Sansorella 2010), (Kennel Club 2005-2009).
In 2008 the Welsh Assembly under a new minister Elin Jones announced a ban would be introduced in Wales. The Scottish government announced that they would await the results of the DEFRA study (AW1402 and AW1402A) that has been reviewed as part of this paper.

In 2010 the Welsh Assembly announced a ban on electronic collars through the Animal welfare (electronic collars) (Wales) regulations 2010. This was challenged by the Electronic Collar Manufacturers association (ECMA) and the challenge was ruled against. (Kennel Club 2005-2009)
A man has been convicted on 18-7-2011 of using the collar on his dog in Bridgend Magistrates court in Wales and has been fined £2000 (BBC 2011)

The collars currently remain legal in England, Scotland and Northern Ireland.
The AW1402 and AW1402A study is proposed to provide direction for DEFRA to make a recommendation as to the welfare implications of electronic collars in domestic dogs in the U.K.

2. Methods

2.1 Raw data analysis

Data from AW1402A was provided. The 9 pieces of proposed data have been separated and individually addressed in the subsequent analysis seen in Table 1.

Table 1. Data presented from study and subsequent analytical method

Data proposed	Data presented	Analysed	Reason for not analysing	Method of analysis	Result obtained
Video of behaviour	Yes	no	Not blinded, incomplete	n/a	no
Ethograms	Yes	no	Not blinded	n/a	no
Data from video	Yes	no	Not blinded	n/a	no
Heart-rate measurement	Partial	no	Abandoned	n/a	no
Urine cortisol	yes	yes	n/a	ANOVA	yes
Salivary cortisol	yes	yes	n/a	ANOVA	yes
Cognitive bias	yes	yes	n/a	ANOVA	yes
PANAS	yes	yes	n/a	ANOVA	yes

Impulsivity	no	no	Not included	n/a	no

2.2 Methodology

The method for AW1402A was also an important aspect to this research and where it is relevant-particularly to the video data extraction and blinding protocols , it has been discussed in context.

2.2.1 Methodology- blinding protocol

The blinding protocol used in the application for funding for AW1402A is provided below:

It is crucial to the scientific validity of the study that the researchers involved in data extraction do not know which dogs are wearing the active collar and which is wearing the dummy collar. For example, all the dogs will wear an electronic training collar but only one of each pair of dogs will wear an active collar. Any additional procedures would also be used with both dummy collar and active collar wearing dogs.

Blinding will cover three aspects

1. Not knowing which dog is wearing the active collar,
2. Not knowing when a collar is activated apart from behavioural indications,
3. Evaluation of behavioural response to be done by a researcher who only has the video and was not present at the training site and without input from the researchers who attended the training sessions.

The blinding process used by University of Lincoln complies with points 1, 2 and 3 to ensure that those assaying samples in the laboratory or extracting information from video tapes will be blind to treatment (control or e-collar dogs).

The blinding protocol fails in all three aspects of the criteria provided by Lincoln researchers.
With regard to 1. While all dogs had collars- the activation unit (often attached via a lanyard around a trainer's neck) is not present in all videos. It is clear from observing video data that the identity of trainers who are using active electronic collars by identifying them through their attachment to an activation unit. See figure 1.

With regard to 2. The trainers who are using training collars will reach up to the activation unit and activate it when required if an active collar is being used. Trainers not using a training collar will have a dog that is wearing an e-collar on but no activation unit visible at any time. See figure 2. and figure 3.

With regard to 3. The presence or absence of data extractors at the site of training is an invalid criterion for determining blinding. Data extractor location is no longer a valid criterion in blinding where there has been breaching of criteria's one and two.

This is regarded as a flaw in the methodology management of this project

Figure 1. trainers with e-collars and activation units (arrows).

Figure 2. trainers with e-collars and no activation units.

Figure 3. trainer with e-collar and activation unit in hand. (arrows)

2.3 Experiments
No experiments were performed in this study. An analysis of the results obtained by the experiments performed by Lincoln researchers and the relevance of these experiments to the methodology proposed is the focus of this research.

2.4 Data Collection
The data collected for this research is identical to the data collected by the Lincoln researchers.

2.5 Data Analysis
Method of analysis will vary between research groups as identical method and approach to analysis is not possible as this study is done prior to the release of the findings by Lincoln University and without their input.

2.6 Statistical Analysis

Analysis of variance (ANOVA's) for repeated measurements were used to investigate if stimuli (static pulses) induced responses, to determine if responses depended on the intervention used and when this was the case to identify which intervention group differed with regard to their response.

3. Results

3.1 Heart Rate
The heart rate collected during the experiment consisted of 7 dogs measured over 5 days with two measurements on each day. A further 8 dogs had their heart rate measured with a stethoscope but there was data missing from these measurements. 63 dogs were recruited for this study and it would appear that heart rate measurement was abandoned shortly after the study began.

3.2 Saliva Cortisol
An ANOVA with one between-subjects factor (collar condition) and one within subjects factor (trial, i.e. salivary cortisol levels across the 5 days of testing), with seven levels for the within subjects factor (pre

testing day 1, post intervention day 1, post intervention day 2, post intervention day 3. post intervention day 4, pre testing day 5 and post intervention day 5).
A further ANOVA with one between –subjects factor (collar condition) and one within-subjects factor (Trial) with six levels for the within subjects factor (average of pre-testing day 1 and 5, post intervention day 1, post intervention day 2, post intervention day 3. post intervention day 4 and post intervention day 5)

Results revealed no significant main effect of trial, either when the variable was entered with 7 or 6 levels. There was no significant main effect of collar condition, and no significant interaction between collar condition and trial (whether trial was entered with 6 or 7 levels).

Salivary cortisol levels did not differ significantly between the collar conditions on any day of testing whether before or after any testing intervention.

3.3 Urinary Cortisol Results

A mixed design ANOVA was carried out using a between subjects factor of collar condition and a within subjects factor of "trial", with 6 levels; day 1, day2, day 3, day 4, day 5, 3 months.

Analysis revealed a significant main effect of trial, with dogs having significantly lower urinary cortisol concentrations 3 months post- intervention, than on days 3, 4 or 5 of the intervention. Post- hoc tests also showed that the dogs had significantly lower urinary cortisol concentrations on day1 of the intervention than on days 4 or 5.

There was no significant main effect of collar condition on urine cortisol level results for all dog groups.

3.4 Cognitive Bias

Analysis of Variance revealed 3 significant ($P<0.05$) effects on the cognitive bias tests:

1. A significant main effect of 'position of the food bowl', with dogs showing a slower latency to approach bowls in the positions labeled 'No Food' and 'NR-', than those labeled 'Food' and 'NR+'.
2. A significant main effect of 'trial', with dogs becoming progressively slower to approach the food bowls with increased testing.
3. A significant interaction between 'position of the food bowl' and 'trial'. The dogs' latency to approach the bowls labeled 'Food' and 'NR+', did not change dramatically over the three phases of testing. However, animals were significantly slower to approach the bowls labeled 'No Food' and 'NR-' on their third phase of testing than on trials 1 or 2. In other words, dogs learned over time that the bowls placed in these positions contained no food, and put less effort into approaching them.

There was no significant effect of collar condition on the animals' latency (cognitive bias) results.

3.5 PANAS

Analysis was carried out using one mixed design ANOVA for between subjects factor of collar condition and within subjects factor of trial (pre and post) for each of the subscale scores(negative activation, positive activation, energy and interest, persistence and excitement).

Results show a significant effect of 'trial' on two of the PANAS scores, namely 'Negative Activation' and 'Persistence'. Unfortunately, without knowing the actual valence attached to the scores, it is impossible to determine the direction of these main effects. Importantly, there was no significant effect of collar condition on any of the subscale scores.

3.6 Video of Behaviour

3.7 Ethograms

3.8 Data extraction from video

Data analysis relating to the video data, ethograms and data extraction was not performed. Despite having a blinding protocol as part of the methodology it is clear from the subsequent results of the video behaviour recording that this aspect of the study was not blinded and that data extractors could easily determine which animals had on an electronic collar that was active and being used during the trial process. The ability to allow bias to enter into the video analysis, subsequent ethogram production and data extraction through this lack of blinding is a flaw in the execution of the methodology of this experiment.

4. Discussion

Of the 9 independent variables proposed- only 4 (Saliva cortisol, Urine cortisol, Cognitive bias and PANAS) produced valid results. Of these valid results there was no effect of collar condition on any of the three groups (collar and 2 controls) of dogs.

4.1 Heart rate

Results were produced in this section. There was no data analysis performed as this aspect of the study was abandoned after commencement of the study.

4.2 Video of behavior

4.3 Ethograms

4.4 Video data extraction

There was significant data produced for all three criteria. No behavioural data was analysed in this study. The data collected and submitted for analysis was not subjected to the blinding protocol produced in the AW1402A study methodology.

The following paragraph is an extract from Martin and Bateson: *The point of an experiment is to find out whether varying one condition produces a particular outcome. Observers will almost inevitably have some expectations about the outcome of an experiment even if they are not consciously aware of these expectations. This potential source of bias can be removed by ensuring that the person making the* *measurements is unaware of which treatment each subject has received until after the experiment is over. This procedure is referred to as running a blind experiment. Observers may influence their own observations in the direction of a favored hypothesis. The cumulative effect of many such minor biases may be an apparent significant difference between the experimental and control groups. These effects are often surprisingly large and the only sure way to minimize them is for you to be genuinely unaware of how the subjects have been treated until after the data has been collected. An experiment in which neither the person making the measurements, nor the subjects, know the treatment that each subject has received is called a double blind experiment. This type of study design is widely used, for example in assessing the clinical affects of drugs and other forms of medical intervention.*

Behavioural data relies on observer detection, so the project must prevent observer bias, consequently observers of video tapes will be blind to treatment to avoid such bias (Mills et al. 2006, Anon 2009). Valid measures should be as unbiased as possible.
While raters were not present at the test, this is at odds with the initial proposal to have behaviour recorded by raters with direct observation present at the test. (Anon 2009).

The fact that a blinding protocol was produced and not adhered to would raise questions as to the management of the study.

Not all behavioural data was completed and submitted for analysis. Follow up data was missing. No impulsivity scores were included in the result analysis despite being included in funding proposal for AW1402A (Anon 2009). There was however a paper on impulsivity produced by Lincoln University (Wright, Mills and Pollux 2011). Although it was performed at the same time as AW1402A there was no reference to AW1402A in this paper.

When combined with abandonment of heart rate data collection then of the 9 variables proposed for measurement, only 4 are valid.

4.5 Urine Cortisol.

Urine cortisol is an accepted indicator of arousal in animals and humans (Hiby 2006). Determination of cortisol in serum and urine has been a frequent (and consistently used) marker for different kinds of stress induced reactions. (Aardal 1995, Mason1986, Yehuda 1990, Pitman1990, Dallman 1993). Cortisol levels indicate arousal but should not be interpreted alone as a high urinary cortisol reading can indicate arousal, stress or distress (Hiby 2006) and most physiological measures using cortisol tend to be (incorrectly) interpreted as measuring negative rather than positive affect (Harding 2004). Urine cortisol samples have the advantage of collection of being non invasive. Cortisol is sequestered into the urine over several hours (Hay et al. 2000) hence titers in urine can be used to measure background levels of stress over the preceding period and the impact of sudden peaks is minimized (Hiby 2006). In urine cortisol as it is dependent on renal tubular excretion and glomerular filtration, the amount of free cortisol depends on the amount of urine collected in the 24 hour period. To overcome these aspects of urine cortisol measurement a ratio of cortisol to creatinine has been introduced to detect relative levels of cortisol regardless of urine volume produced. (Aardal 1995).

Essentially, it seems that all dogs' urine cortisol levels became progressively higher over the course of the intervention returning to roughly day 1 baseline levels of cortisol post- testing (i.e. when tested again at 3 months). Since some behaviors may occur in contexts not related to stress, behavioural data are easily misinterpreted with regard to chronic stress and may only be meaningful when physiological measures such as cortisol, especially urine cortisol to creatine ratios are also determined (Beerda et al 2000).

The results analysed indicate an effect of the main trial on *all* dogs. As the trial progressed over the five days they were all becoming aroused and this returned to baseline levels at 3 months re-test. There was no effect of collar condition on any of the three groups with respect to urine cortisol levels. The e-collar group has not been identified through this analysis. Rather than relying on single measures that may be open to ambiguity and misinterpretation, the use of a number of discrete and independent tools that provide measure of the same unknown has found to be the most reliable approach (Anon 2009). In this study, there was a reliance on cortisol levels in the saliva and urine as the only physiological indicator of stress at the time of intervention.

Heart rate measurements were abandoned shortly after the trial began. Both urinary and salivary cortisol indicators did not reveal the e-collar group but these results need to be interpreted in context as a sole indicator measurement (cortisol level) and therefore a weak contribution to any overall interpretation of welfare. The increase in urinary cortisol over the 5 day intervention period would indicate an increase in arousal of all animals involved in the trial.

Elevated cortisol levels are a strong indication of chronic stress, although normal cortisol levels do not exclude chronic stress since physiological adaptations and stressor –specific responses cannot be ruled out. (Beerda et al 2000).

4.6 Salivary Cortisol

Similar to urine relative cortisol levels, the levels of saliva cortisol (absolute levels) are accepted as indicators of overall circulating cortisol in an animal. There is a high to very high correlation between overall cortisol and salivary cortisol in dogs (Vincent and Michell, 1992; Beerda1997). According to Vincent and Michelle (1992) the cortisol concentration in canine saliva is about 4-10% of the plasma cortisol. Beerda (1997) found saliva cortisol concentrations to have a value between 7.2% and 11% of plasma cortisol concentration. Interestingly the salivary cortisol measurements did not differ significantly between the e-collar group and control groups as the trial progressed as seen in the urine cortisol analysis for this study.

This seems to support some observations that physiological measures correlate poorly with how strongly an animal avoids an aversive stimulus (Dawkins 2001, Rushen 1996).

Also of note is that all dogs were not tested in a similar environment with some dogs being trialed in snow conditions (See figures 1, 2 and 3). While outdoor testing may have been necessary for the trials to occur, all dogs should have had similar exposure to environmental factors considering that cortisol levels can increase by 250% in animals exposed to a temperature of -5°C for an hour (Palazzolo and Quadri 1987).

4.7 PANAS

Affective state (feelings and emotions) is a complex phenomenon generally considered to comprise both positive and negative dimensions. Affective state can be measured using a wide variety of tests in humans but the most commonly employed assessment tool is the positive and negative affect schedule (PANAS) developed by Watson and colleagues (1988). The PANAS consists of 20 single word items that describe both positive (e.g. excited, alert, and determined) and negative (e.g. upset, guilty, jittery) emotions. Participants completing the test are required to consider each item and indicate to what degree on a 5 point scale it applies to them at that moment in time.

The PANAS is one of the most widely used affect scales and reliability scores are high for both positive and negative affect sub-scales. The test has been used extensively over the years to assess the affective state of both adults and children, both in normal and "abnormal" populations.

4.7.1

PANAS and animals

An increasing amount of attention has been devoted to studying the affective state of animals. One way to do this is to "ask" the animal how it is feeling by using tools such as cognitive bias testing or ask the animal owner/carer to try and establish if a dog is displaying positive or negative emotions. Psychometric tests have been developed to assess the emotional functioning of animals with a view to using such information to predict individuals at risk from poor welfare (e.g. C-BARQ Dufy et al 2008).

It has been suggested by Sheppard and Mills (2002) that the study of companion animal behaviour is developing through the use of methods and concepts developed in the human field to explore the mind of other animals including psychometric approaches to the assessment of personality or temperament. There have been a number of studies on "personality" in dogs (Ley and Bennet 2007, Svatberg& Forkman 2002; Svatberg et al 2005) which may otherwise be referred to as "temperament" (Serpell and Sue 2001, Taylor and Mills 2006) " character" (Ruefenacht et al 2002) and emotional dispositions (Sheppard and Mills 2002). Regardless of the terminology used, these studies are all attempting to assess behavioural styles or traits that are consistent over time. (Wright 2011).

In 2002 Sheppard and Mills developed a psychometric test based loosely on PANAS to assess emotional predisposition in dogs. The resulting 45-item test assessed both positive and negative facets of emotion. Dog owners were required to respond, using a 5 point Likert scale (ranging from strongly agree to strongly disagree), to statements such as 'your *dog is rarely frightened'*,' *your dog becomes aggressive if you try to remove its favorite toy or food*' The test was shown to have good test- re-test reliability and it was concluded that the scales held considerable promise as a tool for assessing positive and negative affects in dogs.

Whilst modeled to some degree on the PANAS, the scale is not necessarily assessing emotive state (which is a transient phenomenon) but rather the emotional disposition (a more stable assessment of personality); in this respect it is hard to see how it differs from more traditionally employed canine temperament test. In a recent paper (Wright 2011) the authors highlight that their test assesses 'personality', i.e. traits that are stable over time. The scale developed by Sheppard and Mills in 2002 has not been used extensively by other researchers and there is evidence of only one other study employing it in the ten years it has been developed- in this case to assess owners reports of their German shepherd dogs' dispositions (Wan et al 2009).

As personality is a stable feature over time and does not alter readily (Wright 2011) it is posited that the PANAS test was included to establish if the use of e-collars can cause any personality changes in the e-collar population. It has been suggested that there is strong evidence that personality differences do exist and can be measured accurately in domestic dogs (Gosling et al 2003). There was no indication in this study of any changes of personality in the group that had e-collar intervention compared with the two control groups.

PANAS analysis for this study showed a significant effect of 'trial' on two of the PANAS scores, namely 'Negative Activation' and 'Persistence' for *all* dogs in the trial. Without knowing the actual valence attached to these scores it is not possible to determine the direction of these main effects. Importantly, however, there was no significant effect of collar condition on any of the subscale scores. Similar to the urinary cortisol results there was an effect on PANAS score for all the dogs during the trial. Training had an effect on all dogs in their persistence and negative activation scores. Presumably these traits, temperaments, characters or personalities which are stable characteristics over time were altered in all dogs in this trial due to the training received. Interestingly, no group had a different PANAS score to any other. All three types of training (trainers with active e-collar, trainers used to e-collars with inactive e-collar and trainers with inactive e-collars who don't use e-collars in training programs) had the same effect on the dogs with regard to PANAS score.

4.8 Cognitive bias

Cognitive bias is another measure of affect or emotional state of an animal (Burman et al 2008). Monitoring of emotional processes in animals by measuring behavioural and physiological changes are important tools but , as discussed have limitations including difficulties with interpretation, standardization of behavioural analysis (external validity of studies) and the realization that many indicators of welfare that include physiological and behavioural observations may be sensitive indicators of emotional arousal but not valence- pleasantness/ unpleasantness. Unlike sensory experiences, emotional experiences do not represent physical features of the world and there are no sensory receptors for emotional value (Clore and Ortony 2000). Cognitive components of welfare in animals are largely unexplored sources of information that could be analysed and add to the current standard protocol of using a combined bilateral approach of physiology and behavioural measurements for welfare assessments. This is a relatively recent tool for welfare assessment studied in 2004 by Harding, 2005 by Paul and proposed in 2008 by Burman et al in rats (Burman et al 2008). In an article in 2010 Mendl refers to the cognitive bias measure of animal affect as "new".

Affective state (mood) can influence various cognitive processes, ranging from judgement and memory through to attention and focus. Generally speaking, individuals experiencing a negative affect tend to pay more attention to negative stimuli and judge neutral situations in a more pessimistic manner than individuals with a more positive affect.

Researchers have started to explore the cognitive processes of animals using so called cognitive bias tests. Some studies have recently demonstrated that such testing allows cognitive states induced by housing conditions (e.g. enrichment, cage size) to be determined (Paul et al 2005). Although never been conducted, cognitive bias may be a useful tool for assessing the effect of treatment (e.g. e-collar versus control) on a dog's judgement or way of looking at the world. It introduces a third discrete variable to the traditional (two) accepted measures of animal welfare viz. physiological measures and behavioural observation.

For example a cognitive bias test could be utilized to address the question "does exposure to e-collar make a dog more or less likely to perceive an ambiguous situation in a negative or positive manner?"

4.8.1 Cognitive bias testing in dogs

Most of the research on cognitive bias training in animals has been conducted on rats (e.g. Burman et al. 2008), but dogs have started to attract some scientific attention.

For example, Mendl et al. (2010) discovered that dogs prone to separation anxiety were more likely to perceive an ambiguous stimulus (an empty food bowl) in a pessimistic as opposed to a positive way, being slower to approach an empty food bowl placed further away from the position of a bowl originally filled with food. More recently, Burman and associates (2011) found, quite surprisingly, and counter to their hypothesis, that dogs who had experienced a rewarding event actually judged a visually ambiguous stimulus (a grey card) in a more negative manner than dogs not provided with a rewarding experience. So while it is a potential third criterion of measuring welfare, it is not fully evolved into a valid tool of measurement but a promising tool of measurement.

A typical cognitive bias test for dogs involves a protocol something along the lines of the following. Having learned the position of a bowl which contains food (P) and the position of a bowl devoid of food (N), dogs are presented with food bowls in ambiguous positions, e.g., half-way between the positions of P and N (bowls are absent from these places). The latency to approach the 'ambiguous' bowl is then recorded. Dogs with a negative cognitive bias are more likely to judge the ambiguous bowl as devoid of food, and hence their latency to approach this is typically slower than dogs with a positive cognitive bias, which are more likely to assume the ambiguous bowl contains food. Bowls may be placed in 5 different positions (each one a set distance from the original P and N); a number of trials per position are generally undertaken, and the mean latency to approach each of the 5 bowls is calculated.

4.8.2 Cognitive Bias criticism

Criticism of cog bias testing can be directed at the latency times being measure to reach a food bowl being due to a dogs size, height and speed and not the animals state of affect. Another criticism is that over time dogs will learn the test and realise that no food is on offer in certain positions of the bowl. Another confounder is the dog's ability to smell the presence of food in a bowl from a distance. Related to this, there is a lack of clear a priori predictions for how responses in some tests (e.g. tests of spontaneous behaviour such as the open field) reflect emotional state (e.g. is activity in the open field an indicator of curiosity- motivated exploration or fear motivated escape?), making implementation and interpretation of such tests in species other than the ones they were developed necessarily post-hoc (Burman 2008). For a cognitive bias test to be attributable to an e-collar versus non e-collar intervention the dogs involved in the trial would ideally need to be of similar breed, age, sex and have the same environmental conditions before and between tests.

4.8.3 Cognitive Bias. The current study AW1402A

From looking at the dataset, it appears that the dogs in this study were tested using a robust and fairly similar protocol to that adopted by Burman and colleagues (2008) on rats. Most dogs seem to have been tested on 3 separate occasions (pre-training with the collars, post-training, and then again 3 months later) –although some dogs have only been tested once or twice. Dogs had 2 training sessions, during which data was recorded on their latency (in seconds (s)) to approach the bowl containing food and latency to approach a bowl not containing food.

4.8.3 Cognitive Bias results

Analysis of Variance revealed 3 significant ($P<0.05$) effects on the cognitive bias tests:

1. A significant main effect of 'position of the food bowl', with dogs showing a slower latency to approach bowls in the positions labeled 'No Food' and 'NR-', than those labeled 'Food' and 'NR+'.
2. A significant main effect of 'trial', with dogs becoming progressively slower to approach the food bowls with increased testing.
3. A significant interaction between 'position of the food bowl' and 'trial'. The dogs' latency to approach the bowls labeled 'Food' and 'NR+' did not change dramatically over the three phases of testing. However, animals were significantly slower to approach the bowls labeled 'No Food' and 'NR-' on their third phase of testing than on trials 1 or 2. In other words, dogs learned over time that the bowls placed in these positions contained no food, and put less effort into approaching them.

Importantly, there was no significant effect of collar condition on the animals' latency scores.

4.8.4 Cognitive bias conclusion

Cognitive bias was an interesting and much needed addition to the criteria used for assessment of animal welfare. The researchers should be applauded for including it in this study. Interpretation of cognitive bias testing data in this type of test cannot be relied upon as a sole mid to long term indicator of change in affect in an animal.

4.9 Results in relation to experimental design

The experimental design was sound to include physiological and behaviour measures and these are accepted indicators of welfare in animals. The experimental design should be applauded for attempting to include indicators of cognition and affective state to assess the long term affect that e-collars have on dogs. This is innovative and the inclusion of the results of these aspects of the study allows further investigation into this area.

The blinding protocol was included in the study but was not adhered to and this would prevent independent unbiased behavioural data analysis and interpretation of the data.

AW1402A was a second redesign after concerns were shared between Lincoln University researchers, ECMA and DEFRA with the original objective 4 of AW1402 which was abandoned in favour of the new and well proposed AW1402A.

The abandonment of heart rate results affected overall interpretation of physiological results. The use of two separate population groups in a snow and non snow environment potentially affecting cortisol and other data measurement should have been addressed in the methodology.

The use of combined measure of physiological and behavioural indicators is an established approach for addressing animal welfare in companion animals (Broom 1991, Fraser et al 1997). In their rationale to approaches for AW1402A researchers from Lincoln indicated that dogs will be subjected to impulsivity scoring along with PANAS scores. There was no raw data provided for impulsivity score analysis and again along with heart rate results this appears to have been abandoned (in this study) but has appeared in a separate study carried out at the same time by researchers from the same University while it appears to have been proposed and funded for this study. It is unclear if the impulsivity study by Wright (2011) was a part of AW1402A and if so it has not been included as part of this analysis.

In their rationale for method the researchers had indicated an attempt to collect behavioural data by direct observation and this was meant to be supported by video recording (Anon 2009). There are no recorded results of direct observation data and all behavioural analysis has been by video observation and unfortunately it did not adhere to the proposal blinding methodology. Direct observation of data is preferred to video observation and behaviour is often easier to observe and analyse live and in context rather than by watching it later on a screen. (Martin and Bateson 2007)

Researchers were unable to complete the follow up behavioural data analysis set out in their proposal. These components of the study proposal, methodology and analysis allowed the proposal to be stronger than the execution of the study.

Conclusion:

While the 9 criteria proposed for the study would have presented a clear and robust approach to the investigation of the welfare of animals in the study, the application of the proposal methods to the study appears to have affected the reliance of any conclusion made by this study.
The four acceptable criteria that have been used to investigate the welfare of e-collars on dogs have revealed that there is no significant effect of the e-collar on urinary cortisol levels, salivary cortisol levels, cognitive bias results or PANAS scores.

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