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# A review of environmental enrichment for kennelled dogs, *Canis familiaris*

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## Abstract

Domestic dogs can be housed in a variety of confined conditions, including kennels, shelters and laboratories. Concern over the well-being of dogs housed in human care has prompted much research in recent years into the enrichment of environments for kennelled dogs. This paper highlights the findings and recommendations arising from this work. Two types of general enrichment method are discussed, namely animate (i.e. enrichment through the provision of social contacts with conspecifics and humans) and inanimate (i.e. enrichment through the provision of toys, cage furniture, auditory and olfactory stimulation). The benefits and, where relevant, possible disadvantages, to these various types of enrichment method are highlighted throughout.

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## 1. Introduction

The domestic dog is one of the most commonly owned household pets in Western society. In the United Kingdom alone, there are over 6.7 million pet dogs and 4.8 million households owning such animals (PFMA, 2002).

The vast majority of dogs are kept for companionship and spend most, or all, of their lives in their owners' care. Many dogs, however, spend variable periods of time in confinement (see Hubrecht, 1995a; Hubrecht and Turner, 1998 for reviews). Some, for instance, are housed in kennels for boarding, security or military reasons. Others, including strays and animals relinquished by their owners, may spend time in the care of a rescue shelter, some indefinitely (Wells et al., 2002a). Yet other dogs, are born and bred in laboratories for research purposes.

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The welfare of domestic dogs, like other animals, can be seriously compromised by inappropriate confinement. Recent years have thus witnessed a surge of interest in methods of environmental enrichment for dogs housed in institutions. This paper reviews the various methods of enrichment that have been advocated by scientists in the field. Two types of enrichment practice are specifically addressed, namely animate (i.e. enrichment through the provision of social contacts with conspecifics and humans) and inanimate (i.e. enrichment through the provision of toys, cage furniture, auditory and olfactory stimulation).

## 2. Animate enrichment

Particular attention has been directed towards the animate environment of kennelled dogs. Dogs are social animals, needing contact with both conspecifics (Fox, 1965; Fox and Stelzner, 1967) and humans (Fox, 1986, 1989; Fox and Bekoff, 1975; Freedman et al., 1961; Wolfle, 1987, 1990).

### 2.1. Conspecific contact

Housing dogs in conditions of social isolation from their conspecifics is generally considered detrimental to animal well-being, typically resulting in the onset of behavioural deficits such as withdrawal, inactivity, stereotypy and barking (e.g. Beerda et al., 1999a; Hetts et al., 1992; Hubrecht, 1995b; Hubrecht et al., 1992; Hughes et al., 1989; Luescher et al., 1991; Mertens and Unshelm, 1996) and greater physiological stress responses, including increased salivary and urinary cortisol concentrations (Beerda et al., 1999b). Single housing can also encourage dogs to exhibit 'publicly unacceptable' behaviour. Wells (1996), for example, discovered that dogs housed singly in a rescue shelter, spent most of their time (>65%) at the back of the kennel, a behaviour which potential adopters generally find undesirable (Wells and Hepper, 1992).

In light of the above, it is now widely suggested that kennelled dogs are housed in pairs or groups of three or more animals (e.g. Hetts et al., 1992; Hubrecht, 1995b; Hubrecht et al., 1992; Mertens and Unshelm, 1996). The mere sight, sound and scent of other dogs can greatly increase the complexity of the captive environment, thereby fulfilling one of the suggested goals of environmental enrichment (see Poole, 1998). Providing sheltered dogs with increased social contacts may also allow an animal to gain more control over its environment, thereby decreasing the chances of the individual failing to cope with the pressures of confinement (Hubrecht et al., 1992). The issue of animal compatibility is highly important when housing dogs together. Indiscriminate pair or group housing can be counter-productive, leading to outbreaks of aggression and possible injuries to both the dogs and those staff who try to intervene. Thus, care must be always be taken when deciding which animals should be held together.

Unfortunately, pair or group housing is not always practical, especially in rescue shelters. Caging dogs together can increase the risk of disease transmission, and/or injury as a result of aggression (e.g. Hubrecht, 1995b). For this reason, many institutions which house dogs, cage their animals separately. Where such single housing is necessary, the provision of visual contact with other dogs is considered preferable to total isolation from other animals.

Wells and Hepper (1998) discovered that single-housed dogs in a rescue shelter spent more of their time at the front of their pens (in a position to see other dogs) whenever they were provided with visual conspecific contact than whenever they were denied such contact (87.7% versus 24.6% of the observations, respectively). The results suggest that kennelled dogs are motivated to fulfil their 'inherent desire' for social contact. Where dogs are housed individually, the provision of visual intraspecific contact may help to reduce the under-stimulation commonly associated with single housing.

It must be borne in mind that designing dog kennels that afford visual conspecific contact can stimulate allelomimetic behaviour such as barking (Solarz, 1970). This may unfortunately have a negative impact upon potential adopters' perceptions of dog desirability in the rescue shelter setting (Wells and Hepper, 1992). Increased barking may also be detrimental from an animal welfare point of view since high sound levels can damage hearing and impair other physiological systems (Sales et al., 1997).

## 2.2. Human contact

There are suggestions that human contact may be more important for the well-being of dogs than conspecific contact (Fox, 1986; Wolfle, 1987, 1990). Studies have consistently shown that both the behaviour and physiology of dogs can be affected by the presence of humans. The sudden appearance of a person, for example, results in kennelled dogs becoming more active and spending more time at the front of their cage, presumably in a bid to decrease human–animal distance and facilitate interaction (Campbell et al., 1988; Hughes et al., 1989; Wells and Hepper, 2000a). Lynch and Gantt (1968) revealed that dogs housed in a laboratory showed reduced heart rate following handling by humans, and Verga and Carenzi (1983) discovered that dogs housed with their human care-givers showed fewer fear reactions in a foraging test than those born and reared in captivity. Unfortunately, dogs housed in kennels seldom receive much in the way of human contact, despite the evidence highlighting its benefits for animal welfare. Indeed Hubrecht et al. (1992) discovered that dogs housed in laboratories and rescue shelters were provided with little opportunity to interact with humans (from between 0.3 and 2.5% of time observed).

Daily grooming sessions with kennel staff may be a useful means of providing dogs with human contact and helping to reduce levels of stress (Tuber et al., 1999). Stroking dogs has a well-reported ameliorating effect on the animals' physiological and behavioural responses to stressors (Fuller, 1967; Hennessy et al., 1998; Lynch and McCarthy, 1967). Increased handling can also encourage socialisation. Hubrecht (1993, 1995b) found that laboratory-housed beagles provided with small amounts (30 s) of handling each day spent less time chewing their cage furniture and became noticeably more approachable towards both familiar and un-familiar humans.

Grooming and handling sessions should ideally be undertaken by both male and female care-givers, in light of the evidence that dogs react differently towards the two human sexes. Lore and Eisenberg (1986), for example, discovered that male, although not female, dogs housed in a kennel environment were less likely to approach an unfamiliar man than an unfamiliar woman, although both male and female dogs were as likely as each other to approach the strange woman. Hennessy et al. (1997) similarly reported that sheltered dogs interacting with an unfamiliar female had lower cortisol levels at the end of the testing

session than dogs interacting with a male. The researchers' later work (Hennessy et al., 1998), however, revealed little significant effect of human gender on the plasma cortisol concentrations of dogs following stroking in a prescribed manner, leading the authors to conclude that differences in the way men and women interact with dogs may explain previously observed sex differences. Wells and Hepper (1999), however, found that sheltered dogs showed significantly more barking towards, and maintained eye contact longer with, unfamiliar men who were standing passively in front of the animals' cages than unfamiliar women behaving in exactly the same manner. Differences in the behavioural signals emitted by men and women may thus not fully explain why dogs react differently towards the two human sexes.

Dog training may be another useful method of providing kennelled canids with social stimulation. This may be of particular value for sheltered dogs, considering the large number of such animals that are returned shortly after acquisition because of their unruly behaviour. In a recent study, Wells and Hepper (2000b) found that of 556 people who had acquired a dog from a rescue shelter, most (68.3%) reported that their new pet exhibited a behaviour problem within the first 2 weeks of its acquisition. Fearfulness and hyperactivity were particularly common. Most of those respondents (89.7%) who returned their dog to the shelter did so because the animal exhibited behaviour that they considered undesirable. The introduction of behaviour therapy programmes to rescue shelters may produce great benefits, serving to reduce the incidence of dogs that are re-homed with undesirable behaviours, and again promoting more dog–human interactions.

Finally, play between confined dogs and their care-givers may be of value, and indeed is becoming commonplace in some institutions housing domestic canids. The dog can exhibit high levels of play, and is one of few species to engage in interspecific play with humans (Russell, 1936). In the non-confined environment, play between dogs and their owners constitutes a high proportion of overall interactions (Hart, 1995). Play in the kennelled environment may serve a number of valuable functions, including socialisation, preparation for re-homing and the establishment of appropriate dog–human relationships. Whilst some authors have expressed concern over the implications of dog–human play for dominance relationships (see for example, O'Farrell, 1992; Rogerson, 1992), recent work suggests that play does not have any detrimental effect on the dominance dimensions of the dog–human relationship, at least in certain breeds of dogs, e.g. Labrador Retrievers, Golden Retrievers (Rooney, 1999; Rooney and Bradshaw, 2002).

### 3. Inanimate enrichment

Kennelled dogs not only require contact with conspecifics and humans, they also need a complex and stimulating inanimate environment.

#### 3.1. Toys

Toys are one of the most frequently employed forms of inanimate enrichment and are routinely provided to both domestic and exotic captive animals in a bid to encourage play and

reduce boredom. Despite the widely held belief that toys are a source of fun and a panacea for psychological disturbance, research exploring the value of toys for the welfare of captive animals provides contradictory results. Thus whilst some studies suggest that toys can be advantageous for animal well-being, helping to promote exploration, increasing levels of activity and reducing abnormal behaviours, others indicate that toys exert absolutely no effect upon the behaviour or welfare of animals housed in institutions (see Newberry, 1995; Shepherdson et al., 1998 for reviews).

The effect of toys on the behaviour and welfare of confined dogs has been subject to some exploration. Laboratory-housed dogs have been found to show much interest in toys, particularly those which are novel in nature, can be chewed (e.g. rawhide, gumabone) or generate noise, e.g. chains (DeLuca and Kranda, 1992; Hubrecht, 1993, 1995b). Suspending toys slightly off the ground is considered to be a useful way of keeping the objects clean, facilitating staff husbandry duties and reducing outbursts of possessive aggression between animals (Hubrecht, 1993, 1995b).

Somewhat surprisingly, dogs housed in rescue shelters do not appear to benefit from toys to the same extent as laboratory-housed animals. In three separate studies, sheltered dogs were found to largely overlook the introduction of a variety of toys (e.g. Kong balls, gumabone, Boomer balls, tug ropes) to their kennels (Wells, *in press*; Wells and Hepper, 1992, 2000a). The authors suggested that the rescue shelter environment may be so stimulating that the presence of a mere toy has little significance to a kennelled dog; thus rather than making the shelter environment more enriched, toys are simply rendering the environment somewhat less impoverished. Nonetheless, dogs housed in rescue shelters may gain indirect benefits from the introduction of toys to their kennels. Research suggests that potential adopters find those dogs that have a toy in their pen (even if the animal is not seen playing with the item) much more desirable than those in barren environments, hence the simple introduction of a ball or chew may ultimately improve the animals' chances of subsequent re-homing (Wells and Hepper, 1992, 2000a).

Whilst kennelled pups have been shown to express keen interest in the same toys several weeks after their introduction to the environment (Hubrecht, 1993), adult dogs have been shown to habituate to toys rapidly over several days, generally only expressing a renewed interest following the introduction of a completely novel stimulus (DeLuca and Kranda, 1992; Wells, *in press*). For older animals, the rotation of toys may thus be of more importance than their mere introduction into the kennel environment.

### 3.2. *Cage furniture*

The provision of cage 'furniture' to dogs housed in institutions may a useful method of increasing the complexity of the animals' environment. Hubrecht (1993) installed high platforms made accessible by steps to the kennels of laboratory-housed dogs, thereby allowing the animals to see beyond their own pens. The dogs were reported to employ the platforms for over 50% of the total observation time. Standard kennels may also be of value, particularly in terms of enhancing the security of the dogs' environment. Research has shown that dogs housed in laboratories spent 35% of the observation time inside their kennels, either resting or sleeping. The kennels were also used for play, with animals running around, and jumping on top of, the structures (Hubrecht et al., 1992).

The location of cage furniture within the captive environment can be important, particularly in rescue shelters, where one of the primary aims is to ensure the adoption of the animals housed within. Placing a dog's bed near the front of its enclosure can encourage the animal to spend more of its time in this particular location of the pen. This facilitates dog-visitor interactions and greatly increases the likelihood of subsequent re-homing. Wells and Hepper (2000a) discovered that dogs spent 64.3% of their time at the front of the cage whenever their bed was moved to this location, but only 35.7% of their time at the front of enclosure whenever their bed was at the rear of the pen. The incidence of dogs adopted from the rescue shelter also increased from an average of 69 animals a month whenever the dogs' beds were at the rear of their cages to 88 a month whenever the bedding was moved to the front.

Some rescue shelters, particularly in the United States, have started to place televisions into the environment of kennelled dogs. Research suggests that captive-housed primates benefit from such visual stimulation, particularly if exposed to moving images of conspecifics (e.g. Brent and Stone, 1996; Harris et al., 1999; Platt and Novak, 1997). To date, however, there is no scientific evidence to suggest that dogs benefit from the introduction of such cage furniture; nonetheless, such objects may create a more aesthetically-pleasing environment, thereby possibly helping to encourage more positive public perceptions of dog desirability.

### 3.3. Music

Music, and other types of auditory stimulation, can have a dramatic impact upon both the behaviour (e.g. Ragneskog et al., 1996; Yalch and Spangenberg, 2000) and mood (e.g. Hayakawa et al., 2000; McCraty et al., 1998; Scheel and Westefeld, 1999; Sousou, 1997) of humans. Exposure to 'grunge rock' music for instance can result in increased hostility, sadness, tension and fatigue, whilst listening to 'designer music' (i.e. music created to have a specific effect on the listener) can result in increased mental clarity, vigour and relaxation (McCraty et al., 1998).

Recognition of the benefits associated with music for human well-being has prompted recent research into the value of auditory stimulation as a means of enriching the environment of captive animals. The value of auditory enrichment has been studied in a variety of species, including birds (Gvoryahu et al., 1989; Ladd et al., 1992; Nicol, 1992; Reed et al., 1993), cattle (Evans, 1990; Uetake et al., 1997; Wisniewski, 1977), horses (Haupt et al., 2000) and primates (Brent and Weaver, 1996; Hanson et al., 1976; Markowitz and Line, 1989; Novak and Drewson, 1989; Ogden et al., 1994; O'Neill, 1989; Shepherdson et al., 1989). Many of these studies report changes in the behaviour and/or physiology of animals exposed to music recordings, radio broadcasts or ecologically relevant sounds.

Very recently, it has been discovered that kennelled dogs also react to their auditory environment (Wells et al., 2002b). Specifically, dogs housed in a rescue shelter were found to spend more of their time showing behaviours suggestive of relaxation (i.e. decreased barking, increased resting) upon exposure to classical music and more of their time displaying behaviours suggestive of agitation (i.e. increased barking) upon exposure to heavy metal music. Neither human conversation nor pop music had any effect on the dogs' behaviour. It is particularly important, from an animal welfare point of view, that an appropriate form of

auditory stimulation is employed in the shelter environment. Rescue shelters are extremely noisy environments. Adding further auditory stimulation, particularly that which causes agitation or increased stress, may actually do more harm than good and should ideally be avoided. Providing auditory stimulation that has a calming influence on the dogs' behaviour, however, may be advantageous, resulting in improved animal welfare, enhanced perceptions of dog desirability and an increase in the number of dogs that are re-homed (Wells et al., 2002b).

### 3.4. Odour

Recently, some attention has been directed towards the value of odour as a form of environmental enrichment for captive animals. Much of this work has been conducted on exotic cats, producing positive results. Powell (1995), for example, discovered that the introduction of scents including musk cologne, allspice and extracts of peppermint and almond, increased the activity level of captive-housed African lions, *Panthera leo*. Similar findings were reported by Schuett and Frase (2001) in their study of zoo-housed lions exposed to zebra dung, cinnamon, chilli powder and ginger, and by Pearson (2002) in her study of captive Asiatic lions exposed to herbs (i.e. rosemary, chives, lemongrass, allspice), and essential oils (i.e. peppermint, ylang, eucalyptus). More recently Wells and Egli (2004) discovered that zoo-housed black-footed cats, *Felis nigripes*, showed an increase in activity upon exposure to odours including nutmeg, catnip and the body odour of a potential prey animal (quail).

The dog is well renowned for its olfactory acuity (Kalmus, 1955; Hepper, 1988; Schoon and de Bruin, 1994; Settle et al., 1994; Sommerville et al., 1993). Odour introduction may thus hold potential as a form of environmental enrichment for kennelled canids. In the first study of this kind, Graham, Wells and Hepper (unpublished data) explored the effect of two odours known to have calming properties (i.e. lavender, chamomile) and two odours known to have stimulating properties (i.e. rosemary, peppermint) on humans, on the behaviour of 50 dogs housed in a rescue shelter. The 'calming' odours, and lavender in particular, were found to encourage behaviours more suggestive of relaxation in the dogs (e.g. decreased barking, increased resting), whilst the 'stimulating' odours, especially peppermint, heightened the dogs' activity, resulting in more movement. Further work is now needed to explore whether these preliminary findings are generalisable.

## 4. Conclusion

The domestic dog is an animal that needs both a complex animate and inanimate environment. The provision of social contacts, both with other dogs and humans, is absolutely essential and should be considered the most important form of environmental enrichment for confined canids. At the very least, dogs should be provided with visual conspecific contact. The provision of a complex and stimulating inanimate environment is also important to ensure adequate psychological well-being in kennelled dogs. The introduction of appropriate toys, music, scents and cage furniture can all help to enhance an otherwise relatively

routine environment. The regular rotation of such items is considered particularly important in preventing habituation.

Many institutions housing dogs are now paying more attention to the animals' environment and the important relationship between kennel design and canine welfare. The on-going research in this area will hopefully ensure that developments continue to be made in our understanding of how to ideally house kennelled dogs in order to promote both their physical and psychological well-being.

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## References

- Beerda, B., Schilder, M.B.H., Van Hoof, J.A.R.A.M., De Vries, H.W., Mol, J.A., 1999a. Chronic stress in dogs subjected to social and spatial restriction. I. Behavioral responses. *Physiol. Behav.* 66, 233–242.
- Beerda, B., Schilder, M.B.H., Bernadina, W., Van Hoof, J.A.R.A.M., De Vries, H.W., Mol, J.A., 1999b. Chronic stress in dogs subjected to social and spatial restriction. II. Hormonal and Immunological Responses. *Physiol. Behav.* 66, 243–254.
- Brent, L., Weaver, D., 1996. The physiological and behavioral effects of radio music on singly housed baboons. *J. Med. Primat.* 25, 370–374.
- Brent, L., Stone, A.M., 1996. Long-term use of televisions, balls, and mirrors as enrichment for paired and singly caged chimpanzees. *Am. J. Primat.* 39, 139–145.
- Campbell, S.A., Hughes, H.C., Griffin, H.E., Landi, M.S., Mallon, F.M., 1988. Some effects of limited exercise on purpose-bred Beagles. *Am. J. Vet. Res.* 49, 1298–1301.
- DeLuca, A.M., Kranda, K.C., 1992. Environmental enrichment in a large animal facility. *Lab. Anim.* 21, 38–44.
- Evans, A., 1990. Moosic is for cows, too. *Hoard's Dairyman* 135, 721.
- Fox, M.W., Bekoff, M., 1975. The behaviour of dogs. In: Hafez, E.S.E. (Ed.), *The Behaviour of Domestic Animals*. Bailliere Tindall, London, pp. 370–409.
- Fox, M.W., Stelzner, D., 1967. The effects of early experience on the development of inter and intraspecies social relationships in the dog. *Appl. Anim. Behav. Sci.* 15, 377–386.
- Fox, M.W., 1965. Environmental factors influencing stereotyped and allelomimetic behaviour in animals. *Lab. Anim. Care* 15, 363–370.
- Fox, M.W., 1986. *Laboratory Animal Husbandry*. State University of New York Press, London.
- Freedman, D.G., King, J.A., Elliot, O., 1961. Critical periods in the social development of the dog. *Science* 133, 1016.
- Fuller, J.L., 1967. Experiential deprivation and later behaviour. *Science* 158, 1645.
- Gvaryahu, G., Cunningham, D.L., van Tienhoven, A., 1989. Filial imprinting, environmental enrichment and music application effects on behavior and performance of meat strain chicks. *Poul. Sci.* 68, 211–217.
- Hanson, J.D., Larson, M.E., Snowdon, C.T., 1976. The effects of control over high intensity noise on plasma cortisol levels in rhesus monkeys. *Behav. Biol.* 16, 333–340.
- Harris, L.D., Briand, E.J., Orth, R., Galbicka, G., 1999. Assessing the value of television as environmental enrichment for individually housed rhesus monkeys: a behavioral economic approach. *Contemp. Topic Lab. Anim. Sci.* 38, 48–53.



- Hart, L.A., 1995. Dogs as companions: a review of the relationship. In: Serpell, J. (Ed.), *The Domestic Dog: Its Evolution, Behaviour and Interactions with People*. Cambridge University Press, Cambridge, pp. 161–179.
- Hayakawa, Y., Miki, H., Takada, K., Tanaka, K., 2000. Effects of music on mood during bench stepping exercise. *Percept. Motor Skill* 90, 307–314.
- Hennessy, M.B., Davis, H.N., Williams, M.T., Mellot, C., Douglas, C.W., 1997. Plasma cortisol levels of dogs at a county animal shelter. *Physiol. Behav.* 62, 485–490.
- Hennessy, M.B., Williams, M.T., Miller, D.D., Douglas, C.W., Voith, V.L., 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? *Appl. Anim. Behav. Sci.* 61, 63–77.
- Hepper, P.G., 1988. The discrimination of human odour by the dog. *Perception* 17, 549–554.
- Hetts, S., Clark, J.D., Calpin, J.P., Arnold, C.E., Mateo, J.M., 1992. Influence of housing conditions on beagle behaviour. *Appl. Anim. Behav. Sci.* 34, 137–155.
- Houpt, K., Marrow, M., Seeliger, M., 2000. A preliminary study of the effect of music on equine behavior. *J. Equine Vet. Sci.* 20, 691–737.
- Hubrecht, R.C., 1993. A comparison of social and laboratory environmental enrichment methods for laboratory housed dogs. *Appl. Anim. Behav. Sci.* 37, 345–361.
- Hubrecht, R.C., 1995a. The welfare of dogs in human care. In: Serpell, J. (Ed.), *The Domestic Dog*. Cambridge University Press, Cambridge, pp. 180–198.
- Hubrecht, R.C., 1995b. Enrichment in puppyhood and its effects on later behaviour of dogs. *Lab. Anim. Sci.* 45, 70–75.
- Hubrecht, R.C., Turner, D.C., 1998. Companion animal welfare in private and institutional settings. In: Wilson, C.C., Turner, D.C. (Eds.), *Companion Animals in Human Health*. Sage, London, pp. 267–289.
- Hubrecht, R.C., Serpell, J.A., Poole, T.B., 1992. Correlates of pen size and housing conditions on the behaviour of kennelled dogs. *Appl. Anim. Behav. Sci.* 34, 365–383.
- Hughes, H.C., Campbell, S., Kenney, C., 1989. The effects of cage size and pair housing on exercise of Beagle dogs. *Lab. Anim. Sci.* 39, 302–305.
- Kalmus, H., 1955. The discrimination by the nose of the dog of individual human odours and in particular the odour of twins. *Br. J. Anim. Behav.* 3, 25–31.
- Ladd, J.K., Albright, J.L., Beck, A.M., Ladd, B.T., 1992. Behavioral and physiological studies on the effect of music on animals. *J. Anim. Sci.* 70, 170.
- Lore, R.K., Eisenberg, F.B., 1986. Avoidance reactions of domestic dogs to unfamiliar male and female humans in a kennel setting. *Appl. Anim. Behav. Sci.* 15, 262–266.
- Luescher, U.A., McKeown, D.B., Halip, J., 1991. Stereotypic or obsessive-compulsive disorders in dogs and cats. *Vet. Clin. N. Am.: Sm. Anim. Pract.* 21, 401–413.
- Lynch, J.J., Gantt, W., 1968. The heart rate component of the social reflex in dogs: the conditional effects of petting and person. *Cond. Reflex* 3, 69–80.
- Lynch, J.J., McCarthy, J.F., 1967. The effect of petting on a classically conditioned emotional response. *Behav. Res. Ther.* 5, 55–62.
- Markowitz, H., Line, S., 1989. Primate research models and environmental enrichment. In: Segal, E. (Ed.), *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*. Noyes Publications, New Jersey, pp. 203–212.
- McCraty, R., Barrios-Choplin, B., Atkinson, M., Tomasino, D., 1998. The effects of different types of music on mood, tension and mental clarity. *Altern. Ther. Health Med.* 4, 75–84.
- Mertens, P.A., Unshelm, J., 1996. Effects of group and individual housing on the behaviour of kennelled dogs in animal shelters. *Anthrozoös* 9, 40–51.
- Newberry, R.C., 1995. Environmental enrichment: increasing the biological relevance of captive environments. *Appl. Anim. Behav. Sci.* 44, 229–243.
- Nicol, C.J., 1992. Effects of environmental enrichment and gentle handling on behaviour and fear responses of transported broilers. *Appl. Anim. Behav. Sci.* 33, 367–380.
- Novak, M.A., Drewson, K.H., 1989. Enriching the lives of captive primates: issues and problems. In: Segal, E. (Ed.), *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*. Noyes Publications, New Jersey, pp. 135–160.
- O'Farrell, V., 1992. *Manual of Canine Behaviour*. British Small Animal Veterinary Association, Cheltenham.

- O'Neill, P., 1989. A room with a view for captive primates: issues, goals, related research and strategies. In: Segal, E. (Ed.), *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*. Noyes Publications, New Jersey, pp. 135–160.
- Ogden, J.J., Lindburg, D.G., Maple, T.L., 1994. A preliminary study of the effects of ecologically relevant sounds on the behaviour of captive lowland gorillas. *Appl. Anim. Behav. Sci.* 39, 163–176.
- Pearson, J., 2002. On a roll: novel objects and scent enrichment for Asiatic lions. *Shap. Enrich.* 11, 7–10.
- PFMA., 2002. Profile 2002. Pet Food Manufacturers Association, London.
- Platt, D.M., Novak, M.A., 1997. Videostimulation as enrichment for captive rhesus monkeys (*Macaca mulatta*). *Appl. Anim. Behav. Sci.* 52, 139–155.
- Poole, T., 1998. Meeting a mammal's psychological needs. In: Shepherdson, D.J., Mellen, J.D., Hutchins, M. (Eds.), *Second Nature: Environmental Enrichment for Captive Animals*. Smithsonian Institution Press, Washington, DC, pp. 83–94.
- Powell, D.M., 1995. Preliminary evaluation of environmental enrichment techniques for African lions (*Panthera leo*). *Anim. Welfare* 4, 361–370.
- Ragneskog, H., Brane, G., Karlsson, I., Kihlgren, M., 1996. Influence of dinner music on food intake and symptoms common in dementia. *Scan. J. Caring Sci.* 10, 11–17.
- Reed, H.J., Wilkins, L.J., Austin, S.D., Gregory, N.G., 1993. The effect of environmental enrichment during rearing on fear reactions and depopulation trauma in adult caged hens. *Appl. Anim. Behav. Sci.* 36, 39–46.
- Rogerson, J., 1992. *Training Your Dog*. Popular Dogs Publishing Co. Ltd., London.
- Rooney, N.J., 1999. Play behaviour in the domestic dog *Canis familiaris*, and its effects on the dog-human relationship. Ph.D. Thesis. University of Southampton, UK.
- Rooney, N.J., Bradshaw, J.W.S., 2002. An experimental study of the effects of play upon the dog-human relationship. *Appl. Anim. Behav. Sci.* 75, 161–176.
- Russell, E.S., 1936. Playing with a dog. *Q. Rev. Biol.* 11, 1–15.
- Sales, G., Hubrecht, R., Peyvandi, A., Milligan, S., Shield, B., 1997. Noise in dog kennelling: is barking a welfare problem for dogs? *Appl. Anim. Behav. Sci.* 52, 321–329.
- Scheel, K.R., Westefeld, J.S., 1999. Heavy metal music and adolescent suicidality: an empirical investigation. *Adolescence* 34, 253–273.
- Schoon, G.A.A., de Bruin, J.C., 1994. The ability of dogs to recognise and cross-match human odours. *Forensic Sci. Int.* 69, 111–118.
- Schuett, E.B., Frase, B.A., 2001. Making scents: using the olfactory senses for lion enrichment. *Shape Enrich.* 10, 1–3.
- Settle, R.H., Sommerville, B.A., McCormick, J., Broom, D.M., 1994. Human scent matching using specially trained dogs. *Anim. Behav.* 48, 1443–1448.
- Shepherdson, D.J., Mellen, J.D., Hutchins, M., 1998. *Second Nature: Environmental Enrichment for Captive Animals*. Smithsonian Institution Press, London.
- Shepherdson, D., Bemment, N., Carman, M., Reynolds, S., 1989. Auditory enrichment for Lar gibbons *Hylobates lar* at London Zoo. *Int. Zoo Yrbk* 28, 256–260.
- Solarz, A.K., 1970. Behaviour. In: Anderson, A.C. (Ed.), *The Beagle as an Experimental Animals*. Iowa State University Press, Ames, pp. 453–468.
- Sommerville, B.A., Settle, R.H., Darling, F.M.C., Broom, D.M., 1993. The use of trained dogs to discriminate human scent. *Anim. Behav.* 46, 189–190.
- Sousou, S.D., 1997. Effects of melody and lyrics on mood and memory. *Percep. Motor Skill.* 85, 31–40.
- Tuber, D.S., Miller, D.D., Caris, K.A., Halter, R., Linden, F., Hennessy, M.B., 1999. Dogs in animal shelters: problems suggestions and needed expertise. *Psychtr. Sci.* 10, 379–386.
- Uetake, K., Hurnik, J.F., Johnson, L., 1997. Effect of music on voluntary approach of dairy cows to an automatic milking system. *Appl. Anim. Behav. Sci.* 53, 175–182.
- Verga, M., Carezzi, C., 1983. Behavioural tests to quantify adaption in domestic animals. In: Smidt, D. (Ed.), *Indicators Relevant to Farm Animal Welfare*. Martinus Nijhoff, The Hague, pp. 97–108.
- Wells, D.L., 1996. The welfare of dogs housed in an animal rescue shelter. Ph.D. Thesis. Queen's University Belfast, UK.
- Wells, D.L., in press. The influence of toys on the behaviour and welfare of kennelled dogs. *Anim. Welfare*.
- Wells, D.L., Egli, J.M., 2004. The influence of olfactory enrichment on the behaviour of black-footed cats, *Felis nigripes*. *Appl. Anim. Behav. Sci.* 85, 107–119.

- Wells, D.L., Hepper, P.G., 1992. The behaviour of dogs in a rescue shelter. *Anim. Welfare* 1, 171–186.
- Wells, D.L., Hepper, P.G., 1998. A note on the influence of visual conspecific contact on the behaviour of sheltered dogs. *Appl. Anim. Behav. Sci.* 60, 83–88.
- Wells, D.L., Hepper, P.G., 1999. Male and female dogs respond differently to men and women. *Appl. Anim. Behav. Sci.* 61, 341–349.
- Wells, D.L., Hepper, P.G., 2000a. The influence of environmental change on the behaviour of sheltered dogs. *Appl. Anim. Behav. Sci.* 68, 151–162.
- Wells, D.L., Hepper, P.G., 2000b. Prevalence of behaviour problems in dogs purchased from an animal rescue shelter. *Appl. Anim. Behav. Sci.* 69, 55–65.
- Wells, D.L., Graham, L., Hepper, P.G., 2002a. The influence of length of time spent in a rescue shelter on the behaviour of kennelled dogs. *Anim. Welfare* 11, 317–325.
- Wells, D.L., Graham, L., Hepper, P.G., 2002b. The influence of auditory stimulation on the behaviour of dogs housed in a rescue shelter. *Anim. Welfare* 11, 385–393.
- Wisniewski, E.W., 1977. Behavioral modification of milking parlour entrance order in dairy cattle trained by operant conditioning methods. Ph.D. Thesis, Purdue University, West Lafayette.
- Wolfe, T.L., 1987. Control of stress using non-drug approaches. *J.A.V.M.A.* 191, 1219–1221.
- Wolfe, T.L., 1990. Policy, program and people: the three P's to well-being. In: Mench, J.A., Krulisch, L. (Eds.), *Canine Research Environment*. Scientists Center for Animal Welfare, Bethesda, pp. 41–47.
- Yalch, R.F., Spangenberg, E.R., 2000. The effects of music in a retail setting on real and perceived shopping times. *J. Bus. Res.* 49, 139–147.