© 2007 Universities Federation for Animal Welfare
The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

Animal Welfare 2007, 16: 435-447
ISSN 0962-7286

The effect of the kennel environment on canine welfare: a critical review of experimental studies

KD Taylor and DS Mills*

Animal Behaviour, Cognition and Welfare Group, Department of Biological Sciences, University of Lincoln, Riseholme Park, Lincoln, LN2 2LG, UK
* Contact for correspondence and requests for reprints: dmills@lincoln.ac.uk

Abstract

Dogs can be held temporarily or permanently in kennels for a number of reasons, not necessarily for their own benefit. Although restrictive environments have been associated with poor welfare, priorities for research and change cannot be understood unless the various aspects of the kennel environment are appreciated separately. This review critically evaluates the experimental research regarding the physical, social, sensory, occupational, nutritional and psychological aspects of the kennel environment and their effects on canine welfare, with a view to providing a consolidated report on our current state of knowledge on this subject. However, the lack of within-dog, single manipulations and a focus on quantitative measures affects the ability to make valid conclusions about the welfare benefits of several aspects, including social housing, kennel size and location. Despite these criticisms, the evidence for the positive benefits of group housing is strong. There is also considerable evidence for the benefits of positive human contact particularly on sociability and stress responses in other situations. Surprisingly few studies have looked at other forms of enrichment and even less have considered the potential for the kennel to be over-stimulating in an auditory, olfactory and visual sense. Such topics are suggested as priorities for further research, in addition to ways of minimising aggression in group housing and the effect of establishment of predictability on adjustment to kennelling.

Keywords: *animal welfare, assessment, dog, kennel, quality of life, shelter*

Introduction

Domestic dogs are held in temporary or permanent confinement for a variety of reasons; re-homing, treatment, human or animal-related research, teaching, breeding, service work and assistance training. Whilst research dogs are bred for this purpose (Wells 2004a), dogs held in re-homing shelters were usually once pets, even if only briefly. Dogs held in kennels for the purposes of work or training for work may have been bred for the role (Pfaffenberger 1963) or sourced from shelters or owners who no longer want them (Crespo 2001). Despite the variety of reasons for containment of these dogs, and differences in their genetic and environmental background, the situations in which they are held are often similar. For the purposes of practicality, expense and standardisation, the kennel environment is usually restricted in size and complexity and may involve limited contact with other dogs, humans and the outside world. Until recently, the standard laboratory environment constituted single housing with only auditory contact with other dogs and contact with humans limited to daily cleaning and research procedures (Hetts 1991). Now group housing is more common and consideration for exercise, play and socialisation is made (see Loveridge 1998; Mikkelsen & Ottesen 2004). However, single housing still features heavily within the rescue shelter environment, partly out of increased concern about aggression and transmission of disease (Wells 2004a).

Efforts are made on the part of the canine charities, research institutions and governmental organisations to improve conditions for kennelled dogs. However, it is appreciated that without rigorous evaluation of the effect of the kennel environment on the welfare of dogs, priorities for change and the effectiveness of implementations will not be known (Hetts 1991). One aspect of this involves the periodic review of current knowledge. This review was therefore designed to answer the question, 'what do we know about the effects of the kennel environment on the welfare of dogs?' There are a number of aspects of the kennel environment that might impact on the welfare of the animal contained within it, including the space provided and opportunities for environmental and social stimulation. Information on the effects of these is best gained through studies that have manipulated one or more of them under experimental conditions or have made comparisons between housing systems. The extent to which such studies have provided useful information about the impact of various aspects of the kennel environment on canine welfare will be discussed in the context of their use of appropriate welfare measures. In particular, aspects of the environment where information is particularly lacking will

be highlighted so that priorities for further research can be identified. The review began initially with a PubMed® search using the terms 'dog' or 'canine' and; 'welfare', 'behaviour', 'kennel', 'shelter' and 'measure'. The various aspects of the kennel environment were grouped as Rochlitz (2005). Her review grouped the housing requirements of domestic cats in terms of the physical, social, sensory, occupational and nutritional environment, which appears to make intuitive sense. However, one other aspect of the kennel environment deserves review and this is the psychological aspect, namely provision for control and predictability, which are increasing concerns for confined animals (Sambrook & Buchanan-Smith 1997).

The physical environment

Space

Current guidelines for cage sizes for medium-sized dogs in research institutions are 4.5 m^2 for dogs housed singly and 2.25 m^2 per dogs held in groups (4.5 m^2 minimum, HMSO 1989). Cage sizes for dogs held in rescue shelters have been reported to be slightly greater than this, between 5 and 6 m^2 (Wells & Hepper 1992, 1998, 2000, 2001; Wells *et al* 2002a, b; Wells 2004b; Graham *et al* 2005a,b, Tod *et al* 2005). However, sizes much smaller (1 m^2, Hennessey *et al* 1997, 1998, 2002a,b) and larger (14 m^2, Mertens & Unshelm 1996) have also been reported. A number of studies have looked at the effects of cage size on dogs (Newton 1972; Neamand *et al* 1975; Hite *et al* 1977; Pettijohn *et al* 1980; Campbell *et al* 1988; Hughes *et al* 1989; Hughes & Campbell 1990; Clark *et al* 1991; Hetts *et al* 1992). No effect of varying cage sizes was reported on measures of health and fitness (Newton 1972; Hite *et al* 1977; Clark *et al* 1991), aggression (Pettijohn *et al* 1980) or on physiological indicators of stress such as cortisol or immune function (Neamand *et al* 1975; Hite *et al* 1977; Campbell *et al* 1988; Clark *et al* 1991). Dogs held in kennels are commonly reported to spend the majority of their time inactive (Hughes *et al* 1989; Hughes & Campbell 1990; Hetts *et al* 1992; Hubrecht *et al* 1992; Wells & Hepper 1992; Hubrecht 1993; Beerda *et al* 1999; Yeon *et al* 2001; Meers *et al* 2004). Most of the studies that looked at activity levels have also failed to report an increase in activity with increasing cage size (Neamand *et al* 1975; Hite *et al* 1977; Campbell *et al* 1988; Bebak & Beck 1993). Regardless of cage size or access to a large run, dogs have been reported to spend only 0.5 to 1.5 hours a day in activity (Hughes & Campbell 1990). This finding has led some to suggest that dogs are lazy (Hughes & Campbell 1990) and smaller cages pose no adverse effects on welfare (Newton 1972; Hite *et al* 1977; Hughes & Campbell 1990). However, in the majority of the studies the cage sizes were very small, 1 m^2, with relatively little increase in the larger size (2 m^2 in Hite *et al* 1977, Campbell *et al* 1988 and Hughes *et al* 1989, 3 m^2 in Neamand *et al* 1975, 7 m^2 in Beback & Beck 1993, 8 m^2 in Newton 1972). These changes may therefore have made no appreciable difference to the dog (Hubrecht *et al* 1992; Hubrecht 1995a). In addition, less than five dogs were compared across treatments in four of the nine studies reviewed (Newton 1972; Neamand *et al* 1975; Campbell *et al* 1988; Hughes *et al* 1989). Given the likelihood of variation between individuals in activity levels, sample sizes of this magnitude may have been unlikely to have detected a significant difference.

Clark *et al* (1991) and Hetts *et al* (1992) reported on the same study that compared the physiology and behaviour of dogs in various cages ranging from less than 1 m^2 to a 54 m^2 outdoor run. Clark *et al* (1991) reported no change in physiology, but Hetts *et al* (1992) reported that dogs spent more time moving and less time in repetitive behaviours in the larger pens. Hughes and Campbell (1990) noted that dogs in a 7 m^2 run travelled a distance of over 4,000 m per day compared to 500 m in a standard 1 m^2 cage. However, there was no change in time spent in locomotion, suggesting that larger cages may encourage the dogs to trot or run (Hughes & Campbell 1990; Hubrecht *et al* 1992). Therefore, larger kennels might improve welfare as defined as species normal behaviour by allowing the dog to use more gaits (Hubrecht *et al* 1992). Some studies have found that dogs in smaller cages are more active (Hite *et al* 1977; Hughes *et al* 1989; Hetts *et al* 1992; Hubrecht *et al* 1992). However, this could be due to the dogs in smaller cages performing stereotypies (Hetts *et al* 1992) or competing for space (Hughes *et al* 1989). The lack of qualitative measurement may therefore limit many of the studies' ability to make conclusions about welfare since the quality of the activity is also important (Hubrecht 1995a). Other possible explanations for the apparent lack of effect of cage size on activity is that dogs are more likely to be active if stimulated (eg by toys or the presence of other dogs or humans; Hubrecht 2002) or that perceived inability to roam inhibits motivation to be active. Increased activity during periods of human activity such as feeding and cleaning times (Neamand *et al* 1975; Hughes *et al* 1989; Hetts *et al* 1992) may support the former hypothesis. The finding that dogs held on 3 m long tethers were as inactive as those held in pens (Yeon *et al* 2001) does not help distinguish between these competing hypotheses.

Outdoor access

Studies that have compared indoor and outdoor access are complicated by simultaneous provision of greater space (see above) and group housing (see below) (Clark *et al* 1991; Hetts *et al* 1992; Hubrecht *et al* 1992; Mertens & Unshelm 1996; Beerda *et al* 1999). In the absence of singular comparisons it is impossible to determine how outdoor access *per se* affects the welfare of the dog. Dogs in rescue shelters often have access to a small amount of both, and increasingly so do laboratory dogs (Hubrecht 2002). Generally, provision of outdoor access is associated with a decrease in stereotypy (Hetts *et al* 1992; Beerda *et al* 1999) and sometimes an increase in activity or pace (Hughes & Campbell 1990; Hetts *et al* 1992; Hubrecht *et al* 1992). By their very nature, outdoor and/or group housing may also increase the physical complexity of the kennel environment. Hetts *et al* (1992) and Mertens and Unshelm (1996) found that dogs outdoors investigated and

© 2007 Universities Federation for Animal Welfare

manipulated their environment more than indoors, possibly because there were more items with which to interact (sticks and stones, odours of other dogs). Hubrecht *et al* (1992) and Mertens and Unshelm (1996) also reported more ground sniffing in group-housed dogs.

Kennel furniture

Most kennels provide the dog with bedding, a dog bed (Eisele 2001) and some division of living areas (Hubrecht 2002; Hafen 2005). However, aside from this, and largely for practicality reasons, their environment can be bare (Hubrecht 1995a). Hubrecht (1995a) drew attention towards a mismatch between a species that tends to range, hunt and scavenge for food and life inside such a barren environment. Nonetheless, more complex additions to the kennel may be costly and need to be defended by evidence of an effect on their welfare. However, there have been few controlled studies into the effect of kennel enrichment on dog welfare. Wells and Hepper (2000) found that moving the dog's bed to the front of the cage made the dog more likely to be at the front even though the dog's activity was not altered. The direct welfare implications of being at the front of the kennel are not clear but, Wells and Hepper (2000) suggest that doing so may indirectly increase their welfare by facilitating their adoption. This assertion was based on evidence that visitors reported dogs at the front of cages to be more attractive than ones at the back (Wells & Hepper 1992; Wells 1996). Perhaps as a result, more dogs were re-homed during this period than the equivalent period the previous year (Wells & Hepper 2000), but a causal link cannot be assumed on the basis of this work.

The provision of kennels may make the dog feel more secure (Hubrecht 1995a) and are often used by dogs living outdoors (Hubrecht *et al* 1992). Platforms also increase the physical complexity of the environment and provide vantage points (Hubrecht 2002). Raised platforms were used by young dogs 55% of the time and after two months the dogs were rated as more confident, friendly and playful than previously (Hubrecht 1993). However, although platforms and kennels have been advocated (Feldhaus 1980; Hubrecht 2002; Hafen 2005) their welfare effects have not been studied in controlled experiments. The use of an area approximating a living room has been advocated on the basis that it might provide some respite from the barren kennel, provide a more realistic setting for assessment of the dog's behaviour and enable the dog to remain, or become, familiarised to a typical household environment (Tuber *et al* 1999). The use of such a room for 30 minutes a day was reported to increase the sociability of puppies more than a similar period of contact conducted within the kennel (Tuber *et al* 1999). But the effectiveness of such a tool in preventing behaviour problems in the new home or reducing stress levels whilst still in the shelter has not been assessed. In addition, although sheltered cats are increasingly being held in rooms that represent mini living rooms (Taylor personal observation 2005) the permanent provision of a similar environment for dogs may be less practical.

Social environment

Intra-specific contact

Due to practical considerations and concerns about transmission of diseases and the increased likelihood of aggressive encounters, dogs are often housed singly, particularly within rescue shelters (Tuber *et al* 1999; Wells 2004a). However, they are social animals (Fox 1978) and even feral dogs will naturally congregate into social groups (Boitani *et al* 1995). Social affiliation within primates has been shown to be one of the most powerful modulators of the stress response (Sapolsky 1994). It has been suggested that keeping dogs in groups offers them the opportunity to satisfy a biological need for physical exercise and for social contact with conspecifics (Sonderegger & Turner 1996). Many have therefore proposed that the welfare of dogs could be improved if they are group-housed (Hetts 1991; Hubrecht *et al* 1992; Hubrecht 2002; Wells 2004a).

An increased risk of behavioural abnormalities when housed singly has been observed (Hetts *et al* 1992; Hubrecht *et al* 1992; Mertens & Unshelm 1996; Beerda *et al* 1999). This is particularly apparent if dogs are isolated from a young age (Thompson *et al* 1956; Fuller & Clark 1966; Scott 1980). Studies have reported that singly-housed dogs were more likely to circle repetitively (Hubrecht *et al* 1992; Beerda *et al* 1999), vocalise (Hetts *et al* 1992; Mertens & Unshelm 1996; Beerda *et al* 1999) and self groom (Hetts *et al* 1992; Beerda *et al* 1999). Almost complete absence of stereotypies has been reported in group-housed dogs (Hubrecht *et al* 1992; Hubrecht 1993; Mertens & Unshelm 1996). In addition, Mertens and Unshelm (1996) reported that group-housed, sheltered dogs were more active, less aggressive, were quicker to re-home and showed less behaviour problems in the new home. Given that the size of the kennels in this study for the singly-housed dogs was relatively large (14 m^2) it might suggest that social housing has greater welfare benefits than provision of space. This suggestion is also supported by the findings of Hetts *et al* (1992). Their study has, to date, been the only properly controlled within-dog study, which involved laboratory beagles.

Displaced aggression towards another individual may provide an outlet for frustration caused by the otherwise psychologically stressful environment (Sapolsky 1994). High levels of aggression have been reported in groups of kennelled dogs (Feddersen-Petersen 2001; Bruno 2004), but other studies have reported low aggression during group housing or group exercise (Pettijohn *et al* 1980; Mertens & Unshelm 1996; Sonderegger & Turner 1996; Shyan *et al* 2003). In most of these situations the aggression was mainly ritualised and did not escalate. Aggression has also not been reported to increase when housed in groups in smaller pens (Pettijohn *et al* 1980; Bebak & Beck 1993) although it appears that in larger cages, dogs naturally spaced themselves further apart (Bebak & Beck 1993). Feddersen-Petersen (2001) found evidence that, in comparison with wolf packs, some breeds of dogs such as poodles, retrievers

and pugs were unable to co-operate, compete or establish and maintain rank order in a group situation. As a result they were not successful in removing a threat and aggressive encounters escalated. This suggests that there might be breed differences that might limit the dog's ability to socialise within a group. This might be related to differences in signalling ability between breeds arising from differences in morphology (Goodwin *et al* 1996).

Early assessment of the dog's ability to socialise and integrate successfully with other dogs in a holiday shelter upon initial entry into a group was found to be possible by Sonderegger and Turner (1996). Such a procedure could potentially be used more widely in facilities using group housing to identify individuals at risk of poor integration so that significant welfare problems are averted and additional assistance provided when appropriate. However, it should be noted that in this study, animals with a history of biting other dogs were excluded before the assessment was made, which provided an additional safeguard. Similarly, unsociable dogs were excluded in the study of Mertens and Unshelm (1996), so the true risk of aggression during integration cannot be determined from these studies as they are inevitably an underestimate of the prevalence of the problem. The high level of aggression observed in the shelter in Bruno (2004) was probably due to severe overcrowding, with 100 dogs to a 7 × 20 m (length × breadth) cage. All male cages were the most aggressive (Bruno 2004). An appropriate mixture of males and females and the removal of females in oestrus may help reduce aggression and excessive attention towards females (Mertens & Unshelm 1996; Sonderegger & Turner 1996). Elevated, but mild, aggression may also be observed in young dogs (Pettijohn *et al* 1980; Hubrecht 1993). Competition for food may increase aggression (Pettijohn *et al* 1980), but the effect of *ad libitum* feeding on this is not known.

Sonderegger and Turner (1996) suggest that keeping dogs in very large groups (50–100 individuals as in their study) prevents the formation of social hierarchies and the agonistic behaviour that this would create. However, the dogs in the shelter studied by Mertens and Unshelm (1996) were in smaller groups (approximately 30 individuals, which is closer to wolf pack size). They attributed the lack of aggression to turnover of dogs as they were returned to their owners, which may also serve to prevent the formation of social hierarchies. By contrast it could be argued that large groups or lack of social hierarchies are unstable and would be expected to increase aggression. The mechanism by which turnover or large group size may serve to reduce aggression is therefore not fully understood, nor their relative effectiveness. Pair housing may be seen as a compromise to group housing since no difference in time spent active or interacting with the other dogs has been observed between pair or group housing (Hughes *et al* 1989; Hughes & Campbell 1990; Hubrecht 1993). But the presence of humans may increase activity, (Hughes *et al* 1989). Interestingly, in Mertens and Unshelm (1996) and Sonderegger and Turner (1996) the outdoor, group situation allowed for greater contact with humans, who were able to spend more time walking through the pens, checking on the dogs and preventing fights. Perhaps as a result, both authors reported an increased attraction towards humans in the dogs over time. Thus, other dogs do not appear to be simply a substitute for human contact, and it is increasingly recognised that dogs appear to have developed a unique selective attention and attachment tendency towards humans (Topál *et al* 2005).

Singly-housed dogs are reported to show attraction towards each other, for example, by standing on their hind legs to look over walls and by spending more time at the front of the kennel when another dog is in the kennel opposite (Wells & Hepper 1998). As a result, in the absence of group housing, the ability to hear or see other dogs has been suggested to be a form of enrichment (Wells 2004a). However, behaviours that may be related to attempts to access other dogs may become stereotypical, for example, wall bouncing or rearing (Hubrecht *et al* 1992) and fence-pacing (running alongside another dog within a next door run; Hetts *et al* 1992; Hubrecht *et al* 1992). In addition, dogs are sensitive to the sound of other dogs barking and may be stimulated to bark themselves (Adams & Johnson 1994; Ledger *et al* 1996), suggesting that this behaviour is socially facilitated. Wells and Hepper (1998) did not report reduced barking in dogs with visual access to others, in fact, Solarz (1970) reported increased frequency of barking in dogs with visual access to others. These findings suggest that, as has been recently suggested for another social species, visual and auditory perception of a conspecific without the opportunity to physically interact might actually be very frustrating (McAfee *et al* 2002; Mills & Davenport 2002). Therefore Wells' (2004a) recommendation that singly-housed dogs should at least have visual access to conspecifics, whilst made with the best intentions, deserves further study, particularly in light of concerns about noise levels in kennels, see below.

Inter-specific contact

Despite the fact that in shelters and laboratories dogs are confined under the close care and observation of humans, direct contact with them is often very limited (Hubrecht 2002). This may have important welfare implications since there is considerable evidence that the presence of humans can be both stimulating and calming and that even laboratory dogs are attracted to humans. Evidence that dogs are stimulated by human presence include the studies of Neamand *et al* (1975); Hughes *et al* (1989) and Hetts *et al* (1992) where periods of human activity were correlated with increased dog activity. Campbell *et al* (1988) found that dogs would only be stimulated to be active during exercise time in the presence of other humans. Wells and Hepper (2000) reported that dogs were more likely to stand near the front of the cage and bark during busy visiting periods. Hubrecht *et al* (1992) found that shelter dogs were more likely to stand compared to laboratory dogs and attributed this to increased human contact in these environments. Sales *et al* (1997) and Ledger *et al* (1996) also reported that barking increased with human activity.

© 2007 Universities Federation for Animal Welfare

Evidence specifically for attraction towards humans can also be found within the kennel situation. Sonderegger and Turner (1996) reported that, upon entering a group-housing situation, female dogs tended to remain near the handler rather than investigate the other dogs. One week after admittance to the group-housing situation both sexes showed an increased attraction towards the handler. In fact, some studies suggest dogs may value human company over other dogs and that this may be a more important form of enrichment (Tuber *et al* 1999; Wells 2004a). In Pettijohn *et al* (1977) separation distress in puppies was alleviated more in the presence of a human than another dog, food or toys. During a novel room test, Tuber *et al* (1996) found that dogs were more likely to maintain proximity and solicit attention when their human caretaker was present compared to their kennel mate. However, these findings may reflect increased attraction to the human due to their comparative, non-frightening novelty, the association with the caretaker with food or the possibility that the human may engage the dog more then its kennel mate (acknowledged in Pettijohn *et al* 1997) and/or in different ways (eg stroking) rather than an inherent preference for one over the other. In fact, properly controlled preference tests similar to those conducted in farm animals have been rarely reported for dogs (Hubrecht 1995a).

Even short periods of contact with humans may make the dog more sociable, more emotionally stable and less fearful towards humans at other times (Hennessy *et al* 2002a). This effect has been reported, in particular, when the dog is still developing (see Serpell & Jagoe 1995 for review; Boxall *et al* 2004). Human contact may also be important in the alleviation of pain and stress-related behaviour and physiology (see McMillan 1999) and may provide a mechanism for helping kennelled dogs cope with stress (Hennessey *et al* 1998). Petting can reduce heart rate, after an initial rise upon greeting (see Lynch & Gantt 1968; Kostarczyk 1992) and can be used as a reward in conditioning (Kostarczyk 1992). Odendaal and Meintjes (2003) observed a significant drop in blood pressure and an increase in a range of positive-affect related biochemicals during a short petting session.

There appears to be evidence that petting by humans may prevent an acute, negative stress response rather than ameliorate it. For example, Tuber *et al* (1996) found that a decrease in plasma glucocorticoid levels occurred during a novel room test when the human was in the room, but not in the presence of another dog. Both Odendaal and Meintjes (2003) and Hennessey *et al* (1997, 1998) found that petting for 20 minutes prevented a rise in cortisol following a stressful event (blood sampling). However, petting did not reduce plasma cortisol levels below the levels of dogs that had not been petted first (Hennessey *et al* 1997, 1998) or significantly reduce cortisol levels below baseline (Odendaal & Meintjes 2003). In another study, dogs not provided with supplementary human interaction showed an increase in plasma cortisol levels during a battery of tests in the rescue shelter, compared to those that had received such a programme (Hennessey *et al* 2002b). There is also little evidence that short periods of contact alter the behaviour of dogs at other times. Increased, minimal contact with humans did not change behaviour, including activity levels, significantly at other times (Hughes & Campbell 1990; Hubrecht 1993; Hubrecht 1995b), although in the latter two studies there was evidence that the dogs with human contact showed expectant or frustrated behaviour at other times (a small increase in repetitive behaviour and time spent on hind legs or standing looking out of pen). Similar findings were seen after cessation of a walking programme (Meers *et al* 2004).

Sensory environment

Visual

The effect of the visual environment *per se* on kennelled dogs has not received much scientific attention. Lack of visual contact with other dogs and humans has been listed as a cause of stress in kennelled dogs (Hanson *et al* 1976; Hennessy *et al* 1997, 1998; Beerda *et al* 1999). However, as mentioned above, there may be legitimate concerns that provision of visual, in the absence of physical, access may be over-stimulating, facilitate barking and/or be a source of frustration to the dog. The extent to which visual access to humans may also be detrimental to the welfare of the dogs, particularly for fearful dogs in shelters during visiting times, has not been fully explored. Two studies suggest that dogs may be initially aroused and attracted towards the human visitors but over time become withdrawn; spending more time at the back of the kennel (Wells *et al* 2002a) or reacting to them with less interest (Wells & Hepper 1992). However, how much of this change in behaviour reflects psychological withdrawal or learning that they cannot gain physical access to the humans is not yet known.

Although dogs often have access to two views, indoors and outdoors, the effect of this provision is not known, nor how this might be improved upon. Hubrecht (1995a) pointed out that occupants can often view all areas of their pen without moving, another reason which might account for inactivity in these environments. Increasing the complexity of kennel may therefore not only provide more physical interest for the dog but encourage exploration *per se* because the dog cannot view all aspects of the kennel at once. Platforms have been suggested as devices that might also add another vantage point for the dog (Hubrecht 2002), but as already mentioned have yet to be fully evaluated. Graham *et al* (2005b) recently looked at the provision of television monitors for dogs in shelters. The dogs showed more interest in moving images of dogs, other animals and humans than the blank screen, and were more active and vocalised less during the study. However, this effect was relatively small and declined over time, leading the authors not to recommend the use of televisions as an effective enrichment tool. The provision of other sources of visual stimulation has yet to be studied.

Olfactory

In an olfactory sense, kennelled environments have the potential to be either under-stimulating (due to lack of conspecifics, monotonous environments and high levels of hygiene) or over-stimulating (from the presence of many dogs in a small space and the use of powerful anti-bacterial and viral agents). Given that olfactory investigation and communication is an important aspect of canine behaviour (Fox 1978), it is surprising that the effect that such environments may have on the welfare of dogs has so far been poorly studied. Only two studies could be found in relation to olfaction in kennelled environments and these relate to the provision of additional aromas as opposed to the reduction of potentially noxious ones. Graham *et al* (2005a) looked at the effect of various aromatherapy vapours on the behaviour of dogs in a rescue shelter for five days each. They reported that dogs spent more time resting and less time moving and vocalising under the lavender and chamomile treatment and more time standing, moving and vocalising with the rosemary and peppermint treatment. This might suggest that provision of lavender or chamomile might promote relaxation and that provision of apparently stimulating aromas might help those dogs that are depressed. However, in the absence of more qualitative measures and the short time frame of the study this conclusion may not be drawn with confidence yet. The effect of dog appeasing pheromone (DAP) on the behaviour of dogs in shelters has also been investigated recently (Tod *et al* 2005). This is a synthetic analogue of a pheromone produced by the lactating bitch which has been reported to reduce a range of anxiety-related behaviours in dogs (Sheppard & Mills 2003; Gaultier *et al* 2005; Mills *et al* 2006). Tod *et al* (2005) reported significant reductions in barking volume and some difference in behaviour in response to a friendly stranger under the DAP treatment (more sniffing and resting in their presence and less barking). This might therefore be a useful method for improving the welfare of dogs in kennels, particularly if it helps to reduce noise levels, discussed below.

Auditory

Wells *et al* (2002b) looked at the effects of providing various types of auditory stimulation (human conversation, heavy metal music, pop music, classical music and no sound) on the behaviour of dogs in a rescue shelter. During the classical music the dogs spent more time resting and less time standing and barking. In comparison, dogs spent more time barking during heavy metal music compared to all other treatments. This might suggest that playing classical music may encourage the dogs to appear more restful and calm, which might also indirectly facilitate adoption (Wells *et al* 2002b). However, each music treatment was for one day only and, since dogs may habituate, longer-term studies are required.

With the exception of this study, the auditory environment has been poorly examined for kennelled dogs. This is surprising since several authors have raised concerns about sources of over-stimulation in the kennel environment, particularly from excessive noise levels (Hubrecht 1995a; Tuber *et al* 1999; Patronek & Sperry 2001; Marston & Bennett 2003). Sound levels have been monitored in laboratory and shelter facilities. Milligan *et al* (1993) found that levels could reach 80–95 dB in the low frequency range when dogs were barking or humans were cleaning. Sales *et al* (1997) found that levels were frequently above 100 dB during the day with peaks of 125 dB, again when dogs were barking largely in response to human activity. At 90 dB humans must wear ear defenders in the work place (Sales *et al* 1997). If these levels can be damaging to human ears and dogs can hear sound four times lower than humans, then it could be argued that these levels are likely to be equally, if not more, damaging to their ears (Sales *et al* 1997). Barking in the kennel environment may not be context specific (Fox 1978), it may be socially facilitated (Solarz 1970; Ledger *et al* 1996) or an individual reaction to fear, separation anxiety, excitement, aggression and a demand for attention (Sales *et al* 1997; Hennessy *et al* 1998; Sheppard & Mills 2003). Beerda *et al* (1997) found that one dog accidentally subjected to a noise of 95 dB showed both a behavioural and physiological stress response. Some of the specific stress-related behavioural reactions reported in this study, paw lifting and tongue flicking, have also been reported in kennelled dogs (Beerda *et al* 1999; Hiby *et al* 2003). The potential for noise levels to impact on the dog's stress levels has therefore been inadequately studied. In addition, its effects on hearing and the consequences of this on behaviour problems in the new home, including difficulty in training and recall, deserves further attention.

Occupational environment

Exercise

Consideration of the need to exercise as a basic biological requirement has been acknowledged for dogs (Hubrecht 2002). In addition, regular exercise can reduce blood pressure elevation caused by stressful situations in humans (Mathias 1991). Nonetheless, no long-term effect of 30 minutes a day treadmill or free exercise has been found on heart rate (Clark *et al* 1991), plasma cortisol levels or immune function (Campbell *et al* 1988; Clark *et al* 1997a), although Pohoska (1979) did report that cage confined dogs had a reduced capacity for prolonged exercise. There is conflicting evidence from behavioural observations of the welfare benefits of the provision of exercise. Campbell *et al* (1988), Clark *et al* (1997a) and Hubrecht (1993) reported few changes in behaviour at times other than the exercise period. Clark *et al* (1997a) found that on exercise days dogs spent more time lying down and less time rearing at the back of the cage, barking or play bowing. By contrast, Hubrecht (1993) reported an increase in standing on hind legs and barking and Meers *et al* (2004) reported an increase in activity, self and social grooming and exploration in their cages during an exercise programme. Cessation of the walking programme after only 10 days in the study by Meers *et al* (2004) resulted in increased apathy and vocalisation, which they attributed to stress. These latter two studies therefore suggest that an exercise programme may

© 2007 Universities Federation for Animal Welfare

have an arousing effect, perhaps due to anticipation of a positive, social experience.

Toys

Enrichment techniques seek to both increase so-called normal behaviour (play, foraging, exploration, etc) and reduce undesirable behavioural patterns (stereotypies, excessive inactivity, etc) (Chamove 1989). Since play behaviour, in particular, is thought to indicate well-being (Broom 1991; Carlstead *et al* 1993; Hetts *et al* 2004), provision of toys in order to elicit this is often suggested for confined animals (Wells 2004b). Toys have been found to provide interest for kennelled dogs at the cost of less time spent inactive or performing stereotypies (Hubrecht 1993, 1995a; Wells 2004b). However, toys are not always effective at promoting change in the animal's behaviour (see Newberry 1995; Shepherdson *et al* 1998) and other studies with dogs have reported less positive results (Wells & Hepper 1992, 2000).

'Toys' is a term given to a variety of objects for which the motivation for their use is not always play (Newberry 1995). Motivation to chew appears to influence the use of most toys by dogs, seen by a preference for chews over tug toys, pipes and balls in the studies by DeLuca and Kranda (1992), Hubrecht (1993, 1995a) and Wells (2004b). This may be because motivation to chew is particularly strong for dogs or the context in which the toy is provided affects its use. Tug toys were more popular in the study by Hubrecht (1995a) than in Wells (2004b) but, in the former, the dogs were group housed. Similarly, throwing in a range of toys to singly-housed dogs was largely ineffective in Wells and Hepper (1992), possibly because there was no other individual with which to interact or draw attention to it. There seems to be a large age effect, since the studies by Hubrecht (1993, 1995a) involved young dogs, and for them motivation to play and chew may be greater (Wells 2004b). The percentage time spent playing with the toys was greater in young dogs where it can take up a significant proportion of their time (28–94% of time in puppies [Hubrecht 1995a] and 24% of time for 6–9 month old dogs [Hubrecht 1993]), compared to adult dogs (10–20% of the time, Wells [2004b]). There have also been some reported breed differences in toy preference in DeLuca and Kranda (1992); beagles liked squeaky toys and chewing plastic tugs, hounds preferred flavoured gumabone tugs.

Decline in interest is often reported for enrichment items (Newberry 1995; De Monte and Le Pape 1997). This may be because of a loss of novelty, which may be the primary reason for interest in the toy. Substrate enrichment was not reported to decline for rabbits (Huls *et al* 1991), which suggests that some enrichments might have more functional significance to the animal than others (Newberry 1995). Hubrecht (1993) reported some decline in interest in a rawhide chew over two months but not other chews. In fact he reported that it took some time for the puppies to make use of the chews and their use increased over the two months, although this could also be a developmental effect. By contrast, Wells (2004b) reported rapid decline over three days for most toys but the study was quite short term. Dogs in this study were also housed singly so if they had not had prior experience of the toy they may not know or be able to learn how to use it. Disinterest was also observed in a chew suspended on a chain to keep it clean and accessible (Wells & Hepper 2000). This is in contrast to the study by Hubrecht (1993), which again, might be explained by large differences in the age and experience of the dogs. Novelty may be maintained by rotating toys between kennels (Wells 2004b). However, if the dog has had no experience of the toy, it is not presented in the correct context and the dog is not motivated to use the toy then the use of such items may be limited.

Nutritional environment

Diet has been used as a treatment for behaviour problems in dogs, particularly hyperactivity and aggression (Mugford 1987; Dodman *et al* 1996; Anderson & Marinier 1997; DeNapoli *et al* 2000). In particular, Anderson and Marinier (1997) suggest that their high protein diet together with the regularity of meals may have prevented the expression of behaviour problems stemming from unfulfilled appetitive or consummatory behaviour (behaviours related to searching for food and its consumption, eg increased activity, pica, chewing, aggression, see Hughes and Duncan 1988). Appetitive behaviour has been associated with stereotypies in some carnivores (Mason & Mendl 1997). However, the ability of diet to affect repetitive behaviour in kennelled dogs has not yet been reported. In one establishment, the use of food hoppers that delivered small amounts of pellets, resulted in dogs spending much longer feeding (10% of time compared to around 2% of time in normal conditions — Hubrecht *et al* 1992). The finding that animals may prefer to work for food (contra-freeloading) can be employed as an enrichment tool, but has been little studied in dogs compared to other species (Inglis *et al* 1997). Given the large number of differences between establishments in the study by Hubrecht *et al* (1992) it is not possible to say if provision of a food hopper had any effect on the prevalence of behaviour problems. The use of foraging devices and food delay toys therefore require further evaluation.

Hennessey *et al* (2002a) found that feeding a high quality diet for eight weeks to dogs in a rescue shelter, in addition to a socialisation programme, led to some differences in behaviour in a test and a reduction in ACTH levels over time. Dogs were less likely to try to escape in response to an air horn and were more likely to lick a stranger in an approach test. Subjects were less likely than those not on the programme to pant and lip lick in response to the stranger, which are signs associated with chronic and acute stress (Engeland *et al* 1990; Beerda *et al* 1998, 1999; Schilder & van der Borg 2004). The authors suggest the diet and intervention might have resulted in calmer animals but since they were more likely to put on weight they may also have been less active, as evidenced by fewer line crossings in the test. It is unfortunate that they did not look at behaviour further in the kennel.

Psychological environment

Control

Lack of control within the kennel environment may be a source of stress to the dog (Hennessey *et al* 1997, 1998; Tuber *et al* 1999; Patronek & Sperry 2001). For animals that were previously feral or pets, loss of the ability to control access to outdoors, rewards or interaction with humans and conspecifics may be an additional stressor (Hennessy *et al* 1998). Previously housetrained dogs may cease to be so in the rescue environment, largely because they are denied the ability to control access to outdoors (Marston & Bennett 2003). The extent to which this experience is physically or even psychologically stressful for them, at least in the short term, is not known. Somewhat surprisingly, given their historically long use for psychological research, the importance of control within the living environment of dogs has been little studied. Control *per se* has been shown to be important to dogs in experiments involving the delivery of electric shocks (see Maier & Seligman 1976; Dess-Beech *et al* 1983). Inability to control the shocks in particular was shown to induce a phenomenon known as learned helplessness (Maier & Seligman 1976). This presents as apathy or failure to learn within a situation due to experience of lack of control in a similar, previous situation. It has been suggested that the apathy commonly reported within the kennel environment may represent a form of learned helplessness (Wells *et al* 2002a; Stephen & Ledger 2005).

Environmental controllability may be more important than complexity (see Sambrook & Buchanan-Smith 1997) however, provision of enrichment often brings with it some aspect of control. Increasing the complexity of the kennel may allow the animals to exert some control over their environment by giving them a choice about where to sit, stand or lie. For example, dogs with outdoor access may be offered an indoor kennel or shelter, and both Hubrecht *et al* (1992) and Beerda *et al* (1999) reported that these were used heavily, particularly in bad weather. The provision of the kennel therefore allowed the dogs the ability to exercise choice. Another aspect of control is the ability to escape or hide from aversion. Whilst escape may not be possible in the kennel environment, provision of hiding places has been reported to be beneficial for sheltered cats (Patronek & Sperry 2001), but has yet to be evaluated for dogs.

Predictability

The predictability of events is another important aspect of the environment that can have a psychological impact. Unpredictability can cause stress to animals (see Hanson *et al* 1976; Wiepkema & Koolhaas 1993). Loss of predictability has found to be stressful for laboratory cats (Carlstead *et al* 1993) and dogs (Dess-Beech *et al* 1983). Lack of predictability with the kennel environment has been highlighted as a cause of stress and fear (Hennessy *et al* 1997, 1998; Patronek & Sperry 2001; Stephen & Ledger 2005). For pet dogs that once had a predictable routine, the inability to predict the occurrence of exercise and food within the rescue shelter environment may be particularly stressful (Hennessy *et al* 1998).

However, predictability within the laboratory or rescue environment and its effect on canine welfare has been relatively overlooked. It may be assumed that the time period when the dog is re-learning new routines may be stressful but once these are learnt the kennel environment may become less stressful. This may in part explain the physiological and behavioural adjustment to kennelling that has been reported (Garnier *et al* 1990; Hennessy *et al* 1997; Beerda *et al* 1999; Hiby *et al* 2003; Rooney *et al* 2004). The extent to which adjustment is affected by establishment of predictability as opposed to other factors is not known. Additional stressors unique to the rescue process, such as the loss of attachment figures (Tuber *et al* 1999; Patronek & Sperry 2001; Marston & Bennett 2003) and novelty (Hanson *et al* 1976; Hennessy *et al* 1997, 1998; Beerda *et al* 1998; Tuber *et al* 1999; Patronek & Sperry 2001; Marston & Bennett 2003), may also affect the ability of dogs to learn these new routines and therefore adjust. However, some degree of unpredictability is natural for the animal and, once established, an extremely monotonous and predictable routine may then become stressful in itself (see Wiepkema & Koolhaas 1993). This might explain reports of an increase in cortisol levels (Beerda *et al* 1999) and repetitive behaviours (Stephen & Ledger 2005) several weeks after onset of kennelling. Longitudinal physiological and behavioural evaluation of this kind is still required in order to confirm and understand this process (Marston & Bennett 2003).

The relationship between routine and cues within the kennel environment and their effect on the predictability of events is not fully understood. Loss of both predictability and control may result in increased arousal and vigilance (Hennessy & Levine 1979). However, high levels of predictability may also be arousing, as demonstrated by the relationship between feeding regimes and some stereotypies in horses (see Cooper *et al* 2005). Lack of external cues within the kennel environment for regular events may result in persistent arousal, just as may provision of cues in the absence of the event (eg sounds of food preparation but no food, visual access to humans but no contact or release). Increased arousal in dogs provided with socialisation and exercise programmes (Hubrecht 1993, 1995b; Meers *et al* 2004), but with possibly no cues for when these might occur, might be an example of the former. Arousal during general human activity (Neamand *et al* 1975; Hughes *et al* 1989; Hetts *et al* 1992; Ledger *et al* 1996; Sales *et al* 1997; Wells & Hepper 2000) might be an example of the latter. Behavioural changes that might be indicative of stress were attributed to the cessation of a walking programme routine (Meers *et al* 2004), although it is not known if the dogs had come to expect this event and it was this change in predictability that caused them stress or the lack of exercise *per se*. Food and exercise are presumably enjoyable experiences for the dog, however, the impact of the predictability of aversive experiences such as might occur within a rescue, training or research institution have not been looked at.

© 2007 Universities Federation for Animal Welfare

Discussion

Reviews of all aspects of animal welfare research are important because they serve to collate current knowledge and suggest priorities for further work. Previous reviews of the welfare of dogs in kennels (Hubrecht 1995a; Wells 2004b) have only covered a proportion of the various aspects of kennel environment and have been less critical. Critical appraisal of such studies is important, especially given differing views of what constitutes and reflects good or poor welfare. Despite our close association with dogs over many millennia and their continued widespread popularity in a range of contexts, surprisingly little is known about welfare indicators in dogs. This is in direct contrast to other domesticated animals such as those used in farming where the field of animal welfare still retains much of its focus (Hubrecht 1995a). Knowledge of the welfare implications of each aspect of the kennel environment is therefore limited by the choice of measures to reflect the welfare state of the animal. For example, physiological parameters such as plasma cortisol, heart rate and immune function are non-specific and may not reflect emotional state (Fraser 1995; Beerda *et al* 1997; Clark *et al* 1997b; Hewson 2003). Reliance on these, such as occurred in the early studies on kennel size led some to suggest that small kennels did not impact on welfare (Newton 1972; Hite *et al* 1977; Hughes & Campbell 1990). However, these authors were perhaps defining welfare in terms of physical health (see Hewson 2003) and did not look in detail at the dog's behaviour. This, together with the fact that in most cases the change in kennel size was small, may result in there being, with the exception of the study by Hetts *et al* (1992), less information on the impacts of kennel size on welfare than there appears.

Another concern is the heavy reliance on quantitative measures of behaviour such as activity level to inform conclusions about welfare. Recording whether the dog is sitting, standing or moving, arguably provides little information about their welfare state (Hubrecht 1995a). In addition, because behaviour is often an adaptive response to the environment it is also very difficult, if not senseless, to suggest at what point a certain percentage of sitting reflects poor physical or mental health (Barnett & Hemsworth 1990). It may be possible to compare time budgets with conspecifics in more naturalistic settings (Hetts 1991). However, it is more problematic to do this for domesticated animals, not only because of environmental differences, but also because selection may have altered them behaviourally and psychologically from their wild counterparts (Hubrecht 1995a). The differences in lifestyle within and between populations of feral and domestic dogs also limit the ability to make a valid comparison (Hubrecht 1995a; Veasey *et al* 1996). Therefore conclusions about the impacts of both kennel size (Neamand *et al* 1975; Hite *et al* 1977; Campbell *et al* 1988; Hughes *et al* 1989) and enrichment techniques (Wells & Hepper 1998, 2000; Wells *et al* 2002b; Wells 2004b; Graham *et al* 2005a,b) based on these measures may be premature. The quality of behavioural states such as playing, fighting, stereotyping and behavioural events such as paw lifting and growling, are perhaps more valid welfare indicators, although the same concerns still apply. Nonetheless, the development of more sophisticated welfare measures is urgently required if we are to measure more subtle, positive changes in well-being that might occur as a consequence of changes in environment.

Studies have also suffered from the lack of within-dog, single manipulations of each aspect of the kennel. This is particularly evident in the studies of the physical and social environment, since many involved manipulation of both indoor and outdoor, size and group housing (Clark *et al* 1991; Hetts *et al* 1992; Hubrecht *et al* 1992; Mertens & Unshelm 1996; Beerda *et al* 1999). Perhaps because of this, the differences in welfare were greatest within these studies, but do not help inform priorities for increasing the capacity and complexity of the physical environment when such wholesale environmental changes are not possible. Similarly, some studies made comparisons across institutions (eg Hubrecht *et al* 1992; Mertens & Unshelm 1996), which reduces confidence that the differences in the behaviour observed were due to the environmental differences and not other, institutional, managerial or dog-based factors. In particular, these two studies were concerned with the intra-specific social environment, which is unfortunate since this leaves only the study by Hetts *et al* (1992) as a within-dog, within-institution study of this variable. Nevertheless, all three studies suggest that group housing can have significant, beneficial effects on behaviour and therefore possibly welfare. However, more work needs to be done on the management of risks of aggression and disease transmission in these situations. Factors within the studies to date suggest that risk of aggression may depend on the size of the enclosure, the number of dogs in the enclosure, the turnover of the dogs, the sex, age, temperament and breed of the dogs and competition for food, but controlled studies are warranted. Of particular interest is whether group size or rate of dog turnover is more important in reducing aggression and what size of group should dogs be held in (Hubrecht 1995a).

An additional problem relates to experiences such as exercise and socialisation for which there is growing evidence that they might not have any beneficial effect on the dog's behaviour at other times (eg Hubrecht 1993). What do we conclude about the importance of provision of these experiences if the welfare of the dog appears unchanged when returned to the kennel? Does this mean that welfare should be measured across various time points or include the assessment of the provision of needs in addition to the outcome? There are methodologies for the determination of important needs (eg comparisons with free-living counterparts and preference tests, see Hetts 1991). However, both of which have been little used for dogs (Hubrecht 1995a) and as a result, dilemmas of this sort will continue to occur.

The use of toys in kennelled dogs needs to be more fully evaluated in order to maximise their effective use, not just

by looking at the context in which it is presented and the age and breed of dog it is intended for, but the type of 'toy' itself. Many studies appear to be relatively short term and it is essential that proper controls for a novelty effect are in place. It may be that food-related, chewable items are more biologically relevant and therefore more universally attractive. It is interesting that carnivores and primates are often given toy items whereas rodents are often given substrate items which can stimulate a range of behaviours, not just play (De Monte & Le Pape 1997). This may stem from both a practical and anthropomorphic point of view. The effect of provision of substrate-type items may be more effective at occupying the time of kennelled dogs but have yet to be reported. In fact, failure to look at stimuli that may have more relevance to dogs than ourselves such as olfaction and hearing has perhaps caused us to overlook the impact of these within the kennel situation (Hubrecht 2002). Over-stimulation, by the visual presence of visitors and other caged dogs, noise levels and strong artificial or dog-related odours, may be just as stressful to this species as under-stimulation in the physical and social sense.

In various studies it has been suggested that the environmental manipulation may indirectly increase adoption rates, thereby affecting the dogs' welfare in the long term (Wells & Hepper 2000; Wells *et al* 2002b; Wells 2004a; Graham *et al* 2005a). These hypotheses were based on an increase in behaviours that a survey of members of the public reported to find attractive in dogs in kennels (not barking, at the front of kennel, with a toy; Wells & Hepper 1992; Wells 1996) and an increase in adoption rates when toys were placed in kennels and beds were placed near front (Wells & Hepper 2000). However, this increase was in relation to the previous year and it has not been reported by how much adoption rates can fluctuate yearly. The contention that provision of pleasant aromas (Graham *et al* 2005a) and music (Wells *et al* 2002b) may increase adoption rates by making the environment more pleasant is based on an observation that those people that purchased a dog spent more time looking at it (Wells & Hepper 2001). However, this study involved only three purchases and it is not known if the relationship is causal. Clearly more direct evidence of an influence on adoption rates by either influencing the behaviour of the dogs or the visitors is required if such enrichment techniques are to be implemented on the basis of increasing adoption rates alone.

This review has focused primarily on kennel-related factors that impact on the welfare of dogs in these environments. However, dog-related factors can also affect adjustment to kennelling and the reaction to components within it. Dog-based factors include the sex, age, breed, background and temperament of the dog. Perhaps surprisingly, there has not been much focus until recently on these factors, although evidence for their importance can be found in the literature reviewed here and elsewhere. A comprehensive review of such factors is beyond the scope of this paper, but such factors should not be overlooked. For example, there was evidence for the effects of age on toy use and effects of sex on aggression in group housing. Within laboratory animals these factors are much less variable than they are in rescue shelters (Anon 2004), which may have an impact on evaluating effects of manipulations in these environments. For dogs that are placed into kennels from another environment the novelty of the new kennel may be an additional source of psychological stress for the animal. This will obviously be affected by the animal's temperament and its previous experience. The latter might explain more rapid physiological adjustment to kennelling in dogs that have had prior experience (Hiby *et al* 2003; Rooney *et al* 2004) and suggests a method to help manage this potential problem. The stress induced by the novelty of the environment may also be alleviated through other simple techniques such as the provision of DAP in new environment, as already discussed (Tod *et al* 2005).

Conclusion

There is growing evidence of the welfare implications of multiple changes to the kennel environment such as outdoor, grouped, large enclosures and provision of human-directed exercise and socialisation. However, in the absence of single variable studies, the relative effects of these are not known, which can be problematic when large scale changes to a housing system cannot be made. Studies of the welfare of dogs in kennels have suffered not only from this oversight, but on the use of physiological and quantitative measures that may, at worst be irrelevant and at best, crude indicators of (poor) welfare. A range of aspects of the kennel environment have yet to be studied in any detail including the effect of over-stimulation of the visual, olfactory and auditory senses, and lack of control and predictability in the environment. It is unfortunate that the environment of an animal which was the first to be domesticated and with which we have arguably the strongest relationship has been so poorly studied, especially when we appreciate how much they may have given to humans.

Acknowledgements

This paper formed part of a wider review of approaches to the assessment of welfare and quality of life in kennelled dogs commissioned by the Dogs Trust and we are indebted to them for their support of this work. The first author was supported by the charity to undertake these reviews. We would also like to thank members of the Dogs Trust 'quality of life working party' for their support and comments; Jon Bowen, John Bradshaw, Keith Butt, Rachel Casey, Philip Daubeny, Paul DeVile, Sarah Heath, Andrew Higgins, Chris Laurence, Matthew Leach, Sam Lindley, David Main, Joe Mayhew, Rose Mcllrath, Dirk Pfeiffer, Jacqueline Reid, Irene Rochlitz, Marian Scott, Jacqueline Stephen, Natalie Waran, Deborah Wells and Lesley Wiseman-Orr.

References

Adams GJ and Johnson KG 1994 Behavioural responses to barking and other auditory stimuli during night-time sleeping and waking in the domestic dog, *Canis familiaris. Applied Animal Behaviour Science 39:* 151-162

© *2007 Universities Federation for Animal Welfare*

Anderson G and Marinier S 1997 The effect of food and restricted exercise on behaviour problems in dogs. In: Mills DS, Heath SE and Harrington LJ (eds) *Proceedings of the 1st International Conference on Veterinary Behavioural Medicine* pp 183-186. Universities Federation for Animal Welfare: Wheathampstead, Hertfordshire, UK

Anon 2004 Refining dog husbandry and care: Eight report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement. *Laboratory Animals 38 (1)*

Barnett JL and Hemsworth PH 1990 The validity of physiological and behavioural measures of animal welfare. *Applied Animal Behaviour Science 25:* 177-187

Bebak J and Beck AM 1993 The effect of cage size on play and aggression between dogs in purpose-bred beagles. *Laboratory Animal Science 43:* 457-459

Beerda B, Schilder MBH, van Hooff JARAM and De Vries HW 1997 Manifestations of chronic and acute stress in dogs. *Applied Animal Behaviour Science 52:* 307-319

Beerda B, Schilder MBH, Van Hooff JA, De Vries HW and Mol JA 1998 Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science 58:* 365-381

Beerda B, Schilder MBH, Van Hooff JARAM, De Vries HW and Mol JA 1999 Chronic stress in dogs subjected to social and spatial restriction I: Behavioural responses. *Physiology and Behaviour 66:* 233-242

Boitani L, Francisci F, Ciucci P and Andreoli G 1995 Population biology and ecology of feral dogs in central Italy. In: Serpell J (ed) *The Domestic Dog: its Evolution, Behaviour and Interactions with People* pp 217-244. Cambridge University Press: Cambridge, UK

Boxall J, Heath S, Bate S and Brautigam J 2004 Modern concepts of socialisation for dogs: implications for their behaviour, welfare and use in scientific procedures. *Alternatives to Laboratory Animals 32(2):* 81-93

Broom DM 1991 Animal welfare: concepts and measurement. *Journal of Animal Science 69:* 4167-4175

Bruno RL 2004 Overcrowding and its behavioural consequences. In: Heath S and Osella C (eds) *Proceedings of the 10th European Congress on Companion Animal Behavioural Medicine* pp 99-101. 22-23 October 2004, Cremona, Italy

Campbell SA, Hughes HC, Griffin HE, Landi MS and Mallon FM 1988 Some effects of limited exercise on purpose-bred beagles. *American Journal of Veterinary Research 49:* 1298-1301

Carlstead K, Brown JL and Strawn W 1993 Behavioural and physiological correlates of stress in laboratory cats. *Applied Animal Behaviour Science 38:* 143-158

Chamove AS 1989 Environmental enrichment: a review. *Animal Technology 40:* 155-178

Clark JD, Culpin J and Armstrong RB 1991 Influence of type of enclosure on exercise fitness of dogs. *American Journal of Veterinary Research 52:* 1024-1028

Clark JD, Rager DR, Crowell-Davis S and Evans DL 1997a Housing and exercise of dogs: effects on behaviour, immune function and cortisol concentration. *Laboratory Animal Science 47:* 500-510

Clark JD, Rager DR and Calpin JP 1997b Animal wellbeing IV: specific assessment criteria. *Laboratory Animal Science 47:* 586-597

Cooper JJ, McCall N, Johnson S and Davidson HPB 2005 The short term effects of increasing meal frequency on stereotypic behaviour of stabled horses. *Applied Animal Behaviour Science 90:* 351-364

Crespo S 2001 The occurrence and effects of stress in kennelled dogs- a review paper. In: *Proceedings of the 10th International Society for Anthrozoology Annual Conference.* 2-4 August 2001, University of California, Davis, USA

De Luca AM and Kranda KC 1992 Environmental enrichment in a large animal facility. *Laboratory Animal 21:* 38-44

De Monte M and Le Pape G 1997 Behavioural effects of cage enrichment in single-caged adult cats. *Animal Welfare 6:* 53-66

DeNapoli JS, Dodman NH, Shuster L, Rand WM and Gross KL 2000 Effects of dietary protein content and tryptophan supplementation on dominance aggression, territorial aggression and hyperactivity in dogs. *Journal of the American Veterinary Medical Association 217*: 504-508

Dess-Beech N, Linwich D, Patterson J and Overmier J 1983 Immediate and proactive effects of controllability and predictability on plasma cortisol response to shocks in dogs. *Behavioural Neuroscience 97*: 1005-1013

Dodman NH, Reisner I, Shuster L, Rand W, Luescher UA, Robinson I and Houpt KA 1996 Effect of dietary protein content on behaviour in dogs. *Journal of the American Veterinary Medical Association 208:* 376-379

Eisele PH 2001 A practical dog bed for environmental enrichment for geriatric beagles with applications for puppies and other small dogs. *Contemporary Topics in Laboratory Animal Science 40*: 36-38

Engeland WC, Miller P and Gann DS 1990 Pituitary-adrenal adrenomedullary responses to noise in awake dogs. *American Journal of Physiology 258:* 672-677

Feddersen-Petersen DU 2001 'Normal aggressive behaviour' in domestic dogs. In: *Proceedings of the 10th International Society for Anthrozoology Annual Conference.* 2-4 August 2001, University of California, Davis, USA

Feldhaus RA 1980 A resting platform for dog pens. *Laboratory Animal Science 30:* 714-715

Fox MW 1978 *The Dog: its domestication and behaviour*. Garland STPM Press: London, UK

Fraser D 1995 Science, values and animal welfare: exploring the inextricable connection. *Animal Welfare 4:* 103-117

Fuller JL and Clark LD 1966 Effects of rearing with specific stimuli upon post-isolation behaviour in dogs. *Journal of Comparative and Physiological Psychology 61:* 258-263

Garnier F, Benoit E, Virat M, Ochoa R and Delatour P 1990 Adrenal cortisol response in clinically normal dogs before and after adaptation to a housing environment. *Laboratory Animal 24:* 40-43

Gaultier E, Bonnafous L, Bougrat L, Lafont C and Pageat P 2005 Comparison of the efficacy of a synthetic dog-appeasing pheromone with clomipramine for the treatment of separation-related disorders in dogs. *The Veterinary Record 156:* 533-538

Goodwin D, Bradshaw JWS and Wickens SM 1996 Paedomorphosis affects agonistic visual signals of domestic dogs. *Animal Behaviour 53:* 297-304

Graham L, Wells DL and Hepper PG 2005a The influence of olfactory stimulation on the behaviour of dogs housed in a rescue shelter. *Applied Animal Behaviour Science 91:* 143-153

Graham L, Wells DL and Hepper PG 2005b The influence of visual stimulation on the behaviour of dogs housed in a rescue shelter. *Animal Welfare 14:* 143-148

Hafen MR 2005 Animal housing and exercise areas. In: *Proceedings of the 2005 North American Veterinary Congress* pp 418-419. 8-12 January 2005. Orlando, Florida, USA

Hanson JD, Larson ME and Snowdon CT 1976 The effects of control over high intensity noise on plasma cortisol levels in rhesus monkeys. *Behavioural Biology 16:* 333-340

Hennessy J and Levine S 1979 Stress, arousal and the pituitary-adrenal system: a psychoendocrine model. In: Sprague J and Epstein A (eds) *Progress in Psychobiology and Physiological Psychology*. Academic Press: New York, USA

Hennessy MB, Davis HN, Williams MT, Mellott C and Douglas CW 1997 Plasma cortisol levels of dogs at a county animal shelter. *Physiology and Behaviour 62:* 485-490

Hennessy MB, Williams MT, Miller DD, Douglas CW and Voith VL 1998 Influence of male and female petters on plasma cortisol and behaviour: can human interaction reduce the stress of dogs in a public animal shelter? *Applied Animal Behaviour Science 61:* 63-77

Hennessy MB, Voith VL, Young TL, Hawke JL, Centrone J, McDowell A, Linden F and Davenport G 2002a Exploring human interaction and diet effects on the behaviour of dogs in a public animal shelter. *Journal of Applied Animal Welfare Science 5:* 253-273

Hennessy MB, Voith VL, Hawke JL, Young TL, Centrone J, McDowell AL, Linden F and Davenport G 2002b Effects of a program of human interaction and alterations in diet composition on activity of the hypothalamic-pituitary-adrenal axis in dogs housed in a public animal shelter. *Journal of the American Veterinary Medical Association 221:* 65-71

Hetts S 1991 Psychologic well-being: Conceptual issues, behavioural measures and implications for dogs. *Veterinary Clinics of North America: Small Animal Practice 21:* 369-387

Hetts S, Clark JD, Calpin JP, Arnold CE and Mateo JM 1992 Influence of housing conditions on beagle behaviour. *Applied Animal Behaviour Science 34:* 137-155

Hetts S, Heinke ML and Estep DQ 2004 Behaviour wellness concepts for general veterinary practice. *Journal of the American Veterinary Medical Association 225:* 506-513

Hewson CJ 2003 What is animal welfare? Common definitions and their practical consequences. *Canadian Veterinary Journal 44:* 496-499

Hiby EF, Bradshaw JWS and Rooney NJ 2003 Behavioural and physiological indicators of diminished welfare in the dog. In: *Proceedings of the 48th Annual Congress of the British Small Animal Veterinary Association* p 613. 7-10 April 2003, Birmingham, UK

Hite M, Hanson HM, Bohidar NR, Conti PA and Maltis PA 1977 Effect of cage size on patterns of activity and health of beagle dogs. *Laboratory Animal Science 27:* 60-64

HMSO 1989 *Codes of practice for the housing and care of animals used in scientific procedures*. HMSO: London, UK

Hubrecht RC 1993 A comparison of social and environmental enrichment methods for laboratory housed dogs. *Applied Animal Behaviour Science 37:* 345-361

Hubrecht RC 1995a The welfare of dogs in human care. In: Serpell J (ed) *The Domestic Dog: its Evolution, Behaviour and Interactions with People* pp 180-198. Cambridge University Press: Cambridge, UK

Hubrecht RC 1995b Enrichment in puppyhood and its effects on later behaviour of dogs. *Laboratory Animal Science 45:* 70-75

Hubrecht RC 2002 Comfortable quarters for dogs in research institutions. In: Reinhardt V and Reinhardt A (eds) *Comfortable Quarters for Laboratory Animals, 2nd edition* pp 56-64. Animal Welfare Institute: Washington DC, USA

Hubrecht RC, Serpell JA and Poole TB 1992 Correlates of pen size and housing conditions on the behaviour of kennelled dogs. *Applied Animal Behaviour Science 34:* 365-383

Hughes BO and Duncan IJH 1988 The notion of ethological need, models of motivation and animal welfare. *Animal Behaviour 36:* 1696-1707

Hughes HC and Campbell SA 1990 Effects of primary enclosure size and human contact. In: Mench JA and Krulish L (eds) *Proceedings of 1989 Scientists center for animal welfare: canine research environment* pp 63-73. 22 June 1990, Bethesda, USA

Hughes HC, Campbell S and Kenney C 1989 The effects of cage size and pair housing on exercise of beagle dogs. *Laboratory Animal Science 39:* 302-305

Huls WL, Brooks DL and Bean-Knusden D 1991 Response of adult New Zealand white rabbits to enrichment objects and paired housing. *Laboratory Animal Science 41*: 609-612

Inglis IR, Forkman B and Lazarus J 1997 Free food or earned food? A review and fuzzy model of contra freeloading. *Animal Behaviour 53:* 1171-1191

Kostarczyk E 1992 The use of dog-human interaction as a reward in instrumental conditioning and its impact on the dogs' cardiac regulation. In: Davis H and Balford D (eds) *The inevitable bond – examining scientist- animal interaction* pp 109-131. Cambridge University Press: Cambridge, UK

Ledger RA, Hubrecht R and Sales G 1996 The effect of the level of barking on the behaviour of kennelled dogs. In: *Proceedings of the 30th International Congress of the International Society for Applied Ethology* p 156. 14-17 August 1996, UK

Loveridge GG 1998 Environmentally enriched dog housing. *Applied Animal Behaviour Science 59:* 101-113

Lynch JJ and Gantt W 1968 The heart rate component of the social reflex in dogs: the conditional effects of petting and person. *Conditional Reflex 3:* 69-80

Maier SF and Seligman MEP 1976 Learned helplessness: Theory and evidence. *Journal of Experimental Psychology: General 105:* 3-46

Marston LC and Bennett PC 2003 Re-forging the bond-towards successful canine adoption. *Applied Animal Behaviour Science 83:* 227-245

Mason G and Mendl M 1997 Do the stereotypies of pigs, chickens and mink reflect adaptive species differences in the control of foraging? *Applied Animal Behaviour Science 53:* 45-58

Mathias CJ 1991 Management of hypertension by reduction in sympathetic activity. *Hypertension 17(3)*: 69-74

McAfee LM, Mills DS and Cooper JJ 2002 The use of mirrors for the control of stereotypic weaving behaviour in the stabled horse. *Applied Animal Behaviour Science 78:* 159-173

McMillan FD 1999 Influence of mental states on somatic health in animals. *Journal of the American Veterinary Medical Association 214:* 1221-1225

Meers L, Normando S, Odberg FO and Bono G 2004 Behavioural responses of adult beagles to interruption in a walking program. In: Heath SE (ed) *Proceedings of the 2004 Companion Animal Behaviour Therapy Study Group Study Day* pp 41-42. 31 March 2004, Birmingham, UK

Mertens PA and Unshelm J 1996 Effects of group and individual housing on the behaviour of kennelled dogs in animal shelters. *Anthrozoos 9:* 40-51

Mikkelsen LF and Ottesen JL 2004 Environmental enrichment for dogs. *Animal Welfare 13:* 250

Milligan SR, Sales GD and Khirnykh K 1993 Sound levels in rooms housing laboratory animals: an uncontrolled daily variable. *Physiology and Behaviour 53:* 1067-1076

Mills DS and Davenport K 2002 The effect of a neighbouring conspecific versus the use of a mirror for the control of stereotypic weaving behaviour in the stabled horse. *Journal of Animal Science 74:* 95-101

Mills DS, Ramos D, Gandia Estelles M and Hargrave C 2006 A triple blind placebo controlled investigation into the assessment of the effect of Dog Appeasing Pheromone (DAP) on anxiety related behaviour of problem dogs in the veterinary clinic. *Applied Animal Behaviour Science 98:* 114-126

Mugford RA 1987 The influences of nutrition on canine behaviour. *Journal of Small Animal Practice 28:* 1046-1055

© *2007 Universities Federation for Animal Welfare*

Neamand J, Sweeney WT, Creamer AA and Conti PA 1975 Cage activity in the laboratory beagle: a preliminary study to evaluate a method of comparing cage size to physical activity. *Laboratory Animal Science 25:* 180-183

Newberry RC 1995 Environmental enrichment: increasing the biological relevance of captive environments. *Applied Animal Behaviour Science 44:* 229-243

Newton WM 1972 An evaluation of the effects of various degrees of long-term confinement on adult beagle dogs. *Laboratory Animal Science 22:* 860-864

Odendaal JS and Meintjes RA 2003 Neurophysiological correlates of affiliative behaviour between humans and dogs. *Veterinary Journal 165:* 296-301

Patronek GJ and Sperry E 2001 Quality of life in long-term confinement. In: August JR (ed) *Consultations in Feline Internal Medicine, 4th edition* pp 621-634. WB Saunders Company: Philadelphia, USA

Pettijohn TF, Wont TW, Ebert PD and Scott JP 1977 Alleviation of separation distress in 3 breeds of young dogs. *Developmental Psychobiology 10:* 373-381

Pettijohn TF, Davis KL and Scott JP 1980 Influence of living space on agonistic interaction in telomian dogs. *Behavioural and Neural Biology 28:* 343-349

Pfaffenberger JC 1963 *The New Knowledge of Dog Behaviour*. Howell Book House: New York, USA

Pohoska E 1979 The effect of prolonged restriction of physical activity on exercise performance in dogs. *Acta Physiologica Poloska 30:* 337-350

Rochlitz I 2005 A review of the housing requirements of domestic cats (*Felis silvestris catus*) kept in the home. *Applied Animal Behaviour Science 93:* 97-109

Rooney NJ, Gaines SA and Bradshaw JWS 2004 Physiological and behavioural responses of dogs to kennelling. *Animal Welfare 13:* 253-254

Sales G, Hubrecht R, Peyvandi A, Milligan S and Shield B 1997 Noise in dog kennelling: is barking a welfare problem for dogs? *Applied Animal Behaviour Science 52:* 321-329

Sambrook TD and Buchanan-Smith HM 1997 Control and complexity in novel object enrichment. *Animal Welfare 6:* 207-216

Sapolsky RM 1994 Individual differences and the stress response. *Seminars in the Neurosciences 6:* 261-269

Schilder MBH and van der Borg JAM 2004 Training dogs with the help of the shock collar: short and long term behavioural effects. *Applied Animal Behaviour Science 85:* 319-334

Scott JP 1980 The domestic dog: a case of multiple identities. In: Roy MA (ed) *Species Identity and Attachment: a phylogentic evaluation* pp 129-143. Garland Press: New York, USA

Serpell J and Jagoe JA 1995 Early experience and the development of behaviour. In: Serpell J (ed). *The Domestic Dog: its evolution, behaviour and interactions with people, 2nd edition* pp 79-102. Cambridge University Press: Cambridge, UK

Shepherdson DJ, Mellen JD and Hutchins M 1998 *Second Nature: Environmental Enrichment for Captive Animals*. Smithsonian Institution Press: Washington, USA

Sheppard G and Mills DS 2003 Evaluation of dog appeasing pheromone as a potential treatment for dogs fearful of fireworks. *Veterinary Record 152:* 432-436

Shyan MR, Fortune KA and King C 2003 'Bark-parks'- a study of interdog aggression in a limited-control environment. *Journal of Applied Animal Welfare Science 6:* 25-32

Solarz AK 1970 Behaviour. In: Anderson AC (ed) *The beagle as an experimental animal* pp 453-468. Iowa State University Press: Ames, USA

Sonderegger SM and Turner DC 1996 Introducing dogs into kennels: prediction of social tendencies to facilitate integration. *Animal Welfare 5:* 391-404

Stephen JM and Ledger RA 2005 An audit of behavioural indicators of poor welfare in kennelled dogs in the United Kingdom. *Journal of Applied Animal Welfare Science 8:* 79-95

Thompson WR, Melzack R and Scott TH 1956 'Whirling behaviour' in dogs as related to early experience. *Science 123:* 393

Tod E, Brander D and Waran N 2005 Efficacy of dog appeasing pheromone in reducing stress and fear-related behaviour in shelter dogs. *Applied Animal Behaviour Science 93:* 295-308

Topál J, Gácsi M, Miklósi Á, Virányi Z, Kubinyi E and Csányi V 2005 Attachment to humans: a comparative study on hand-reared wolves and differently socialized dog puppies. *Animal Behaviour70:* 1367-1375

Tuber DS, Hennessy MB, Sanders S and Miller JA 1996 Behavioural and glucocorticoid responses of adult domestic dogs (*Canis familiaris*) to companionship and social separation. *Journal of Comparative Psychology 110:* 103-108

Tuber DS, Miller DD, Caris KA, Halter R, Linden F and Hennessy MB 1999 Dogs in animal shelters: problems, suggestions and needed expertise. *Psychological Science 10:* 379-386

Veasey JS, Waran NK and Young RJ 1996 On comparing the behaviour of zoo housed animals with wild conspecifics as a welfare indicator. *Animal Welfare 5:* 13-24

Wells DL 1996 *The welfare of dogs in an animal rescue shelter*. PhD Thesis, School of Psychology, Queen's University, Belfast, UK

Wells DL 2004a A review of environmental enrichment for kennelled dogs, *Canis familiaris*. *Applied Animal Behaviour Science 85:* 307-317

Wells DL 2004b The influence of toys on the behaviour and welfare of kennelled dogs. *Animal Welfare 13:* 367-373

Wells DL and Hepper PG 1992 The behaviour of dogs in a rescue shelter. *Animal Welfare 1:* 171-186

Wells DL and Hepper PG 1998 A note on the influence of visual conspecifics contact on the behaviour of sheltered dogs. *Applied Animal Behaviour Science 60:* 83-88

Wells DL and Hepper PG 2000 The influence of environmental change on the behaviour of sheltered dogs. *Applied Animal Behaviour Science 68:* 151-162

Wells DL and Hepper PG 2001 The behaviour of visitors towards dogs housed in an animal rescue shelter. *Anthrozoos 14:* 12-18

Wells DL, Graham L and Hepper PG 2002a The influence of length of time in a rescue shelter on the behaviour of kennelled dogs. *Animal Welfare 11:* 317-325

Wells DL, Graham L and Hepper PG 2002b The influence of auditory stimulation on the behaviour of dogs housed in a rescue shelter. *Animal Welfare 11:* 385-393

Wiepkema PR and Koolhaas JM 1993 Stress and animal welfare. *Animal Welfare 2:* 195-218

Yeon SC, Golden G, Sung W, Erb HN, Reynolds AJ and Houpt KA 2001 A comparison of tethering and pen confinement of dogs. *Journal of Applied Animal Welfare Science 4:* 257-270