A REVIEW OF RECENT EVIDENCE IN RELATION TO THE WELFARE IMPLICATIONS FOR CATS AND DOGS ARISING FROM THE USE OF ELECTRONIC COLLARS

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16 November 2015

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1. SUMMARY

Background

The use of electronic collars (ECs) in cats and dogs is controversial because they deliver electrical stimulation as a means of discouraging the animal from an unwanted activity. This has raised concerns about possible adverse animal welfare implications. They are used for three broad purposes: as *training devices* where the collar is activated remotely by the handler, as *fencing systems* in which the device is activated when the animal reaches the designated boundary, and as *anti-barking devices* which are activated when a dog barks (CAWC, 2012).

There are over 170 different devices available for sale in the UK via the internet (Cooper et al, 2010) and it is estimated that between 300,000 and 560,000 devices may be in use (Blackwell et al, 2012; Pickwick, 2014). In a survey of dog owners in England, of 3897 respondents, 3.3% reported using ECs as training devices, 0.9% as fencing systems and 1.4% as anti-bark collars (Blackwell et al, 2012).

There are many different **dog training techniques**, but these are based on 'operant conditioning' in which an animal learns through forming an association between an action and its consequences (McLeod S, 2015). Reinforcement increases the likelihood of a behaviour occurring again, whilst Punishment decreases the likelihood of the behaviour recurring. The consequences can be positive (a reward or aversive stimulus is given) or negative (a reward or aversive stimulus is withdrawn)

This leads to an '**Operant Conditioning Quadrant'** comprising:

- **Positive Reinforcement (R+)**: Good behaviour (e.g. sitting on command or ignoring sheep) is rewarded by a pleasant consequence (e.g. praise, treat or game).
- **Negative Reinforcement (R-)**: Good behaviour is rewarded by the removal of an unpleasant stimulus (e.g. training a dog to walk to heel with a choke lead). This is 'avoidance behaviour' since the animal learns to avoid an aversive stimulus by changing its behaviour.
- **Positive Punishment (P+)**: Bad behaviour (e.g. chasing sheep, jumping up) results in an unpleasant consequence (e.g. electrical stimulus, shouting, or water spray)
- **Negative Punishment (P-)**: Bad behaviour results in a pleasant stimulus being withdrawn (e.g. owner ignores the dog, or removes treats).

Historically, dog training has relied heavily on techniques involving aversive stimuli (negative reinforcement and positive or negative punishment). More recently, increasing emphasis has been placed on reward-based training (positive reinforcement) (Blackwell & Casey, 2006, Pet Site, 2014) but some feel that 'the pendulum has swung too far' in favour of reward based training (ECMA, 2015a).

With all techniques, the action (aversive or reward) must be applied promptly so that the animal can associate its own behaviour with the consequence. Similarly the intensity of discouragement or reward must be sufficiently strong to make an emotional impact on the animal i.e. the unpleasant stimulus must be sufficiently unpleasant to cause the animal to try to escape from or avoid it (O'Heare, 2009), and the reward must be something that is highly valued (Blackwell & Casey, 2006).

Legislation. Under the Animal Welfare (Electronic Collars) (Wales) Regulations 2010, the use of electronic collars in cats and dogs is prohibited in Wales. The devices can be used legally in England and Scotland, although the Scottish Government is to undertake a public consultation this year (Lochhead, 2015). They are banned in eight other European countries and three Australian states.

This review uses the most recent relevant scientific evidence to set out the potential benefits and efficacy of electronic collars, and then considers animal welfare concerns, in order to reach conclusions about whether their benefits outweigh their animal welfare costs.

Efficacy

Efficacy as Training Devices. In the UK, when EC's are used as training devices, they are mainly used to improve a dog's recall or to discourage chasing of livestock, other animals or people (Cooper et al, 2010; Blackwell et al, 2012). The potential benefits are that a dog can be kept under control at a distance, and the method can be effective for any size or strength combination of dog and handler (Katz,2010). There is evidence that use of ECs can suppress predatory behaviour, including attacking a decoy person (Christiansen et al, 2001; Christiansen et al, 2001a; ECMA, 2011; CAWC, 2012; Salgirli, 2012).

However, in the studies by Christiansen et al, 2001, Christiansen et al, 2001a and Salgirli, 2012, the dogs also showed behavioural signs of pain. Even under optimum conditions, dogs trained with ECs displayed more negative emotional responses, than those trained by other methods, which were assessed as being equally effective (Cooper et al, 2014). Furthermore, other studies indicate that alternative training methods, mainly reward-based rather than dependent on harsh aversive stimuli, can be equally effective in pet and working dogs (Yin et al, 2008; Blackwell et al, 2012; Arnott et al, 2014).

Efficacy as Fencing systems. The potential welfare benefits which these systems offer are the safe access and enjoyment of a garden, along with protection of the animal from the hazards of roaming such as road traffic accidents (CAWC, 2012; ECMA, 2015). In relation to dogs, there are clear alternatives, such as construction of a physical boundary fence, ensuring that they are on leads in risky situations, combined with alternative approaches to training. It is much harder to protect cats from road accidents unless they are contained inside a building or enclosure, or supervised and kept on a long leash in the garden. A study by O'Neil et al, 2015 suggested that amongst cats under five years old, trauma (including road accidents) accounted for 47.3% of deaths. Unfortunately, there appears to be very little evidence relating to the animal welfare impacts of electronic fencing systems.

However, there are concerns regarding efficacy of these systems: they can fail through technical problems (CAWC, 2012), animals may learn to run through the 'fence' and then become trapped

outside (ASPCA, 2015), and other animals (not wearing ECs) can enter the contained area without receiving an electrical stimulus and cause injury or distress to the resident dog or cat (Katz, 2010).

Efficacy as Anti-bark devices. Persistent barking may be linked to a range of causes: it can be a warning of danger, a suspicious stranger, or a sign of excitement, boredom or anxiety (Foster and Smith, 2015). Correct assessment of the reason for excessive barking is considered crucial to successful treatment (Juarbe-Diaz, 1997).

Anti-bark collars were found to be effective at deterring barking stimulated by intermittent exposure to an unfamiliar dog (Steiss et al, 2007). However, they are contra-indicated for barking motivated by fear, anxiety or compulsion, where an EC is likely to exacerbate the problem by increasing the dog's anxiety (ASPCA, 2015).

Potential animal welfare concerns associated with electronic collars

Pain and Distress caused by Electrical stimuli. It is not easy to quantify or compare the level of pain perceived by an animal receiving an electrical stimulus via an EC. The strength of the stimulus is determined by the output of the device (voltage and current) and the electrical resistance offered by the animal's skin and underlying tissues. Ascertaining the stimulus actually applied to the animal is further confounded by the variable presence of hair, moisture and debris on the animal, which can affect the reliability with which electrical contact is made with the skin (Jacques and Myers, 2007). It is helpful that members of Electronic Collar Manufacturers Association follow a set of technical standards which specify electrical parameters (ECMA, 2012). Nevertheless, in experimental studies, considerable variation was found in the electrical resistance of dogs' skin and in the energy and electrical characteristics of stimuli produced by different models of EC (Lines et al, 2013). All these variables strongly suggest that an animal will not experience consistent and repeatable stimuli when undergoing training with an EC and this, in itself, is a welfare concern.

The degree of **pain** associated with particular stimuli has not been reported, although Riepl, 2012 considers that 'peak' current from the device is an important electrical feature in stimulation of nociceptors (pain receptors) in the skin. Lines et al, 2013 have developed a 'Stimulus Strength' ranking index. Nevertheless, the principle behind the use of ECs is that they produce an aversive stimulus, which is strong enough to dissuade 'problem' dogs from unwanted behaviours. Therefore, to be effective it must cause discomfort or pain, and this concept is implicit in the way that some products are advertised. For example, an electronic training collar (SportDOG SD-105S) available on the internet, is said to administer the 'high-intensity … attention-grabbing stimulation stubborn dogs need for correction' (SportDog , 2015), and the manual for another product (PAC EXT Exc4), refers to 'unpleasant, higher levels of stimulation' (PAC, 2015).

Most ECs can deliver different intensities of electrical stimulation, described as Low (corresponding to a prickle or tickle), Medium (prickling, jabbing or startling) and High (painful burning sensation) (ECMA, 2015a). The ECMA code of practice (ECMA, 2012a) explains how a 'minimum recognition level' corresponding to a 'prickle or tickle' should be determined and that the stimulation level should be progressively increased as necessary. Dogs are reported to have similar pain thresholds (the least pain a subject can recognise), but to show variation in their pain tolerance (the greatest level of pain it will tolerate), with 'emotionally sensitive' dogs having lower tolerance of pain (ECMA, 2015a).

Other potential welfare concerns are **pressure necrosis of the skin**, caused by electrodes of poorly fitted collars, or as a result of excessive periods of wear (ECMA, 2012a) and the risk of a dog or cat **chewing** an EC and ingesting harmful plastic and electronic components.

Potential for mis-use or abuse. Although ECMA manufacturers provide comprehensive instructions on the safe use of ECs (ECMA, 2012a), only some manufacturers which sell ECs in the UK are members of ECMA (Critchley A, 2015). Furthermore, a study by Cooper et al, 2010 shows that advice in user manuals is not consistently followed: some owners used high settings and had a poor understanding of how to use 'warning cues' which could allow an animal to avoid an electrical stimulus. 36% of owners reported their dogs vocalising on first use and 26% on subsequent uses. Many owners would not be sufficiently knowledgeable to assess the behavioural signs of distress shown by their animal (Jacques and Myers, 2007). Collectively this evidence suggests a substantial risk that some well-intentioned but inadequately informed operators will **deliver excessive electrical stimuli** whilst using ECs. Equally, there is clearly potential for misuse by frustrated, angry or malicious users of these devices.

Poorly timed stimuli, which the animal cannot consistently link to the target behaviour, can cause stress and behavioural problems (CAWC, 2012; Schalke et al, 2007). There is considerable potential for *Electronic training collar* operators to deliver mis-timed electrical stimuli, especially as some transmitters can be used to train up to 6 pets (PAC, 2015), and other models operate with dogs up to 2 miles away from the trainer (PAC, 2015). In relation to *electronic fencing systems* there is concern that, in the absence of a physical barrier, the animal might be unable to associate the aversive stimulus with the boundary (CAWC, 2012). ECMA, 2012a suggests that induction programmes for dogs and cats which include the use of a visual barrier (flags or fence) can minimise this risk. In relation to *anti-bark collars*, concerns have been raised that a dog might receive inappropriately timed electrical stimuli if the collar was activated by another dog or by extraneous noise, but others consider that technological advances mean that their activation is highly specific (CAWC, 2012, ECMA, 2012, Foster and Smith, 2015).

Antisocial behaviour. The use of ECs is thought to carry an increased risk of eliciting inappropriate behaviours such as *anxiety and aggression*, especially if the device is used repeatedly and at intensities which are too high in relation to the sensitivity of the animal (Blackwell and Casey, 2006, Jacques and Myers, 2007,CAWC, 2012). Others assert that the use of an EC to try and stop aggressive behaviour can *suppress the warning signs* displayed by a dog, making their aggression less predictable and more dangerous (MacKellar and Ward, 2010). Drawing on research in humans, Friedman, 2009, states that side effects of punishment-based procedures include increased aggression, generalized fear, apathy, and escape/avoidance behaviour. Others suggest that ECs can cause animals to make an *unwanted association* between aversive stimuli and another factor which happens to be present, such as a child, the trainer, or a location (such as a garden), leading to distrust or fear of the co-incidental factor. This could be a particular concern with electronic fencing systems, where electronic stimuli could potentially become associated with the approach of people or animals towards the property (MacKellar and Ward, 2010; Blackwell and Casey, 2006). If the animal was not contained by a physical barrier, this could lead to a dangerous situation for human or animal passers-by.

Welfare Cost *versus* **Benefit**.

I conclude that the animal welfare cost is likely to exceed the benefits from use of *electronic collars as training devices*, since they may cause pain, effective alternatives exist, and the scope for misuse or abuse is too great.

The animal welfare cost is likely to exceed the benefits from use of *electronic fencing systems* in dogs, since physical fences are an effective alternative, electronic fences cause pain, may fail, and there are welfare concerns if the animal does not associate the electrical stimuli with an invisible boundary. The situation appears more difficult in relation to cats, where the risk from road accidents is a big concern, and there are limited alternatives other than housing for keeping a cat confined. Nevertheless, there are some clear welfare concerns with electronic fencing for cats, and little published evidence from which to assess their relative impact.

Given the limited efficacy of *electronic anti-bark collars* in controlling excessive barking, the existence of alternative approaches, and that less harsh anti-bark collars (such as spray collars) are available, I conclude that the welfare cost exceeds the benefits for anti-bark collars.

2. INTRODUCTION

Electronic collars (ECs) are intended to aid the training of dogs and cats by delivering electrical stimuli to their skin. The stimuli are applied to discourage the animal from doing an undesired activity. The Companion Animal Welfare Committee (CAWC, 2012) defined three broad types:

- Devices operated remotely by the handler : "Remote trainers"
- Containment systems in which the animal receives an electrical stimulus if it reaches the boundary : "Underground fence systems"
- Noise-activated systems in which the animal receives an electrical stimulus if it vocalises : "Anti-barking collars"

The terminology for ECs is not standardised, and a number of alternative terms are used. These include, "electronic training collars" (Salgirli et al, 2012), "electronic training devices" (The Pet Site, 2014), "remote static pulse systems" (Cooper et al, 2011), "static pulse training collars" (ECMA, 2011), "electric pulse training aids" (CAWC, 2012), and "shock collars" (Kennel Club, 2014).

ECs are controversial because of concerns about potential adverse welfare implications for the animal concerned. The issue is complicated to assess as there is a wide range of devices on the market (over 170 were identified by an internet search in the UK in 2007 (Cooper et al, 2010)), and there is only limited peer-reviewed published evidence, supplemented by a range of testimonials (CAWC, 2012). Nevertheless, many people feel strongly about their use, with both advocates and opponents citing animal welfare as their main reason (CAWC, 2012; Scottish Government, 2015).

In a questionnaire survey of dog owners in England (Blackwell et al, 2012), of 3897 respondents, only 3.3% reported using ECs as remote trainers, 1.4% as anti-bark collars, and 0.9% as part of underground fence systems. However, extrapolation from the survey across the estimated UK dog population of 10 million, suggested that approximately 560,000 dogs might be trained with these devices. This figure is higher than indicated by Pickwick, 2014, who suggests that 'more than 300,000' devices were in use in the UK in 2012.

Training Techniques

There are many different dog training techniques, but these are based on 'operant conditioning' in which an animal learns through forming an association between an action and its consequences (McLeod S, 2015). Reinforcement increases the likelihood of a behaviour occurring again, whilst Punishment decreases the likelihood of the behaviour recurring. The consequences can be positive (a reward or aversive stimulus is given) or negative (a reward or aversive stimulus is withdrawn)

This leads to an '**Operant Conditioning Quadrant'** comprising:

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- **Negative Reinforcement (R-)**: Good behaviour is rewarded by the removal of an unpleasant stimulus (e.g. training a dog to walk to heel with a choke lead). This is 'avoidance behaviour' since the animal learns to avoid an aversive stimulus by changing its behaviour.
- **Positive Punishment (P+)**: Bad behaviour (e.g. chasing sheep, jumping up) results in an unpleasant consequence (e.g. electrical stimulus, shouting, or water spray)
- **Negative Punishment (P-)**: Bad behaviour results in a pleasant stimulus being withdrawn (e.g. owner ignores the dog, or removes treats).

Historically, dog training has relied heavily on techniques involving aversive stimuli (negative reinforcement and positive or negative punishment). More recently, increasing emphasis has been placed on reward-based training (positive re-inforcement) (Blackwell & Casey, 2006, Pet Site, 2014) but some feel that 'the pendulum has swung too far' in favour of reward based training (ECMA, 2015a).

With all techniques, the action (aversive or reward) must be applied promptly so that the animal can associate its own behaviour with the consequence. Similarly the intensity of discouragement or reward must be sufficiently strong to make an emotional impact on the animal i.e. the unpleasant stimulus must be sufficiently unpleasant to cause the animal to try to escape from or avoid it (O'Heare, 2009), and the reward must be something that is highly valued (Blackwell & Casey, 2006).

Legislation

Under the Animal Welfare (Electronic Collars) (Wales) Regulations 2010, the use of electronic collars in cats and dogs is prohibited in Wales. The devices can be used legally in England and Scotland, although the Scottish Government is to undertake a public consultation this year (Lochhead, 2015)) and a "Ten Minute Rule" Bill seeking a ban in England was presented to the House of Commons in Westminster in 2014 (Offord M, 2014). In Europe, their use is prohibited in Austria, Denmark, Finland, Germany (CAWC, 2012), Switzerland (Tierschutzverordnung ,2008), Norway, Sweden and Slovenia (Kennel Club, 2014). They are banned in some Australian states (Australian Capital Territory, New South Wales, and South Australia) (RSPCA Australia, 2015) and are only permitted under prescribed circumstances in Victoria – notably if they conform to prescribed technical specifications and are fitted by a veterinary practitioner or a qualified dog trainer (Victorian Government, 2015). Similarly in New Zealand, minimum standards for the use of electric or electronic collars are set out in a code of welfare for dogs (New Zealand Government, 2015).

This review focuses mainly on scientific evidence published since 2010, but older references are cited where these refer to key information which is not date-dependent, or where there are no more recent studies. Its purpose is to help inform decision making in Wales, in relation to whether the policy intent – protection of animal welfare - continues to be well-served by measures currently in place under The Animal Welfare (Electronic Collars) (Wales) Regulations 2010. The report sets out evidence of the potential benefits and efficacy of electronic collars, and then considers potential animal welfare concerns, in order to reach conclusions about whether their benefits outweigh their animal welfare costs.

3. WELFARE BENEFITS AND EFFICACY OF ELECTRONIC COLLARS

WELFARE BENEFIT

Proponents argue that If electronic collars (ECs) are used successfully, they provide long-term welfare benefits which off-set any short –term pain and distress during the training period (ECMA, 2015a). However, according to CAWC, 2012, there are no independent data to substantiate either the tendency to use ECs only for a short period of time, or that their impact is only aversive in the short term. Thirty six per cent of 188 respondents to a questionnaire survey commissioned by CAWC, said that they had used the electronic training device for one month or less, but 16% were still using them after one year (CAWC, 2012).

EVIDENCE OF EFFICACY AS TRAINING AIDS

Electronic training systems comprise an electronic collar and a separate transmitter which can be activated remotely by the trainer. The collar has two electrodes which are designed to make contact with the skin on the underside of the dog's neck. When activated, an electrical stimulus travels between the electrodes through the skin and superficial tissues of the neck (ECMA, 2015a).

In the UK, when ECs are used as training devices, they are reported mainly to be used to improve a dog's recall or discourage chasing of livestock, other animals or people (Cooper et al, 2010; Blackwell at al, 2012). The potential benefits include that a dog can be kept under control at a distance, so allowing safe off-lead exercise, and that the method can be effective for any size or strength combination of dog and handler (Katz, 2010). Other animals may also experience consequential benefits, for example lack of aggression towards livestock, wildlife and other animals, which might otherwise be chased or predated (CAWC, 2012). However, in CAWC's questionnaire survey of electronic collar users, 11% of respondents reported failure of ECs due to "technical problems" such as when batteries became exhausted or when animals were out of range or in woodland (CAWC, 2012).

There is published evidence suggesting that electronic collars can be effective training aids, if used correctly. This includes two Norwegian studies which suggest that sheep- chasing behaviour can be suppressed in some animals over an extended period. In an initial study, 41 Elkhounds, 29 Harehounds and 68 English Setters (all hunting breeds) were introduced into a test area with sheep. 32% of Elkhounds, 7% of Harehounds and 3% of Setters attempted to chase sheep and received an electric current as a deterrent. The dogs showed signs of pain in response to the electrical stimuli, which included jumping, head-shaking and vocalisation. The electrical stimulus comprised a single pulse of 1 second duration, of 0.4 Amps at 3,000 volts, which was applied to dogs approaching within 1-2 metres of sheep, and which was re-applied over a period of up to 5 minutes, if the dog did not withdraw, or re-entered this zone. In a follow-up study, one year later, only one dog which received a current in the first study, required this form of treatment (Christiansen et al, 2001; Christiansen et al, 2001a).

CAWC (2012) reviewed the peer-reviewed literature published up to 2012, and concluded that there were significant limitations, particularly relating to the complexity of experimental design, lack of control animals, and a tendency for authors to over-interpret their data. Despite these shortcomings, CAWC concluded that electronic training devices can suppress predatory behaviour,

may suppress barking in response to a triggering stimulus, but that if the stimulus is applied so that it is not associated with the unwanted behaviour, then this can cause behavioural and welfare problems. A further issue in interpretation of older publications is that the electrical output parameters of the ECs were not consistently documented, and may not be directly comparable to modern ECs. Earlier models of EC were more aversive than current ECs due to less sophisticated, higher energy electrical stimulation. The spacing of the electrodes was also wider than currently permitted under ECMA technical requirements. This meant that for older devices, the electrical impulse travelled through skin and muscle, whereas with new devices, the impulse travels a shorter distance through skin and superficial tissues. The stimulation of deeper structures is thought to be more painful (ECMA, 2015a).

In a German study, 42 police dogs of the Malinois breed, were tested using three different 'punishment-based' methods, on individual training days, held one week apart. In these sessions they were corrected by the use of either, an electronic collar, or a pinch collar (a collar with internal prongs), or a 'quitting signal' (a learned command to withdraw such as a word or whistle), if they sought to attack a decoy person. The effectiveness and relative stress levels resulting from these three approaches was assessed (Salgirli et al, 2012). They concluded that the electronic collar was the most effective, with 39 of 42 dogs ceasing the undesired behaviour by the end of the test, and the quitting signal was least effective (3/42). They recorded that 42% of dogs lowered their backs, 33% crouched and 59% vocalised in response to stimulation of the electronic collar. The size, duration and voltage of the current applied via the EC is not specified, and neither is the amount and duration of training of the 'quitting signal'. The differences in salivary cortisol levels were not statistically different between any of the tests, but the behavioural signs reported following use of ECs are indicative of distress.

In a survey of members of the Training Collar Owners Group, of the 371 respondents, 95% reported that use of an EC solved behavioural problems such as chasing animals or people, nuisance barking or escaping from the garden. Ninety seven per cent of respondents said that their dog or cat was 'happy with' or 'neutral' regarding use of an EC, and 96% reported no negative effects. The members of this group were acknowledged to be likely to be a biased sample in respect of the effectiveness and negative effects of ECs (ECMA, 2011).

Other training methods

It is extremely difficult to make an objective assessment of the relative effectiveness of different training methods. This is because of the many variables which may apply. These include: breed differences, variation in severity of undesired behaviours in individual dogs, differences in competence of trainers, in the duration and commitment to training, and /or in their perception of success (Blackwell et al, 2012).

A study by Cooper et al (2014) attempted to address this difficulty by controlling for trainer and method of training. 63 pet dogs referred for recall related problems around livestock, were assigned to one of three training regimes. Group A were trained by trainers approved by the Electronic Collar Manufacturers Association who used ECs, Group B were trained by the same trainers but without ECs, and Group C were trained using reward-based techniques by members of the Association of Pet Dog Trainers, UK, a professional training organisation which does not allow the use of ECs or other aversive techniques or equipment.   The dogs received two 15 minute training sessions per day for 5

days, apart from 2 dogs (one from group A and one from group B) where the trainers deemed that sufficient progress had been made after 4 days. On the final training day, all the dog owners conducted training under instruction from the trainers.

Video recordings of the sessions were made to analyse behaviour. Dogs in Group A yawned more, were more tense, and interacted less with their environment than dogs in Group C. A small number of dogs in Group A also yelped and panted frequently. The authors concluded that these observations indicated more negative emotional responses in dogs in Group A, than in those in Group C. Only small differences in behaviours were noted between dogs in Groups A and B indicating that the trainer's general approach affects the dog's emotional responses. Following training, 92% of owners reported improvements in their dog's referred behaviour, and there was no significant difference in response to training between the three groups.

There are well-established reward-based training methods which do not use harsh aversive stimuli. In the UK, reward-based training is used for assistance dogs (Blackwell and Casey, 2006; Guide dogs for the Blind, 2015), and according to Offord, (2014), police dogs, armed forces dogs and assistance dogs are never trained using electric shock training devices. This is significant, given the high standards to which such animals must be trained. Reward-based training is also the norm for gun dog training, where ECs are a 'technique of last resort' (Cook, 2008). In a survey of dog owners, statistical analyses suggested that reward based methods were less likely to be used by owners who had attended agility classes (Blackwell et al, 2012). This is puzzling since the organisers of the majority of agility competitions, the UK Agility Association and the Kennel Club are strongly opposed to aversive training methods : electric collars are prohibited from all UK Agility show sites (UKA, 2014) and the Kennel Club has consistently campaigned for a ban in England and Scotland (Kennel Club, 2014).

A study by Yin et al (2008) in America demonstrated that a reward-based training protocol was effective in training dogs with existing problem behaviours, such as barking, jumping or crowding the door when visitors arrived. Six dogs were trained by professional trainers in a controlled laboratory environment, and 15 dogs were trained at home by their 'novice' owners. The protocol, in which the dog was rewarded with a food treat for the desired behaviour, taught dogs to remain calmly on a rug, away from the door when visitors arrived. A very high degree of success was achieved with both groups, which were composed of mixed breeds, but the training process in the laboratory study was achieved more rapidly (in eight days), than in the home environment (between two and 16 weeks). The authors concluded that an important reason for the difference, was the greater competence of professional dog trainers who carried out the laboratory-based study, compared with owners who were inexperienced trainers.

In a questionnaire based study of dog owners in the United Kingdom, a significantly higher proportion of owners using reward-based training reported successful outcomes in relation to recall and chasing behaviours, than those using ECs (Blackwell et al, 2012).

In Australia, an online survey of farm dog keepers was administered for three months during 2013. Eight hundred and twelve respondents submitted details for 1,806 currently working dogs, 864 recently rejected dogs, and 1,357 recently retired dogs. Statistical analyses identified seven factors which were significantly associated with successful canine training. These were: dog breed, housing

style, participation in working dog trials, age at acquisition, use of electronic collars, hypothetical upper limit that owners might be prepared to spend on veterinary treatment, and conscientiousness of the owner. In relation to electronic collars, 93% of respondents did not use these, but those who did use them were significantly more likely to have 'below average' success rates when training their dogs (Arnott et al, 2014).

Collectively this evidence strongly suggests that reward-based training is an effective alternative to aversive training techniques such as ECs. This is also the view of ten UK animal welfare, dog training and animal behaviour organisations, which published a joint statement calling for a ban on the use of electronic training devices, in favour of, "kinder, more humane reward based methods" (The Pet Site, 2014). The organisations involved are The Royal Society for Prevention of Cruelty to Animals, Association of Pet Behaviour Counsellors, Blue Cross, Dogs Trust, Wood Green Animal Charity, Battersea Dogs and Cats Home, Animal Behaviour and Training Council, The Mayhew Animal Home, The UK Association of Pet Dog Trainers and The Kennel Club. However, the Electronic collar Manufacturers Association (ECMA, 2015a) considers that these campaigns are 'exaggerated and emotionalised'.

The use of ECs has been advocated as a technique of last resort, to be used for exceptional cases where all else has failed (CAWC, 2012; Cook, 2008.). The Electronic collar Manufacturers Association (ECMA) states that wherever possible, reward based training methods should be used, but maintains that ECs constitute a valuable training aid to address the antisocial behaviours of problematic dogs, so saving many animals from the more drastic options of re-homing or euthanasia They cite the large numbers sold (almost 50,000 purchasers in the UK per year) as proxy evidence of the efficacy of the devices (ECMA, 2015). However, the American Humane Society asserts that even for 'difficult' dogs, aversive collars suppress the unwanted behaviour, but don't teach the animal what the proper behaviour is. They conclude that, at best, they are unpleasant for the dog, and at worst, they may cause it to act aggressively (Humane Society, 2015). Blackwell et al (2012) thought that a more considered approach, with a deeper understanding of learning theory and dog behaviour would enable an ultimately more successful resolution of undesired behaviour.

EVIDENCE OF EFFICACY OF ELECTRONIC FENCE SYSTEMS

 Electronic fence systems use an electrical stimulation to discourage a dog or cat from moving outside a defined boundary. The pet wears an electronic receiver collar with contact points that rest on the underside of its neck, and if it strays beyond the boundary set by the transmitter, it will receive an electronic stimulation. Some devices have multiple levels of electrical stimulation as well as audible and /or vibratory warning signals to alert the animal as it approaches the boundary. With wired boundary systems, wires are buried just below ground to set the perimeter, which can be any shape. Wireless systems are portable and create a circular boundary (PetSafe, 2015).

The potential welfare benefits which these systems offer are the safe access and enjoyment of a garden, along with protection of the animal from the hazards of roaming such as road traffic accidents (CAWC, 2012; ECMA, 2015). In relation to dogs, there are clear alternatives, such as construction of a physical boundary fence, ensuring that they are on leads in risky situations, combined with alternative approaches to training.

However, in regard to cats, unless contained inside a building or enclosure, or secured under supervision by a long leash, it is much harder to protect them from road accidents, predation or other trauma. In an on-line questionnaire survey completed by 188 EC users in the UK, 92 percent used them with dogs, and 8 per cent with cats. Amongst the small sample relating to cats, ECs were used for containment to protect the cat from road accidents or to prevent impact on neighbours. Of the reported usage in dogs, 30% related to containment and 65% for obedience training (CAWC, 2012).

It is extremely difficult to determine the number of cats involved in road accidents, since these events are not compulsorily notifiable in the United Kingdom. Feline Friends, a cat welfare charity, estimates that between 250,000 and 300,000 cats are involved in road accidents each year in the UK (Feline Friends, 2013). In a study of 4,009 deceased cats, which were randomly selected from all deaths in 118,016 cats attending 90 veterinary practices in England, it was found that whilst the average lifespan of cats is 14 years, trauma (of all types – not just road accidents) was the most common overall cause of mortality, accounting for 12.2% of deaths. However, amongst cats, under five years old, trauma accounted for 47.3% of deaths (O'Neil et al, 2015).

Concerns about the risk of road accidents led to the launch of a petition which has attracted 457 signatures, entitled, 'Save Welsh Cats & Dogs from Death on the Roads' which seeks re-instatement of invisible fencing systems as a legal option in Wales (Anon, 2012). Feline Friends has recommended that electronic containment systems should be used where cats live in proximity to a public road, as a means of reducing the risk of traffic accidents. They cite a successful 'trial' in which owner observations were recorded following the introduction in 2009 of an underground fencing system ('Dogfence') in the garden of her two cat household. The charity has also funded a research project by Mills et al on the welfare aspects of containment systems, which is underway (Feline Friends, 2013).

However, it is clear that electronic fencing systems can fail. In the questionnaire survey (CAWC, 2012), respondents reported technical problems such as failure of the collar to make contact with the animal's neck, batteries becoming exhausted, or breaks occurring in the boundary wire. Some devices have indicators for 'low battery' or 'wire break', which should help mitigate the latter two problems (PetSafe, 2015).

Animals sometimes learn to run through an electronic fence (ASPCA, 2015), and can then become trapped outside the place of safety. Conversely, other animals (not wearing ECs) can enter the 'contained area' without receiving an electrical stimulus, and could injure or cause distress to the resident dog or cat (Katz, 2010).

EVIDENCE OF EFFICACY AS ANTI-BARK DEVICES

Barking is a normal method of communication in the domestic dog, but if a dog barks excessively, this can be considered to be a problem behaviour (Juarbe-Diaz, 1997). Dogs which bark persistently can constitute a 'statutory nuisance' under the Environmental Protection Act, 1990 if they disturb local residents, with a successful conviction resulting in a fine or imprisonment.

Barking may be linked to a range of causes: it can be a warning of danger or a suspicious stranger, a sign of excitement when playing, a sign of boredom, or can occur in anxious dogs experiencing separation anxiety (Foster and Smith, 2015). Correctly assessing the motivation behind a dog's excessive barking is crucial to the implementation of successful treatment (Juarbe-Diaz, 1997).

Anti-bark collars are activated when a sensor detects sound and vibration caused by a dog's bark. When triggered they deliver a disruptive or unpleasant stimulus. These can be: electrical stimuli, citronella or lemon- scented spray, a high pitched ultrasonic noise or vibration. In relation to collars which deliver electrical pulses, the stimulus is delivered to the dog's skin via two electrodes and there may be multiple levels of stimulation intensity (PetSafe, 2015a; Dogtra, 2015).

Anti-bark collars are not recommended as a first choice for dealing with a barking problem. This is especially true for barking that's motivated by fear, anxiety or compulsion, where aversive approaches are likely to increase the dog's anxiety and make the problem worse (ASPCA, 2015). In these situations, behaviour modification achieved through rewarding desired behaviours, introducing distractions (such as music or activity toy), and modifying exercise routines, are usually advocated. Before owners use an anti-bark collar, some advisers in the United States of America recommend seeking advice from a certified veterinary behaviourist or professional dog trainer (ASPCA, 2015; Foster and Smith, 2015).

In a four week study of dogs housed in a rescue shelter in the USA, both electric pulse and lemon-spray anti-bark collars proved effective at deterring barking stimulated by intermittent exposure to an unfamiliar dog. Plasma cortisol levels were not significantly different between either of these groups or compared with those of control dogs fitted with inactivated collars. The activity levels (measured by counting movements of a paw across gridlines on the floor) did not vary significantly over time in any of the groups, although the lemon-spray group was significantly less active than the controls throughout the study. The long—term effectiveness of anti-bark collars was not assessed (Steiss et al, 2007).

4. POTENTIAL ANIMAL WELFARE CONCERNS ASSOCIATED WITH ELECTRONIC COLLARS

Pain and Distress caused by an electronic stimulus

Electronic pulse collars are designed to apply an unpleasant electrical stimulus to an animal in order to discourage it from an undesired activity. According to manufacturers' guidance, with some systems it is possible for the owner to change the 'correction level' according to the needs of the individual dog. Stimulation can be momentary or continuous for less responsive dogs (Petsafe, 2015; Dogtra, 2015).

In a study of 13 ECs, representing nine brands, considerable differences were identified in the **duration** of the electrical stimuli given by different models. The 'momentary' stimulus lasted between 4 and 420 milliseconds (4 to 120 mS for ECMA endorsed brands), whilst the maximum duration of the 'continuous' stimulus varied from 7 to 13 seconds (7 to 13 seconds for ECMA endorsed brands), although in one model (a non-ECMA brand) the stimulus lasted over 60 seconds, presumably because there was no cut-out (Cooper et al, 2010). A cut-out function seems important to avoid over-stimulation of the animals, and in the most recent ECMA technical specifications, the maximum permitted stimulation times for remote trainers, electronic fences and anti-bark collars are 10, 15 -30 and 2 seconds, respectively. There is then a period of 5 seconds for remote trainers and electronic fences, and 2 seconds for anti-bark collars, before another stimulus can be applied. For electronic fencing systems, a 'lock-out' function lasting 60 seconds or until the animal is back inside the boundary is required (ECMA, 2012). These standards only apply to manufacturers which belong to ECMA, and from the author's experience in reviewing EC's available for purchase on the internet, as well as seeking to access the ECMA website (www.ecma.eu.com) , it is not always easy for potential customers to identify which products are ECMA-compliant.

The physical strength of an electrical stimulus, and thus the intensity with which it may be perceived is determined by the *voltage* (V) and *current* (I) generated by the device and the *resistance* (R) in the electrical circuit. These three are related according to Ohm's law : V=I x R. Hence a high resistance in the circuit, would be expected to be associated with a current delivered at high voltage (Cooper et al, 2010).

Resistance. When a stimulus is applied, the electrical circuit is completed by passage of current through the animal's skin and underlying tissues which offer electrical resistance (measured in Ohms). The size and separation of the electrodes affect the resistance (Jacques and Myers, 2007), with Riepl, 2013 suggesting that the greater the spacing of the probes, the greater the resistance offered by the skin. Lines et al, 2013a, suggest that this is unlikely to be a linear relationship. In their study (Lines et al, 2013; Cooper et al 2010), modelled the resistance of skin and subcutaneous tissues, using a collar with electrodes spaced 30 mm apart; they found wide variation in their measured values, even on the same dog, but overall, skin resistance was lower (4-150kOhm) for wet dogs than dry dogs (22 – 950 kOhm). Riepl, 2013 suggests two mechanisms by which moisture might reduce skin resistance. If the moisture is at the interface between the electrodes and the skin, then the resistance would be reduced and the current flow would increase through the skin, causing increased electrical stimulation of the animal. Alternatively, if there is sufficient water on the skin surface, current from the electrodes could be shunted through it, partly bypassing the skin and

reducing electrical stimulation. The latter hypothesis was supported by ECMA's studies using ECs on human volunteers with wet skin (Reipl, 2013). Other dog-related factors, such as the length of the dog's coat, the presence of dirt or debris and the reliability of the electrical contact with the skin also affect the degree of stimulus perceived by the animal (Jacques and Myers, 2007).

Current. Acccording to Riepl (2013), the physiological effects of electric current are twofold: heating of tissue, and electrical stimulation of nerve and muscle cells. In studies by ECMA involving human volunteers, they concluded that the heating from modern ECs is 'inconsequential' due to low 'root mean square' current outputs, and that stimulation of nociceptors (pain receptors) in the skin is linked to 'peak' current. The ECMA technical guidelines specify a limit in 'peak' current output of 150mAmperes per single impulse of current applied into a fixed resistance of 500 Ohm (ECMA, 2012). It is not clear how this correlates with the level of 'peak' current which would pass through a dog, where the resistance might vary from 4kOhm to 950 kOhm, according to Cooper et al 2010 (see above).

Voltage. ECs produce electrical stimuli which comprise rapid sequences of short, complex, high voltage pulses. The maximum voltage is generated for only a few millionths of a second per voltage pulse, and its magnitude is dependent on the resistance of the animal's skin. The maximum voltages recorded for different ECs by Cooper et al, 2010 varied considerably at all the voltages they measured. Nevertheless, - due to the complex shape and variable frequency of the pulses - they concluded that a simple voltage measurement was not an adequate means of quantifying the strength of electrical stimulus.

Power. By integrating the voltage and current over a set period of time, the power (i.e. energy (measured in Joules) dissipated per second) can be calculated. This has been reported to be a better measure of stimulus strength than voltage (Cooper et al, 2010). The power, measured using the worst case value for resistive loads between 500 Ohm and 100 KOhm must not exceed 500mJoules per second in ECMA endorsed ECs (ECMA, 2012). However, in the study (Cooper et al, 2010) of 13 ECs, of which 7 were ECMA brands, considerable differences were identified in the electrical energy output of different models, with the energy dissipated by ECs at their most powerful setting being overall 81 times greater than when at their lowest setting (median figure). The results for ECMA brands in relation to non-ECMA brands were not presented. The strongest ECs in the study, when set to their highest level, delivered 1161 mJoules per second (measured at 50 kOhm), exceeding the ECMA standard for this parameter. For comparison, the authors report that an electric fence and the M26 Taser typically deliver 5000 and 30,000 mJoules per second respectively (Cooper et al, 2010).

However, Lines et al, 2013 developed a **stimulus strength ranking index** (SSRI) which indicates that dissipated energy levels, also correlate poorly with level of perceived pain. The SSRI was developed on the assumption that electrical stimuli such as those provided by ECs would be ranked similarly by humans and dogs. SSRI values for the 13 EC models they tested, varied between models, and also highlighted that the strength of stimuli from ECs in 'continuous' mode was higher than perceived when in 'momentary' mode.

Conclusion: It is not easy to quantify or compare the level of pain or discomfort perceived by an animal receiving an electrical stimulus via an EC. The strength of the stimulus is determined by the

output of the device (voltage and current) and the electrical resistance offered by the animal's skin and underlying tissues. Ascertaining the stimulus actually applied to the animal is further confounded by the variable presence of hair, moisture and debris on the animal, which contribute to the difficulty of ensuring that the EC electrodes make consistent, reliable electrical contact with the skin. It is helpful that members of ECMA follow a set of technical standards which specify electrical parameters (ECMA, 2012). Nevertheless, in experimental studies, considerable variation was found in both, the electrical resistance of dogs skin, and, in the energy and electrical characteristics of stimuli produced by different models of EC. All these variables strongly suggest that an animal will not experience consistent and repeatable stimuli when undergoing training with an EC.

The degree of pain associated with particular stimuli has not been reported, although Riepl, 2012 considers that it correlates with 'peak' current from the device, and Lines et al, 2013 have developed a Stimulus strength ranking index. Nevertheless, the principle behind the use of ECs is that they produce an aversive stimulus, which is strong enough to dissuade 'problem' dogs from unwanted behaviours. Therefore, to be effective it must cause discomfort or pain, and this concept is implicit in the way that some products are advertised. For example, an electronic training collar (SportDOG SD-105S) available on the internet, is said to administer the 'high-intensity … attention-grabbing stimulation stubborn dogs need for correction' (SportDog , 2015), and the manual for another product (PAC EXT Exc4), refers to 'unpleasant, higher levels of stimulation' (PAC, 2015).

Most ECs can deliver different intensities of electrical stimulation, described as Low (corresponding to a prickle or tickle), Medium (prickling, jabbing or startling) and High (painful burning sensation) (ECMA, 2015a). The ECMA code of practice (ECMA, 2012a), which advises its members on suitable content for inclusion in User Guides, explains how a 'minimum recognition level' corresponding to a 'prickle or tickle' should be determined and that the stimulation level should be progressively increased to effect. Dogs are reported to have similar pain thresholds (the least pain a subject can recognise), but to show variation in their pain tolerance (the greatest level of pain it will tolerate), with 'emotionally sensitive' dogs having lower tolerance of pain (ECMA, 2015a).

In addition to welfare concerns in relation to electrical stimulation, the ECMA code of practice, 2012a recognises the risk of **pressure necrosis of the skin**, caused by electrodes of poorly fitted collars, or as a result of excessive periods of wear. ECMA members are required to address this potential issue in their user guides, and include advice on how it can be avoided.

Another potential hazard relates to the risk of a dog or cat **chewing** a companion's EC. Its plastic and electronic components could cause harm if ingested. This risk is presumably greater with anti-bark collars and electronic fence systems, where animals may be left unattended.
Modern, ECMA-approved cat containment systems incorporate receivers which are attached to 'breakaway' type collars (ECMA, 2012a). This is clearly helpful in mitigating the risk if a cat were to become **entangled** by its collar on a branch or other object.

Potential for mis-use or abuse

There are two key animal welfare concerns regarding mis-use or abuse of ECs. These relate to the risk of animals receiving:

a) Excessive (number and/or magnitude) of electrical stimulations, and
b) Poorly timed electrical stimuli, not consistently linked to the target behaviour

Excessive (number and/or magnitude) electrical stimulations

In the study by Cooper et al, 2011, in which one of three groups of dogs was trained by ECMA-approved trainers using ECs, the authors concluded that, whilst this represented best practice in relation to use of ECs, they still detected behavioural evidence of a negative impact on the welfare of some dogs. In a related study (Cooper et al, 2010) found that the instruction manuals gave varying levels of information, and did not always explain the full potential of the devices, for instance with respect to using warning functions such as 'tone' or 'vibrate'.   They also undertook a questionnaire study of owners recruited to their trial, and found that advice in manuals was not reliably followed. Sixty eight per cent of owners purchased their EC new, mainly from the internet, but some used second-hand ECs, sometimes without user manuals. Owner reports suggested they were unclear on how best to use them, with 36% reporting dogs vocalising on their first use and 26% on subsequent uses. Some used high settings and had a poor understanding of how to use the 'warning cues', which could enable the dog to avoid an electrical stimulus. The ECMA Code of Practice, 2012, requires its manufacturers to provide comprehensive and valid advice about their correct use, but the study by Cooper et al, 2010 shows that such advice is not consistently followed, and it is also the case that not all manufacturers which sell in the UK are members of ECMA (Critchley A, 2015).

There are also individual differences between dogs in their responses to aversive stimuli, so that a low level stimulus which appears to be well tolerated in one animal may have a very different impact on another. This may be difficult for an EC user to assess, if they are unaware of the subtleties of canine communication signals (Jacques and Myers, 2007).

Collectively, this evidence suggests that some well-intentioned but inadequately informed operators will deliver excessive electrical stimuli whilst using ECs. Equally, there is clearly potential for misuse by frustrated, angry or malicious users of these devices.

Poorly timed electrical stimuli, not consistently linked to the target behaviour

The rationale behind use of aversive training techniques, such as ECs, is that the animal will associate the unpleasant stimulus with an unwanted behaviour, and will be inclined to stop it. For this to be successful, it is essential that the animal can associate the stimulus with a specific action (Blackwell and Casey, 2006). If the stimulus is applied so that it is not associated with the unwanted behaviour, then this can cause behavioural and welfare problems (CAWC, 2012). In a seven month study to assess the effect of ECs on stress parameters, 14 laboratory – bred beagles were divided into three groups which received electrical stimuli under different circumstances. Group A received a stimulus if they touched a 'dummy prey'; Group H received one if they disobeyed a previously trained recall command, and Group R received stimuli at random. Groups R and H showed a significant rise in salivary cortisol levels, with group R showing the highest levels. The authors concluded that dogs which could associate their action (touching the prey) with the electronic stimulus, showed no persistent stress. They considered that the stress exhibited by dogs in the other two groups was evidence that poor timing or inappropriate use of electric stimuli carries a high risk that dogs will show severe and persistent signs of stress (Schalke et al (2007). It is unfortunate that no behavioural assessment for signs of stress was reported.

A study by Deldalle and Gaunet, 2014 compared the signs of stress displayed by pet dogs attending training classes using different approaches to teaching dogs to sit and walk on a lead. Dogs given reward-based training showed more attentiveness to their owner, whilst those trained by negative re-inforcement (withdrawal of an aversive stimulus) showed signs of stress including lowered body postures.

In relation to **electronic training collars**, there is clearly the potential for untrained users to deliver mis-timed electrical stimuli. There are currently numerous models available for sale via the internet, and many of these can be used to train multiple pets - at least 6 (PAC, 2015)- with a single transmitter. In my view, this must increase the risk of an electronic stimulus being accidentally applied to the wrong dog. This risk would be further increased with models of EC which operate over an extended range – at least up to two miles (PAC, 2015) - at which distance, the animal would almost certainly be out of sight.

In relation to **electronic fencing systems,** there is a concern that, in the absence of a physical barrier, the animal might be unable to associate the aversive stimulus with the boundary (CAWC, 2012). There appears to be very little recent scientific evidence on the welfare impacts this might cause, particularly on cats. The ECMA code of practice,2012 offers guidance on how to minimise the problem, advising on induction programmes for dogs and cats which includes the use of a visual barrier (flags or fence) and, for dogs only, a 'warning' signal which allows the animal to avoid the electronic stimulus.

In relation to **anti-bark collars**, concerns have been raised that a dog might receive inappropriately timed electrical stimuli if the collar was activated by another dog or by extraneous noise, but CAWC, 2012 considered that technological developments should be able to ensure that inappropriate activation does not occur, and the ECMA code of practice (2012) states that such collars are only activated by the bark of the dog wearing the collar. Foster and Smith, 2015 support this view, asserting that because the devices are dependent on detecting vibration of the dog's vocal cord prior to initiating a corrective stimulus, their activation is highly specific.

Antisocial behaviour

In a survey of owners of 2,806 dogs which were relinquished to the Dogs Trust for rehoming between January and December 2005, the most common reason for relinquishments was 'problematic behaviour' (including aggression and destructive tendencies) which accounted for 34% of cases. The Dogs Trust provides advice for prospective dog owners, but for those obtaining their dog from elsewhere, the number who received advice before obtaining their dog was reported to be low, leading the authors to conclude that in some cases, insufficient thought may lead to an inappropriate choice of dog in relation to their owner's lifestyle. Under these circumstances, dogs are thought likely to be left alone for protracted periods, and to receive insufficient exercise, which in turn could lead to the development of behavioural problems (Diesel et al, 2010).

It has been suggested that electronic collars may cause antisocial behaviour in dogs through making them nervous or aggressive (Blackwell and Casey, 2006). Much aggressive behaviour by dogs is triggered by anxiety, and aversive training techniques are thought to precipitate such responses if

too strong an aversive stimulus is applied in relation to the sensitivities of the individual animal (Jacques and Myers, 2007). CAWC, 2012 also concluded that use of ECs carried an increased risk of eliciting inappropriate behaviours such as aggression, especially if the device is used repeatedly and the animal is highly aroused and in a negative affective state. In relation to anti-bark collars, some consider that these are contra-indicated for dealing with some barking problems. This is especially true for barking that's motivated by fear, anxiety or compulsion, where aversive approaches are likely to increase the dog's anxiety and make the problem worse (ASPCA, 2015).

Others assert that the use of an EC to try and stop aggressive behaviour can suppress the warning signs displayed by a dog, making their aggression less predictable and more dangerous (MacKellar and Ward, 2010). Drawing on research in humans, Friedman, 2009, states that teachers, psychologists, parents and children consistently rate positive reinforcement-based procedures for behavioural interventions as more acceptable than punishment-based procedures, citing known side effects of punishment-based procedures to include increased aggression, generalized fear, apathy, and escape/avoidance behaviour in support of this opinion.

There are also concerns about the risks of ECs causing animals to make an unwanted association between aversive stimuli and another factor which happens to be present. This could be a child, or the owner, or location (such as a garden) and could lead to distrust or fear of the co-incidental factor. This could be a particular concern with electronic fencing systems, where electronic stimuli could potentially become associated with the approach of people or animals towards the property (MacKellar and Ward, 2010; Blackwell and Casey, 2006). If the animal was not contained by a physical barrier, this could lead to a dangerous situation for human or animal passers-by.

5. CONCLUSIONS

The use of electronic collars in dogs and cats is controversial, with both advocates and opponents citing animal welfare as their main concern (CAWC, 2012; Scottish Government 2015).

Electronic collars are intended to be used either as remotely controlled training devices (dogs), or as electronic fencing systems (dogs and cats) or as anti-barking devices. The recent published evidence confirms to varying degrees, that they can be effective in suppressing unwanted behaviour under certain circumstances. However, there are also clear potential welfare concerns with the use of these devices. These are: the inherent need to administer electrical stimuli to the animal which are likely to cause varying degrees of discomfort or pain, and the potential for mis-use or abuse. The latter could lead to the administration of excessive electrical stimulation and / or poorly timed stimuli which could cause additional distress to an animal if it was unable to link the stimuli with a specific behaviour. The published evidence reviewed in this report also suggests that under most circumstances, alternative approaches which avoid the need for harsh aversive stimuli can be equally or more effective than electronic collars.

There is a moral and welfare obligation to use the least harmful way of effecting behavioural change in animals. In America, the principle of 'Least Intrusive Minimally Aversive' interventions has been known for over 40 years. A more recent refinement, the 'Least Intrusive Effective Behaviour Intervention' algorithm acknowledges that aversive interventions are not necessarily required and that any interventions which are made must be carefully considered in order to ensure that they are effective (O'Heare, 2009).

In the United Kingdom, the use of procedures for training animals is covered by the Animal Welfare Act 2006, which requires owners and keepers to ensure that they meet the welfare needs of their animals. However, if such procedures were to be applied to animals for a 'scientific purpose', they would be regulated under the Animals (Scientific Procedures) Act 1986 (ASPA). I have been advised that under these circumstances, application of electric shock to an animal would be considered to have the potential to cause the 'animal a level of pain, suffering, distress or lasting harm equivalent to, or higher than, that caused by the introduction of a needle in accordance with good veterinary practice', As such, this would only be permitted under licence, which would only be granted if the severity, duration etc. of the shock could be balanced against the likely benefits of the scientific research. Other commonly used aversive training techniques such as shouting or squealing when a puppy bites, or spraying a small quantity of water when a dog lunges on a lead, would be unlikely to require a licence (Home Office, 2015). This distinction is helpful as it indicates that types of aversive treatments can be differentiated, and some are less harsh than others.

Does the evidence currently available support the decision to ban the devices for training purposes?

In the UK, when EC's are used as training devices, they are mainly used to improve a dog's recall or to discourage chasing of livestock, other animals or people (Cooper et al, 2010; Blackwell et al, 2012). The potential benefits are that a dog can be kept under control at a distance, and can be effective for any size or strength combination of dog and handler (Katz,2010). There is evidence that use of ECs can suppress predatory behaviour, including attack of a decoy person (Christiansen et al, 2001, Christiansen et al, 2001a, CAWC, 2012 and Salgirli, 2012).

However, there is also evidence, that even when ECs are used under optimum conditions, that dogs trained with ECs displayed more negative emotional responses, than those trained by other methods, which were assessed as being equally effective (Cooper et al, 2014). Furthermore, other studies indicate that alternative training methods, mainly reward-based rather than dependent on harsh aversive stimuli, can be equally effective in pet and working dogs (Blackwell et al, 2012, Arnott et al, 2014).

Whilst ECs sold by members of the ECMA trade association conform with ECMA-defined technical standards and are supplied with comprehensive instruction guides (ECMA, 2012 and ECMA 2012a), not all manufacturers which sell devices in the UK are members of ECMA (Critchley A, 2015). In a study of 13 ECs (of which 7 were ECMA brands), considerable variation was found in the electrical output and duration of stimuli. Measurements of the electrical resistance offered by a dog's skin also showed considerable variation (Cooper et al, 2010), and other factors such as the length of the dog's coat, its wetness, the presence of dirt or debris and the reliability of the electrical contacts with the skin (Jacques and Myers, 2007) also affect the size of stimulus it receives. These variables contribute to the difficulty in assessing the level of pain or discomfort perceived by an animal wearing an EC, and raise concerns about the consistency achievable from use of these devices under everyday conditions.

Nevertheless, the principle behind the use of ECs is to produce an aversive stimulus which is strong enough to dissuade 'problem' dogs from unwanted behaviours. ECMA, 2012a recommends that a minimum recognition level, corresponding to a 'prickle or tingle' should be determined for each individual, and that the stimulation level should be progressively increased to effect. Therefore, to be effective it must cause pain or discomfort, and this concept is implicit in the way that some products are advertised. For example, an electronic training collar (SportDOG SD-105S) available on the internet, is said to administer the 'high-intensity … attention-grabbing stimulation stubborn dogs need for correction' (SportDog , 2015), and the manual for another product (PAC EXT Exc4), refers to 'unpleasant, higher levels of stimulation' (PAC, 2015). Whilst behavioural indicators of pain caused by ECs in earlier studies might reflect the harsher nature of early models of ECs, more recent studies such as the report by (Salgirli, 2012) in which 59% of dogs vocalised, and by Cooper et al (2014) in which dogs trained with ECs yelped and panted, indicate that use of modern ECs also causes pain and stress in animals.

There are significant concerns about the potential for misuse of ECs. A study by Cooper et al, 2010 showed that advice in user manuals was not consistently followed by users, and it may be very difficult for an inexperienced user to assess the emotional impact of a stimulus on a dog from its behavioural responses (Jacques and Myers, 2007). If the stimulus is applied so that it is not associated with the unwanted behaviour, then this can cause behavioural and welfare problems (CAWC, 2012, Schalke et al, 2007). There are currently numerous models available for sale via the internet, and many of these can be used to train multiple pets - at least 6 (PAC, 2015) - with a single transmitter. In my view, this must increase the risk of an electronic stimulus being accidentally applied to the wrong dog. This risk would be further increased with models of EC which operate over an extended range – at least up to two miles (PAC, 2015) - at which distance, the animal would almost certainly be out of sight. Collectively, this evidence suggests that some well-intentioned but inadequately informed operators will deliver excessive or mis-timed electrical stimuli whilst using

ECs. Equally, there is clearly potential for misuse by frustrated, angry or malicious users of these devices.

The EC has been advocated as a training technique of last resort (CAWC, 2012; Cook, 2008) to save problematic dogs from the more drastic options of rehoming or euthanasia (ECMA, 2015). However, there is real difficulty in defining what might constitute the 'last resort' where an EC might be the only effective solution, and there is a concern that one person's 'last resort' would be another person's 'second attempt'.

I therefore conclude that the animal welfare cost is likely to exceed the benefits from use of electronic collars as training devices, since effective alternatives exist, and the scope for misuse or abuse is too great.

Does the current evidence available support the ban on the use of electronic collars with invisible fence systems?

Electronic fencing systems are intended as an alternative or a supplement to a physical fence. The animal triggers an aversive electrical stimulus from its collar if it crosses the boundary. In the absence of a physical fence, there is a clear welfare concern that an animal could fail to associate the stimulus with a consistent cause (CAWC, 2012). There are also risks relating to potential misuse, such as damage to the skin (pressure necrosis) from the electrodes, if the collar is left on the animal for long periods (ECMA, 2012a), or, accidental use of excessive levels of electrical stimulation.

Dogs. There is little published evidence (particularly in cats) on the welfare impacts. However, a well maintained physical fence, and the use of a lead for risky situations, would appear to be a highly effective alternative for dogs. I conclude that the animal welfare cost is likely to exceed the benefits from use of electronic fencing systems in dogs.

Cats. The situation appears more difficult to determine for cats, where the risk from road accidents for those living in proximity to roads, is a real concern (O'Neil et al, 2015; Feline Friends, 2013). Other than keeping it indoors, or restrained under close supervision on a long leash, there are no obvious alternatives for confining a cat than the use of an EC.

Nevertheless, there are some clear welfare concerns with electronic fencing for cats, and little published evidence from which to assess their relative impact. Gaps include evidence on the speed, ability and reliability with which cats could learn to comply with electronic invisible fencing systems, and the degree of pain or discomfort they would typically experience during this process. There is also no published independent evidence (as far as I am aware) on whether ECs (even with break-away fastenings) constitute a significant risk for cats of entanglement on tree branches or other objects.

Does the current evidence available still support a ban on the use of these devices when being used as anti-bark collars?

Persistent barking may be linked to a range of causes: it can be a warning of danger, or a suspicious stranger, or a sign of excitement, boredom or anxiety (Foster and Smith, 2015). Correct assessment of the reason for excessive barking is crucial to successful treatment (Juarbe-Diaz, 1997).

Anti-bark collars were found to be effective at deterring barking stimulated by intermittent exposure to an unfamiliar dog (Steiss et al, 2007). However, they are contra-indicated for barking motivated by fear, anxiety or compulsion, where an EC is likely to exacerbate the problem by increasing the dog's anxiety (ASPCA, 2015). In these instances, behaviour modification through rewarding desired behaviours, introducing distractions and modifying the dog's exercise routine, is the preferred approach (Foster and Smith, 2015).

Electronic anti-bark collars carry the same welfare concern as other ECs in relation to the risk of delivering a painful electronic stimulus to the animal. There is also a risk relating to potential damage to the skin (pressure necrosis) from the electrodes, if the collar is left on the animal for long periods (ECMA, 2012a). However, technological developments appear to have eliminated the risk that they can be activated inappropriately by extraneous noise (Foster and Smith, 2015, ECMA, 2012a, CAWC, 2012).

Given the limited efficacy of anti-bark collars in controlling excessive barking, the existence of alternative approaches, and that less harsh anti-bark collars (such as spray collars) are available, I conclude that the Welfare cost exceeds the benefits for anti-bark collars.

What evidence exists to demonstrate that they might induce behaviours that are not normally consistent with a well socialised dog or cat?

Aversive stimuli are intended to cause an animal to take action to escape or avoid them. Intrusiveness of the aversive stimulus is defined by the degree to which it causes harm. At worst, highly intrusive approaches cause generalised problematical emotional behaviour such as fear, anxiety, aggression or injury, whereas less intrusive procedures such as a surprising noise, will not (O'Heare, 2009). Electronic collars used at Low or Medium intensity of stimulation would not be expected to cause a negative emotional impact (ECMA, 2015a).

According to ECMA, 2015a, even at High intensity settings, the emotional impact would last only a short time. However, others have suggested that electronic collars may cause antisocial behaviour in dogs through making them nervous or aggressive, especially if used repeatedly (Blackwell and Casey, 2006; CAWC, 2012). Others believe that ECs can suppress the warning signs of aggression which a dog usually displays, so making their behaviour less predictable and more dangerous (Mackellar and Ward, 2010). A further concern is that, whilst ECs may suppress unwanted behaviour, they do not teach the animal what the acceptable alternative behaviour is (Humane Society, 2015).

Another worry is that ECs could cause animals to make unwanted associations between adverse stimuli and another co-incidental factor, such as presence of the owner, a child, or a location, leading to distrust or fear of that person or situation. This might be a particular issue, with stimuli

from an electronic fence system, where people or animals approaching the property might be put at risk (Blackwell and Casey, 2006; Mackellar and Ward, 2010).

There is also comparative evidence from research in humans about effecting behaviour changes which reports side-effects of punishment-based procedures to include increased aggression, generalised fear, apathy and escape or avoidance behaviour (Friedman, 2009).

A general conclusion is that successful training of dogs, requires considerable time and effort. The Welsh Government's Code of Practice for the Welfare of Dogs (2008), explains the steps required of a dog owner or keeper, in order to ensure that its welfare needs are met, as required by the Animal Welfare Act 2006. Unfortunately, in a survey of people who had relinquished dogs to rehoming centres, the number who had received advice before obtaining their dog was reported to be low, leading the authors to conclude that inappropriate choice of dog in relation to their owner's lifestyle might lead to the development of behavioural problems (Diesel et al, 2010). Therefore, strong and accessible guidance from Government, pet re-homing organisations and breeders on the need for new owners to consider if they have the required skills, time, premises and commitment needed to care for a pet, might help to reduce the number of animals which develop problem behaviours. Likewise for those seeking to adopt 'rescue' animals which are reportedly most often relinquished to re-homing centres because of serious behavioural issues (such as separation anxiety, persistent barking, aggression and poor recall) (Diesel et al, 2010. In reality there is unlikely to be any 'quick fix' for such conditions, which can only be resolved through a lot of effort, time, appropriate housing, and possibly also, costly input from veterinary surgeons and experts in dog training and behaviour.

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