

Animal-assisted interventions as innovative tools for mental health

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Summary. There is a growing interest for the potential health benefits of human-animal interactions. Although scientific evidence on the effects is far from being consistent, companion animals are used with a large number of human subjects, ranging from children to elderly people, who benefit most from emotional support. Based on a comprehensive review of the literature, this paper examines the potential for domesticated animals, such as dogs, for providing emotional and physical opportunities to enrich the lives of many frail subjects. In particular, we focus on innovative interventions, including the potential use of dogs to improve the life of emotionally-impaired children, such as those affected by autism spectrum disorders. Overall an ever increasing research effort is needed to search for the mechanism that lie behind the human-animal bond as well as to provide standardized methodologies for a cautious and effective use of animal-assisted interventions.

Key words: animal facilitated therapy, elderly, children, autism spectrum disorders, dog.

Riassunto (*Interventi assistiti con gli animali come strumenti innovativi per il trattamento dei disturbi psichiatrici*). Negli ultimi anni si sta assistendo a un crescente interesse verso i potenziali effetti benefici per la salute umana derivanti dall'interazione uomo-animale. Sebbene le evidenze scientifiche siano ancora limitate, gli animali da compagnia vengono utilizzati in numerosi programmi di educazione e supporto emozionale per bambini e anziani. Partendo da una rivisitazione della letteratura scientifica disponibile, questa rassegna esamina le potenzialità di impiego degli animali domestici, in particolare il cane, come opportunità di arricchimento psicofisico della vita di soggetti caratterizzati da fragilità emozionale, quali i bambini affetti da disturbi dello spettro autistico. Sebbene i dati presenti in letteratura siano incoraggianti, è necessario promuovere ricerche mirate ad approfondire le potenzialità terapeutiche dell'interazione uomo-animale e a mettere a punto metodologie standardizzate finalizzate a un impiego efficace degli interventi assistiti con gli animali.

Parole chiave: terapia riabilitativa con gli animali, anziano, bambino, disordini dello spettro autistico, cane.

THE HUMAN-ANIMAL BOND

Although the bond between people and animals dates back to prehistory, only recently has this relationship become the subject of serious scientific inquiry.

For a number of people, companion animals represent an emotional, rather than an economical, resource, providing their owners with support, comfort and companionship [1]. Many people feel that their pet is a member of the family and treat it as such, this being particularly evident for the dog, the most ancient companion of humankind [1]. At the end of the last Ice Age, the transition from hunting-gathering to farming has favoured the process of animal domestication. The first species to make the transition from a wild to a domestic state has been the wolf (*Canis lupus*) and its domestication was based on a mutually beneficial relationship with man. Until recently, archaeological findings were the only evidence to highlight the beginning of man's symbiotic relationship with dogs, the commonly accepted date of dog's domestication being placed between 14 000

to 10 000 years ago. However, some anthropologists suggest that the human-dog relationship could be almost as old as modern man himself [2].

In return for companionship and food, the early ancestor of the dog assisted man in tracking, hunting, guarding and a variety of other activities. Ultimately, man began to selectively breed these animals for specific traits. Physical characteristics changed and individual breeds began to take shape. As man wandered across Asia and Europe, he took his dogs with him, using them for additional tasks and further breeding them for selected qualities that would better enable them to perform specific duties. Indeed, an extremely long association between dogs and humans has provided a solid scaffolding for the emergence of numerous dogs' social behaviours fundamental for cooperative and communicative interactions with humans [3-5]. During thousands of years of domestication dogs have been selected for characteristics that enhance their sensitivity to a wide range of human communicative signals, both visual and acoustic [6, 7]. Dogs'

unusual skills at reading human social and communicative behaviour have a heritable component and research with domesticated foxes suggests that this ability (just like neotenic features) might have initially evolved as a result of selection on systems mediating fear and aggression towards humans [8].

This so-called *emotional evolution* placed dogs in a new adaptive space in which they were able to interact with humans as comfortably as with their conspecifics [9], and has laid a foundation for the establishment of the human-dog bond. This special affectionate relationship has strong analogies with the parent-child *attachment* [10]: it is based on dependency and is specific in its focus, endures over time and results in one individual seeking and maintaining proximity to another individual [11]. Moreover, the perpetuating juvenile traits and the retention of youthful dependency motivations that make domestic animals look and behave like young even after sexual maturity, tend to elicit strong feelings of affection and powerful emotional responses in humans and are considered one of the causes behind our “alliance” with domestic animals [12-14]. The forms and manifestation of human’s bond with companion animals has led to their extensive use in different settings, with the implication that this bond is part of what helps patients to achieve therapeutic gains [15]. Humans seem to possess a predisposition to be attracted by the activities of other animals [16] and attention to animals alone is thought to be sufficient to explain some of the benefits of animal assisted interventions, since things that tend to focus and absorb people’s attention in non-threatening ways are also known to exert a calming or de-arousing influence [17, 18]. Moreover, by being able to respond affectionately to human attentions and to elicit pro-social behaviours and positive affect, animals, especially dogs, may possess a unique capacity to serve as an emotional bridge to mediate interactions in otherwise awkward and uncomfortable therapeutic contexts [1].

THE HEALTH BENEFITS OF COMPANION ANIMALS: BASIC MECHANISMS

In humans, negative affective states, such as depression, are associated with premature mortality and increased risk of coronary heart disease, type 2 diabetes, and disability. By contrast, positive affective states, such as those arising from close social relationships, are protective [19]. To date, it is unclear which neurophysiological mechanisms mediate both the beneficial effects of happy close social relationships on psychological stress systems as well as the negative effects of repeated and intense couple conflict [20]. However, a large body of evidence links the central activity of the neuropeptide oxytocin with affiliative behaviour as well as with stress reduction in mammals particularly humans [21].

There is increasing evidence suggesting that a close relationship with a pet animal is associated

with significant health effects in people. The most cited outcomes are: lowered risk factors for cardiovascular disease, such as coronary heart disease [22, 23], higher chance to survive after myocardial infarction [24, 25], less need of physician services during stressful life events [26] and a highly significant reduction in everyday minor health problems during the first months after acquiring a pet [27]. Although in different studies the relationship between owning a pet and health may be explained by an indirect effect such as the association between dog ownership and the number/duration of recreational walks [22, 23, 27, 28], more direct effects of human-animal contacts have been reported, albeit only investigated in the short term. The presence of an animal, or even the mere observation of animals [17, 29], can buffer physiological and psychological responses to stress and anxiety: as an example, a transient decrease in blood pressure and heart rate has been observed in adults and children in the presence of a companion dog as well as while interacting with friendly but unknown dogs [30-34] (for an exhaustive review see [15]).

The need for attention and affiliation already exists in the basic behavioural patterns of many living organisms and it can cross the species barrier [35]. The current claims for success, where animals are used to assist in therapy, are mainly based on the ability of animals to fulfil such needs and this is particularly important for individuals lacking support from family members or close friends. Companion animals somehow possess the ability to reconnect such people with the outside world, breaking down the barriers of isolation that make them refractory to conventional forms of treatment [1]. The presence of an animal, particularly a dog, is able to act as an “ice-breaker”: it catalyzes communication and enhances opportunities for social exchange and shared interests which, in turn, can promote a feeling of social integration [36-39].

In order to study the mechanisms underlying human-animal bonding and its effects on stress and arousal, the role of selected physiological indices involved in arousal and affiliative behaviours has been recently explored. Among the mediators assessed we can enlist: beta-endorphin, oxytocin, prolactin, phenylethylamine, dopamine and cortisol [40]. Being involved in a positive interaction with a dog was found to be as relaxing as quiet book-reading (lowering cortisol levels), but interacting with a dog caused a significantly higher increase of oxytocin, a neuropeptide synthesized in the hypothalamus and released upon lactation and parturition, which plays an important role in pair bonding social affiliation and trust in many species involved with bonding or affiliation [40, 41]. In nonhuman mammals, the neuropeptide oxytocin has been repeatedly shown to increase social approach behaviour and pair bonding. In particular, central nervous oxytocin reduces behavioral and neuroendocrine responses to social stress and is suggested to mediate the rewarding aspects of attachment

Table 1 | Selected publications produced in the last decade in the field of animal assisted interventions

Human disorders	References
Senile dementia, Alzheimer's disease	[44-50]
Psychiatric disorders, schizophrenia	[51-58]
Autism	[59-63]
Cancer	[64-66]
Chronic heart failure	[67, 68]
Spinal cord injury	[69]
Cerebral palsy	[70]
Multiple sclerosis	[71]
Language disorders, aphasia	[72-75]

in highly social species. Interestingly, Nagasawa and collaborators were able to demonstrate that the concentration of oxytocin in the urine of dog owners is positively correlated with the amount of reciprocal gaze with their dog which might indicate the existence of inter-species attachment behaviour and mutual behavioural regulation [41].

EXPLOITING THE HUMAN-ANIMAL BOND

While experimental evidence on the effects of pets for human health is still in the process of being gathered, thousands of volunteers, associations and health professionals worldwide have gradually introduced animals to a variety of health care settings [42, 43]. Different animals are purposely included in various therapeutic/activity programs also known as animal-assisted interventions (AAI), which are receiving growing attention in the fields of nursing, medicine and psychotherapy because of their potential to influence a large number of health-related problems in different clinical populations (Table 1).

The popular term “pet therapy”, was coined in 1964 after a child psychiatrist, Boris M. Levinson, observed a facilitatory effect caused by the presence of his dog, Jingles, during his therapy sessions with severely withdrawn children. This is considered one of the best examples of the therapeutic use of animals reported in the literature. Indeed, through his dog Levinson was

able to establish a relationship with the child and start an effective therapy. Since then, scientists and health professionals have attempted to follow Levinson's model. The term “pet therapy” is now being substituted by a more appropriate terminology which allows distinguishing among different types of interactions, globally defined as AAI (Table 2).

Notwithstanding the large number of AAI, most of the programs lack a solid methodological structure and rely on descriptive, rather than on hypothesis-based, evaluations of outcomes. A standardized and quantitative description of human-animal interactions is often lacking and in many cases confounding variables are present in the protocol, including health habits or pathological conditions, level of attachment to the companion animal and concomitant human social support that make it difficult to assess health outcomes [42, 43].

DOG-ASSISTED INTERVENTIONS

Dogs' ability to develop a complex communication system with humans makes these animals particularly suitable to facilitate social interactions and communication. Dogs are highly interactive and provide opportunities for physical, recreational and social activities and their attitude to be trained has led them to be the most used animals to study the beneficial effects of pets for people of all ages [76]. Different studies have focused on the benefits of dogs ownership and a growing body of research is showing how interacting with dogs that are not owned by the subject (dog-assisted interventions) is associated with a variety of physical, psychological, and social rewards for the persons involved [15].

Elderly

Taking advantage of their extreme predictability and friendliness, dogs are being incorporated in a number of interventions designed to mitigate the effects of institutionalization in geriatric patients. Institutionalization can have serious implications for individual's wellbeing as a result of decreased quality of life and increased stress related to separation from the family [77]. Indeed dog-mediated intervention programs have proven to be effective in improving communication, reducing lone-

Table 2 | Animal-assisted interventions (AAI): definitions

Animal-assisted activities (AAA)	Provide opportunities for motivational, educational, and/or recreational benefits in order to enhance quality of life of humans. AAA are delivered in a variety of environments by specially trained professionals, and/or volunteers in association with animals that meet specific criteria of safety.
Animal-assisted therapies (AAT)	Are goal-directed interventions in which a specifically trained animal is an integral part of the treatment process. AAT are delivered and/or directed by a health/human service provider working within the scope of his or her profession. AAT are designed to promote improvement in human physical, social, emotional, and/or cognitive functioning. They are provided in a variety of settings and involve the individual. This process needs to be documented and evaluated throughout.
Animal-assisted education (AAE)	Relies on the use of animals for specific educational purposes, as is the case with problematic children characterized by behavioural problems.

liness as well as the psychological symptoms linked to depression and stress in community dwelling older people [44, 50, 78-81].

Nonetheless, contradictory data show the need for further research in this area, as visiting dog programs were not always observed to improve mood, cognitive abilities or social interactions [48, 82, 83]. In a recent study [84] a specific ethogram of elderly-dog interactions was derived and characterized, aimed at evaluating the effectiveness of visiting dogs in improving mood, catalyzing social interactions and reducing the every-day apathetic state of geriatric patients. A geriatric depression scale was administered to evaluate mood changes and cortisol levels were measured in the saliva to assess psychophysical activation. Overall, results indicate a time-dependent increase in behaviours indicative of a positive attitude and will to communicate, such as smile, and in spontaneous interactions with dogs as a result of the AAI program. Depending on the specific nature of the intervention (e.g. ludic-recreational vs. therapeutic), behavioural and physiological assessments resulted in different outcomes but the common feature was the ability of human-dog interactions in reducing withdrawal and avoidance behaviours. Results indicate that both a therapeutic and recreational intervention using dogs may decrease the apathetic status of patients living in a nursing home and physiological assessments such as cortisol measurements enlarge and strengthen such a body of evidence. The temporal analysis of the behavioural changes observed suggests that relationships need time to develop and thus benefits of visiting dogs can become detectable after some time (months). Thus sporadic or intermittent intervention programs may result less effective. Future studies will need to test whether behavioural, physiological and psychological changes obtained as a result of AAI programs are long-lasting or whether they are strictly related to a continuous exposure to the dog.

As far as stress indices are concerned, previous studies have shown a decrease in cortisol levels after interactions with dogs in healthy adults [40, 85]. However these results have not been replicated in a geriatric population (Figure 1). The decline in cortisol levels was ascribed to a general de-arousal effect of affiliative animal-human interaction, however, the role of animals, especially dogs, in inducing a general psychomotor activation and stimulating physical activity in otherwise apathetic patients should not be underestimated.

Children

At the other end of human's life is childhood. The influence of pets on children development is a relatively new area for scientific research. Studies focused on the child-dog relationship are grounded on a number of concepts including: attachment theory, contextualism, environmental psychology, child therapy [86]. There is a widespread belief that interaction with an animal is beneficial for the development of children and several studies have investigated the in-

fluence of companion animals on social-emotional and cognitive development [87, 88]. Many parents report that pets can be valuable tools with which to educate their children about life events (e.g. concepts of life and death) and psychological testing has revealed that growing up with pets has a beneficial effect on children's self-esteem and self-confidence, can enhance empathy and sense of responsibility, as well as social status within the peer group [89-93].

Such results support pedagogical common sense that animal contact benefits child development, but the mechanisms that lie behind these results remain not clear. Animals, particularly dogs, can have a profound calming effect on children and the general assumption underlying AAI with these subjects is the non-judgmental and non-threatening nature of the companion animal's support which can promote a climate of "safety" for the child and contribute to a positive perception of a situation [88, 94]. Animals may indeed help children to cope with mildly stressful activities (e.g. visit to the doctor's office or reading aloud) and also with a major, stressful experience like hospitalization, with measurable physiological effects such as decrease in blood pressure and heart rate [64, 95-98]. Since children are less anxious when they interact with therapy dogs they are also more willing to engage with peers and adults: an increase in responsiveness, alertness and willingness to communicate has been observed when a dog was introduced in the classroom or in therapeutic environments [89, 99-103].

Animals may indeed represent a valid help in therapeutic contexts thanks to their ability to catalyze social interactions and to create a more relaxed environment conducive to self-disclosure, a requirement necessary for the therapeutic process. Emotional availability to participate in the therapy practice was enhanced by the presence of a dog during AAI in children who had previously experienced psychological and/or physical abuse and have been separated from their families [94], while children with different disabilities benefit from the use of skilled dogs as teaching assistants and therapeutic adjuncts [102, 103].

Interestingly, different authors suggest that also children with autism spectrum disorder (ASD), who have specific impairments in communicating and adequately relating to other people, exhibit a natural interest towards animals, especially dogs. An intriguing hypothesis suggests that interactions with animals, characterized by simple and more interpretable movement patterns, might facilitate the engagement of autistic people, providing a medium to learn to interpret the more subtle behaviour of human beings [59, 60, 62, 104]. Moreover, dogs, representing a powerful multisensory stimulus – strong and clear sounds, a vivid visual impression, a special smell and an innovation to touch – might target the low sensory and affective arousal levels characterizing ASD patients, involving them in dyadic interactions based on pleasurable activities that have strong sensory, movement, and social foundations [104, 105]. Thus

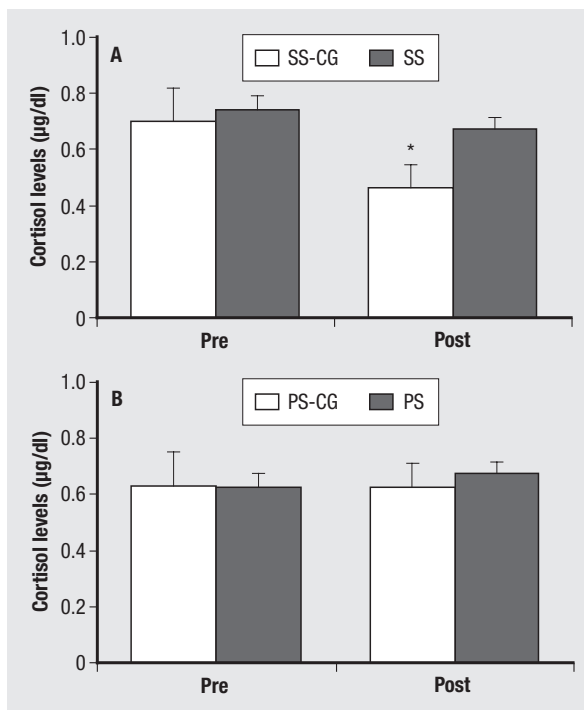


Fig. 1 | Salivary cortisol levels ($\mu\text{g/dl}$) in patients before and after sessions with dog (SS and PS) and without the dog (SS-CG and PS-CG). A) Socialization sessions: SS-CG showed a significant decrease in salivary cortisol from the first to the second sample, but this decrease was not observed in the SS group; B) Physical therapy sessions: both groups failed to show the physiological circadian decrease in cortisol, $*p < 0.05$. Data represent means + SEM of data (transformed as square root of the original value). Pre and Post values represent the average of February and June original data, for a total of 17 subjects. Modified from [84].

AAI with dogs appear to hold the potential to benefit ASD population and preliminary research supports this notion. Introducing a friendly dog into a therapeutic session was found to increase socially appropriate behaviours, attention and language use, a result particularly important considering that language impairment is one of the most pervasive symptom characterizing children affected by ASD [63]. This increase was directed towards the dog and the therapist and was paralleled by a decrease in stereotyped behaviours, aggressive manifestations and self-absorption [59, 62, 63, 104].

Overall, this evidence suggests that interacting with pets, owning a pet as well as animal-based humane education programs have a great potentiality for counteracting child behavioral problems (e.g. learning disabilities, aggressiveness and attention deficit) and for aiding social integration, although further research and long-term studies are required to confirm that animals are positive casual agents in children social and cognitive development. In this context it appears of importance to investigate children's attitudes towards animals, starting from the very early developmental stages, by analyzing their behavioural repertoire in the presence of a pet, a field of research still much unexplored. The

future challenge is to unravel the potential differences of spontaneous behaviour (attitudes) in typical and atypical developing children and to explore the implications of this information for children's therapists [106].

Surprisingly, while there is increasing interest in the role of animals upon children's wellbeing, less attention is paid to the specific characteristics of the child-animal interactions in different child populations. Thus, future research should be aimed at developing experimental designs to explore how children perceive animals, whether dogs are able to stimulate prosocial behaviours to facilitate language acquisition and to enhance motor and verbal skills in early developmental stages both for typically and atypically developing children.

TOWARDS AAI GUIDELINES

At present, in Italy AAI have been recognized as official care by a Legislative Decree (DL.vo issued on February 28th 2003), however there is no specific legislation regulating them, which poses serious problems in terms of safety and protection of humans subjects. Indeed, those who can benefit from AAI are frail subjects and are mainly represented by children as they are often extremely trusting and may easily achieve a level of intimacy with animals, as well as elderly persons. In AAI, the activity performed by the "animal therapist" towards the "human patient" is very complex and to be successful, above all, should entail the contribution of many professional figures. For this reason, a combined effort of a cross-disciplinary team made up of various professional categories should always characterize an AAI program. These categories interact and bring their own specific contribution in a complementary way. In the case of animal assisted therapies (AAT), a physician should always be part of the operating team and be responsible for defining the objectives and the operational constraints. All members of the team (be them health professionals, nurses or veterinarians) should be involved in the different steps of the programs and at the execution of activities and therapies. In particular, it is important that these activities do not result stressful for the animal itself [42, 43, 107].

CONCLUSIONS

In this review we analyzed the evidence underlying the potential influence of interaction with animals, especially dogs, for human health. Despite the methodological weaknesses of some of the existing studies, the current evidence is promising and a growing body of research is starting to address the mechanisms behind the human-animal bond [40]. Animals tend to focus and absorb people's attention in non-threatening ways and are also known to exert a calming or de-arousing influence [17, 18, 108]. Moreover, the ability of domesticated animals to respond affectionately to human attentions and to elicit pro-social behaviour and positive affect may

serve as an emotional bridge to mediate interactions in therapeutic contexts [1].

The “therapeutic potential” of AAI could vary according to the animal species involved. As an example, dogs’ ability to develop a complex communication system with humans, enhanced by the domestication process, makes these animals particularly able to increase responsiveness and willingness to communicate. By and large, domesticated animals should be used as they are those that have been selected for their ability to interact socially (and emotionally) with humans.

Future standards for animal-assisted activities and therapies will rely upon a critical need to document the whole activity/therapeutic process, to understand which techniques work best with each patient, to analyze the inherent problems of designing interventions and begin to examine the practices used in AAI programs, promoting a solid training of all professionals involved and the selection processes: overall, an increasing research effort is needed to provide standardized methodologies which can result in meaning-

ful data supporting AAI as a potential tool for mental health.

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Conflict of interest statement

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

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References

- Serpell J. *In the company of animals: A study of human-animal relationships*. Cambridge: Cambridge University Press; 1996.
- Miklosi A. *Dog behaviour, evolution and cognition*. Oxford: Oxford University Press; 2007.
- Gacsi M, McGreevy P, Kara E, Miklosi A. Effects of selection for cooperation and attention in dogs. *Behav Brain Funct* 2009;5:31.
- Topal J, Gergely G, Erdohegyi A, Csibra G, Miklosi A. Differential sensitivity to human communication in dogs, wolves, and human infants. *Science* 2009;325:1269-72.
- Gacsi M, Gyori B, Viranyi Z, Kubinyi E, Range F, Belenyi B, et al. Explaining dog wolf differences in utilizing human pointing gestures: selection for synergistic shifts in the development of some social skills. *PLoS One* 2009;4:e6584.
- Miklosi A. Evolutionary approach to communication between humans and dogs. *Vet Res Commun* 2009;33(Suppl. 1):53-9.
- Pongracz P, Molnar C, Miklosi A. Barking in family dogs: an ethological approach. *Vet J* 2010;183:141-47.
- Hare B, Plyusnina I, Ignacio N, Schepina O, Stepika A, Wrangham R, et al. Social cognitive evolution in captive foxes is a correlated by-product of experimental domestication. *Curr Biol* 2005;15:226-30.
- Hare B, Tomasello M. Human-like social skills in dogs? *Trends Cogn Sci* 2005;9:439-44.
- Bowlby J. The nature of the child’s tie to his mother. *Int J Psychoanal* 1958;39:350-73.
- Topal J, Gacsi M, Miklosi A, Viranyi Z, Kubinyi E, Csany V. Attachment to humans: a comparative study on hand-reared wolves and differently socialized dog puppies. *Anim Behav* 2005;70:1367-75.
- Lorenz K. Die angeborenen formen möglicher effahrung. *Z Tierpsychol* 1943;5:235-409.
- Archer J. Why do people love their pets? *Evol Hum Behav* 1997;18:237-59.
- Archer J, Monton S. Preferences for infant facial features in pet dogs and cats. *Ethology* 2011;117:217-26.
- Friedmann E, Son H. The human-companion animal bond: how humans benefit. *Vet Clin North Am Small Anim Pract* 2009;39:293-326.
- Kellert SR. The biological basis for human values of nature. In: Kellert SR, Wilson EO (Eds.) *The biophilia hypothesis*. Washington: Island Press; 1993. p. 42-69.
- DeSchrive M, Riddick C. Effects of watching aquariums on elders’ stress. *Anthrozoös* 1990;4:44-8.
- Katcher AH, Friedmann E, Beck AM, Lynch JJ. Looking, talking and blood pressure: The physiological consequences of interaction with the living environment. In: Katcher AH, Beck AM (Ed.). *New perspectives on our lives with companion animals*. Philadelphia: University of Pennsylvania Press; 1983.
- Steptoe A, Wardle J, Marmot M. Positive affect and health-related neuroendocrine, cardiovascular, and inflammatory processes. *Proc Natl Acad Sci USA* 2005;102:6508-12.
- McEwen BS. Physiology and neurobiology of stress and adaptation: central role of the brain. *Physiol Rev* 2007;87:873-904.
- Ditzen B, Schaer M, Gabriel B, Bodenmann G, Ehlert U, Heinrichs M. Intranasal oxytocin increases positive communication and reduces cortisol levels during couple conflict. *Biol Psychiatry* 2009;65:728-31.
- Dembicki D, Anderson J. Pet ownership may be a factor in improved health of the elderly. *J Nutr Elder* 1996;15:15-31.
- Anderson WP, Reid CM, Jennings GL. Pet ownership and risk factors for cardiovascular disease. *Med J Aust* 1992;157:298-301.
- Friedmann E, Katcher AH, Lynch JJ, Thomas SA. Animal companions and one-year survival of patients after discharge from a coronary care unit. *Public Health Rep* 1980;95:307-12.
- Friedmann E, Thomas SA. Pet ownership, social support, and one-year survival after acute myocardial infarction in the cardiac arrhythmia suppression trial (CAST). *Am J Cardiol* 1995;76:1213-7.
- Siegel JM. Stressful life events and use of physician services among the elderly: the moderating role of pet ownership. *J Pers Soc Psychol* 1990;58:1081-6.

27. Serpell J. Beneficial effects of pet ownership on some aspects of human health and behaviour. *J R Soc Med* 1991;84:717-20.
28. Bauman AE, Russell SJ, Furber SE, Dobson AJ. The epidemiology of dog walking: an unmet need for human and canine health. *Med J Aust* 2001;175:632-4.
29. Wells D. The effect of videotapes of animals on cardiovascular responses to stress. *Stress Health* 2005;21:209-13.
30. Allen KM, Blascovich J, Tomaka J, Kelsey RM. Presence of human friends and pet dogs as moderators of autonomic responses to stress in women. *J Pers Soc Psychol* 1991;61:582-9.
31. Allen K, Shykoff BE, Izzo JL Jr. Pet ownership, but not ace inhibitor therapy, blunts home blood pressure responses to mental stress. *Hypertension* 2001;38:815-20.
32. Friedmann E, Locker B, Lockwood R. Perception of animals and cardiovascular responses during verbalization with an animal present. *Anthrozoös* 1993;6:115-34.
33. Friedmann E, Thomas S, Cook L, Tsai C, Picot S. A friendly dog as potential moderator of cardiovascular response to speech in older hypertensives. *Anthrozoös* 2007;20:51-63.
34. Allen K, Blascovich J, Mendes WB. Cardiovascular reactivity and the presence of pets, friends, and spouses: the truth about cats and dogs. *Psychosom Med* 2002;64:727-39.
35. Odendaal JS. Animal-assisted therapy - magic or medicine? *J Psychosom Res* 2000;49:275-80.
36. Wood L, Giles-Corti B, Bulsara M. The pet connection: pets as a conduit for social capital? *Soc Sci Med* 2005;61:1159-73.
37. Wells DL. The facilitation of social interactions by domestic dogs. *Anthrozoös* 2004;17:340-52.
38. Knight S, Edwards V. In the company of wolves: the physical, social, and psychological benefits of dog ownership. *Journal of Aging and Health* 2008;20:437-55.
39. McNicholas J, Collis GM. Dogs as catalysts for social interactions: robustness of the effect. *British Journal of Psychology* 2000;91:61-70.
40. Odendaal JS, Meintjes RA. Neurophysiological correlates of affiliative behaviour between humans and dogs. *Vet J* 2003;165:296-301.
41. Nagasawa M, Kikusui T, Onaka T, Ohta M. Dog's gaze at its owner increases owner's urinary oxytocin during social interaction. *Horm Behav* 2009;55:434-41.
42. Cirulli F, Alleva E. *Terapie e attività assistite con gli animali: analisi della situazione italiana e proposta di linee guida*. Roma: Istituto Superiore di Sanità; 2007 (Rapporti ISTISAN, 07/35).
43. Cirulli F, Francia N, Alleva E. *Terapie e attività assistite con gli animali in Italia. Attualità, prospettive e proposta di linee guida*. Roma: Istituto Superiore di Sanità; 2010 (Rapporti ISTISAN, 10/4).
44. Kanamori M, Suzuki M, Yamamoto K, Kanda M, Matsui Y, Kojima E, et al. A day care program and evaluation of animal-assisted therapy (AAT) for the elderly with senile dementia. *Am J Alzheimers Dis Other Demen* 2001;16:234-9.
45. Edwards NE, Beck AM. Animal-assisted therapy and Nutrition in Alzheimer's disease. *West J Nurs Res* 2002;24:697-712.
46. Richeson NE. Effects of animal-assisted therapy on agitated behaviors and social interactions of older adults with dementia. *Am J Alzheimers Dis Other Demen* 2003;18:353-8.
47. Marx MS, Cohen-Mansfield J, Regier NG, Dakheel-Ali M, Srihari A, Thein K. The impact of different dog-related stimuli on engagement of persons with dementia. *Am J Alzheimers Dis Other Demen* 2010;25:37-45.
48. Motomura N, Yagi T, Ohya H. Animal assisted therapy for people with dementia. *Psychogeriatrics* 2004;4:40-2.
49. McCabe BW, Baun MM, Speich D, Agrawal S. Resident dog in the Alzheimer's special care unit. *West J Nurs Res* 2002;24:684-96.
50. Kramer SC, Friedmann E, Bernstein PL. Comparison of the effect of human interaction, animal-assisted therapy, and AIBO-assisted therapy on long-term care residents with dementia. *Anthrozoös* 2009;22:43-57.
51. Barker SB, Pandurangi AK, Best AM. Effects of animal-assisted therapy on patients' anxiety, fear, and depression before ECT. *J Ect* 2003;19:38-44.
52. Prothmann A, Bienert M, Ettrich C. Dogs in child psychotherapy: Effects on state of mind. *Anthrozoös* 2006;19:265-77.
53. Berget B, Ekeberg O, Braastad BO. Animal-assisted therapy with farm animals for persons with psychiatric disorders: effects on self-efficacy, coping ability and quality of life, a randomized controlled trial. *Clin Pract Epidemiol Ment Health* 2008;4:9.
54. Barak Y, Savorai O, Mavashev S, Beni A. Animal-assisted therapy for elderly schizophrenic patients: a one-year controlled trial. *Am J Geriatr Psychiatry* 2001;9:439-42.
55. Kovacs Z, Kis R, Rozsa S, Rozsa L. Animal-assisted therapy for middle-aged schizophrenic patients living in a social institution. A pilot study. *Clin Rehabil* 2004;18:483-6.
56. Nathans-Barel I, Feldman P, Berger B, Modai I, Silver H. Animal-assisted therapy ameliorates anhedonia in schizophrenia patients. A controlled pilot study. *Psychother Psychosom* 2005;74:31-5.
57. Chu CI, Liu CY, Sun CT, Lin J. The effect of animal-assisted activity on inpatients with schizophrenia. *J Psychosoc Nurs Ment Health Serv* 2009;47:42-8.
58. Bizub AL, Joy A, Davidson L. "It's like being in another world": demonstrating the benefits of therapeutic horseback riding for individuals with psychiatric disability. *Psychiatr Rehabil J* 2003;26:377-84.
59. Silva K, Correia R, Lima M, Magalhaes A, de Sousa L. Can dogs prime autistic children for therapy? Evidence from a single case study. *J Altern Complement Med* 2011;17:655-9.
60. Solomon O. What a dog can do: children with autism and therapy dogs in social interaction. *ETHOS, Journal of the Society for Psychological Anthropology* 2010;38:143-66.
61. Bass MM, Duchowny CA, Llabre MM. The effect of therapeutic horseback riding on social functioning in children with autism. *J Autism Dev Disord* 2009;39:1261-7.
62. Sams MJ, Fortney EV, Willenbring S. Occupational therapy incorporating animals for children with autism: A pilot investigation. *Am J Occup Ther* 2006;60:268-74.
63. Martin F, Farnum J. Animal-assisted therapy for children with pervasive developmental disorders. *West J Nurs Res* 2002;24:657-70.
64. Bouchard F, Landry M, Belles-Isles M, Gagnon J. A magical dream: a pilot project in animal-assisted therapy in pediatric oncology. *Can Oncol Nurs J* 2004;14:14-7.
65. Orlandi M, Trangeled K, Mambrini A, Tagliani M, Ferrarini A, Zanetti L, et al. Pet therapy effects on oncological day hospital patients undergoing chemotherapy treatment. *Anticancer Res* 2007;27:4301-3.
66. Johnson RA, Meadows RL, Haubner JS, Sevedge K. Animal-assisted activity among patients with cancer: effects on mood, fatigue, self-perceived health, and sense of coherence. *Oncol Nurs Forum* 2008;35:225-32.
67. Cole KM, Gawlinski A, Steers N, Kotlerman J. Animal-assisted therapy in patients hospitalized with heart failure. *Am J Crit Care* 2007;16:575-85; quiz 86; discussion 87-8.
68. Abate SV, Zucconi M, Boxer BA. Impact of canine-assisted ambulation on hospitalized chronic heart failure patients' ambulation outcomes and Satisfaction: A Pilot Study. *J Cardiovasc Nurs* 2011;
69. Lechner HE, Kakebeeke TH, Hegemann D, Baumberger M. The effect of hippotherapy on spasticity and on mental

- well-being of persons with spinal cord injury. *Arch Phys Med Rehabil* 2007;88:1241-8.
70. McGibbon NH, Benda W, Duncan BR, Silkwood-Sherer D. Immediate and long-term effects of hippotherapy on symmetry of adductor muscle activity and functional ability in children with spastic cerebral palsy. *Arch Phys Med Rehabil* 2009;90:966-74.
 71. Silkwood-Sherer D, Warmbier H. Effects of hippotherapy on postural stability, in persons with multiple sclerosis: a pilot study. *J Neurol Phys Ther* 2007;31:77-84.
 72. Gee N, Harris S, Johnson K. The role of therapy dogs in speed and accuracy to complete motor skills tasks for preschool children. *Anthrozoös* 2007;20:375-86.
 73. Macauly B, Gutierrez K. The effectiveness of hippotherapy for children with language-learning disabilities. *Commun Disord Q* 2004;25:205-17.
 74. Macauly BL. Animal-assisted therapy for persons with aphasia: A pilot study. *J Rehabil Res Dev* 2006;43:357-66.
 75. LaFrance C, Garcia LJ, Labreche J. The effect of a therapy dog on the communication skills of an adult with aphasia. *J Commun Disord* 2007;40:215-24.
 76. Wells DL. Domestic dogs and human health: an overview. *Br J Health Psychol* 2007;12:145-56.
 77. Prieto-Flores ME, Forjaz MJ, Fernandez-Mayoralas G, Rojo-Perez F, Martinez-Martin P. Factors Associated With Loneliness of Noninstitutionalized and Institutionalized Older Adults. *J Aging Health* 2010;23:177-94.
 78. Banks MR, Willoughby LM, Banks WA. Animal-assisted therapy and loneliness in nursing homes: use of robotic versus living dogs. *J Am Med Dir Assoc* 2008;9:173-7.
 79. Lutwack-Bloom P, Smith B, Wijewickrama R. Effects of pets versus people visits with nursing home residents. *J Gerontol Soc Work* 2005;44:137-59.
 80. Kaiser L, Spence LJ, McGavin L, Struble L, Keilman L. A dog and a "happy person" visit nursing home residents. *West J Nurs Res* 2002;24:671-83.
 81. Banks MR, Banks WA. The effects of animal-assisted therapy on loneliness in an elderly population in long-term care facilities. *J Gerontol A Biol Sci Med Sci* 2002;57:M428-32.
 82. Le Roux MC, Kemp R. Effect of a companion dog on depression and anxiety levels of elderly residents in a long-term care facility. *Psychogeriatrics* 2009;9:23-26.
 83. Phelps KA, Miltenberger RG, Jens T, Wadson H. An investigation of the effects of dog visits on depression, mood, and social interaction in elderly individuals living in a nursing home. *Behavioral Interventions* 2008;23:181-200.
 84. Berry A, Borgi M, Terranova L, Chiarotti F, Alleva E, Cirulli F. Developing effective animal-assisted interventions (AAI) programs involving visiting dogs for institutionalized geriatric patients: a pilot study. *Psychogeriatrics* (In press).
 85. Barker SB, Knisely JS, McCain NL, Schubert CM, Pandurangi AK. Exploratory study of stressbuffering response patterns from interaction with a therapy dog. *Anthrozoös* 2010;23:79-91.
 86. Melson G. Psychology and the study of human-animal relationships. *Society Animals* 2002;10:347-52.
 87. Melson GF. Child development and the human-companion animal bond. *American Behavioural Scientist* 2003;47:31-9.
 88. Endenburg N, van Lith HA. The influence of animals on the development of children. *Vet J* 2010; Dec 30. [Epub ahead of print].
 89. Anderson K, Olson M. The value of a dog in a classroom of children with severe emotional disorders. *Anthrozoös* 2006;19:35-49.
 90. Daly B, Morton LL. An investigation of human-animal interactions and empathy as related to pet preference, ownership, attachment, and attitudes in children. *Anthrozoös* 2006;19:113-27.
 91. Vidović VV, Stetić VV, Bratko D. Pet ownership, type of pet and socio-emotional development of school children. *Anthrozoös* 1999;12:211-7.
 92. Van Houtte BA, Jarvis PA. The role of pets in preadolescent psychosocial development. *J Appl Dev Psychol* 1995;16:463-79.
 93. Guttman G, Predovic M, Zemanek M. The influence of pet ownership in non-verbal communication and social competence in children. In: *The human-pet relationship: Proceeding of the International Symposium on the Occasion of the 80th Birthday of Nobel Prize Winner Prof Dr Konrad Lorenz*. 27-28 October, 1983. Vienna: IEMT; 1985.
 94. Parish-Plass N. Animal-assisted therapy with children suffering from insecure attachment due to abuse and neglect: a method to lower the risk of intergenerational transmission of abuse? *Clin Child Psychol Psychiatry* 2008;13:7-30.
 95. Havener L, Gentes L, Thaler B, Megel ME, Baum MM, Driscoll FA, et al. The effects of a companion animal on distress in children undergoing dental procedures. *Issues Compr Pediatr Nurs* 2001;24:137-52.
 96. Friedmann E, Katcher AH, Thomas SA, Lynch JJ, Messent PR. Social interaction and blood pressure. Influence of animal companions. *J Nerv Ment Dis* 1983;171:461-65.
 97. Nagengast SL, Baum MM, Megel M, Leibowitz JM. The effects of the presence of a companion animal on physiological arousal and behavioral distress in children during a physical examination. *J Pediatr Nurs* 1997;12:323-30.
 98. Tsai C, Friedmann E, Thomas SA. The effect of animal-assisted therapy on stress responses in hospitalized children. *Anthrozoös* 2010;23:245-58.
 99. Hergovich A, Monshi B, Semmler G, Zieglmayer V. The effects of the presence of a dog in the classroom. *Anthrozoös* 2002;15:37-50.
 100. State MW. The genetics of child psychiatric disorders: focus on autism and Tourette syndrome. *Neuron* 2010;68:254-69.
 101. Kotrschal K, Ortbauer B. Behavioural effects of the presence of a dog in the classroom. *Anthrozoös* 2003;16:147-59.
 102. Esteves WS, Stokes T. Social effects of a dog's presence on children with disabilities. *Anthrozoös* 2008;21:5-15.
 103. Limond JA, Bradshaw JWS, Cormack KFM. Behavior of children with learning disabilities interacting with a therapy dog. *Anthrozoös* 1997;10:84-9.
 104. Redefer LA, Goodman JF. Brief report: pet-facilitated therapy with autistic children. *J Autism Dev Disord* 1989;19:461-7.
 105. Rogers S. Neuropsychology of autism in young children and its implications for early intervention. *Ment Retard Dev Disabil Res Rev* 1998;4:104-12.
 106. Prothmann A, Albrecht K, Dietrich S, Hornfeck U, Stieber S, Ettrich C. Analysis of child-dog play behavior in child psychiatry. *Anthrozoös* 2005;18:43-58.
 107. Capone F, Bompadre G, Cinotti S, Alleva E, Cirulli F. Beneficial effects of pet relationships: results of a pilot study in Italy. In: Vitale A, Laviola G (Ed.). *Uomini e animali, differenti contesti e modalità di interazione: aspetti applicativi e normativi*. Roma: Istituto Superiore di Sanità; 2007 (Rapporti ISTISAN, 07/40).
 108. Wilson CC. The pet as an anxiolytic intervention. *J Nerv Ment Dis* 1991;179:482-9.