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Stress level evaluation in a dog during animal-assisted therapy in pediatric surgery

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ABSTRACT

Animal-assisted interventions are associated with positive effects on human psychological and physiological health. Although quality standards in animal-assisted interventions appear to be high, only few investigations have focused on potential welfare implications in therapy dogs. In the present study, we monitored behavioral measures and heart rate in a therapy dog that participated in animal-assisted therapy during postoperative awakening in a pediatric surgery ward. Work-related activity, behavior, response to human action, and heart rate were analyzed for more than 20 working sessions in an experienced therapy dog. No physiological or behavioral indicators of stress, fatigue, or exhaustion were present during animal-assisted therapy, suggesting that, with the limited generalizability of a case study, this activity did not negatively impact on the welfare of the dog. Further investigation into the effects of animal-assisted therapy on dogs' physiological markers and behavior is warranted.

Introduction

Animal-assisted interventions (AAIs) are achieving a certain level of recognition worldwide, and this is accompanied by a growing body of research on the effect of these programs on human health and well-being (Bernabei et al., 2013; Marcus, 2013; Calcaterra et al., 2015). AAIs, which use animals for human benefit, can be considered animal-assisted therapy (AAT) when they involve the implementation of goal-directed, documented, and evaluated methodology in professional settings. In contrast, animal-assisted activities (AAAs) are not centered on a specific goal or treatment outcome and can be carried out by nonprofessional volunteers too (Kruger and Serpell, 2010). Animals are believed to be a source of motivation to take part in health interventions, exercise, and social interaction (Wilson and Barker, 2003; Glenk et al., 2014). The widespread involvement of dogs in AAIs is grounded in the outstanding interspecific social ability of this species and in the dogs' ease in adapting to various human environments (Miklósi and Topál, 2013). Although a growing body of evidence supports the rewards and benefits of human-animal interactions for humans, only few investigations have focused on the potential welfare implications for therapy dogs as a result of their performance in AAIs. Indeed, the welfare of dogs involved in AAA and AAT has been questioned, as social interactions have been described as among the most potent stressors a dog can endure (von Holst, 1998; McEwen and Wingfield, 2003). This may be because social interactions can be unpredictable, requiring the individual to constantly adapt physiologically and behaviorally to maintain homeostasis (Karatsoreos and McEwen, 2011). Study of the physiological and behavioral effects of AAIs on registered dogs is needed to enhance our understanding of animal welfare during these interventions, introduce evidence-based guidelines for handlers, and establish rigorous methods for future

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research. Animal welfare has commonly been assessed by measuring and analyzing stress-associated behavior and physiological indicators of stress in dogs (i.e., heart rate [HR]) (Vincent and Michell, 1992; Beerda et al., 1999; Palestrini et al., 2005). Analysis of behavior has also long been used as a research tool to assess stress and welfare in animals. Stress-associated behavior in dogs, such as increased locomotor activity, lip licking, yawning, and circling, have been observed to occur in response to acute stressors (Beerda et al., 1997; Palestrini, 2009). Ferrara et al. (2004) reported the absence of stress behavior in dogs during AAA/AAT, whereas King et al. (2011) observed multiple behavioral signs of stress (panting, yawning, whining, and lip licking) in dogs after an AAT session. These discrepancies warrant clarification as to whether activity and therapy sessions induce stress-associated behavior.

HR has a long history as a psychophysiological measure of animals' affective and cognitive responses, and several studies have investigated HR responses of dogs to different stimuli and environmental conditions (Beerda et al., 1997). HR represents an accessible, quantifiable, physiological measure underlying emotional responses in dogs, and the possibility of linking physiology and observable behavior is of great importance in gaining a better understanding of the dog's reactions to environmental changes (Kostarczyk, 1992; Beerda et al., 1998; Casey, 2003). Both behavior and HR are considered useful indicators to evaluate stress reactions in dogs (Kostarczyk, 1992) because of the interaction between the central nervous system and the neuroendocrine system (Henry and Ely, 1976; Beerda et al., 1998). The robustness of an animal welfare assessment is thus improved when stress-associated behavior is evaluated in conjunction with cardiac activity (Palestrini et al., 2005; Stiles et al., 2011). In this investigation, the objective was to measure and compare behavior and HR in an experienced therapy dog to examine whether the dog exhibited behavioral or physiological signs of stress in AAT in a pediatric surgery setting.

Materials and methods

Participants

A carefully screened 7-year-old spayed female golden retriever was used as the therapy animal. She had previous experience in AAIs and was already trained and prepared for this type of work. The dog was fully vaccinated, regularly groomed, screened for enteric pathogens, and treated for internal and external parasites on a monthly basis. The dog and handler met hospital policy for participation in AAT, including documentation of the dog's current vaccinations, controllability, and temperament. Twenty immunocompetent children (15 males and 5 females), aged 3-17 years (mean ± standard deviation, 8.59 ± 3.70), undergoing surgical procedures (including orchidopexy, inguinal or umbilical hernia repair, circumcision, and varicocele treatment) were randomly assigned to the AAT session. In all subjects, surgery was performed between 8.30 AM and 12 AM under general anesthesia, at the Pediatric Surgery Unit, Fondazione IRCCS Policlinico S. Matteo, Pavia. Parental permission was obtained by means of written and oral informed consent. Written assent by the patient was also obtained in children of 8 years and older before enrollment.

Procedures and data collection

About 2 hours after surgery, during postoperative awakening, each child underwent a 20-minute session with the AAT dog. The therapy dog was specially prepared and chosen for the interactions, which were evaluated as suitable and recorded together with the handler. During the sessions, the handler monitored the dog, tended to its needs, and supervised the dog-child interactions. Dog behavior was video recorded during the 20 experimental sessions. A video camera (Panasonic NV-GS330; Panasonic Italia, Milano, Italy) was installed in the room (5 × 4 m, with a constant room temperature of 22 ± 1°C) opposite the area where the child and dog-handler team remained during the session. HR was measured using a Polar Vantage NV © (Polar Electro, Kempele, Finland) system (Vincent and Leahy, 1997) to allow comparison between HR and behavior. The Polar was fixed around the chest of the animal with an elastic band. The monitor collected a reading of heart beats per minute every 5 seconds throughout each 20-minute therapy session. The results were then downloaded to a computer using Polar ProTrainer 5 © (Polar Electro, Kempele, Finland) software. Each session was transferred as separate file. The HR device was activated at the start of each session and synchronized with the video recording of behavior to have a perfect match between the behavioral and physiological data.

Statistical analysis

The videotaped sessions were analyzed by 2 trained observers, and the dog's behavior was recorded in 11 categories. Any interaction of the children with the dog, under the handler's supervision, was also recorded. Table 1 shows the list of mutually exclusive categories and

Table 1
Behavioral categories and their definition

Behavioral category	Definition
Duration	
Exploration—EX	Motor activity directed toward physical aspects of the environment, including sniffing, and gentle oral examination such as licking
Passive behavior—PA	Lying down with the head on ground without any obvious orientation toward the physical or social environment
Oriented to the environment—OE	Sitting, standing, or lying down (the head does not rest on the ground) with obvious orientation toward the physical or social environment, including sniffing, close visual inspection, distant visual inspection (vigilance or scanning)
Interaction with the child—IC	Any behavior performed when interacting the child including active physical contact, sniffing, close visual inspection, and gentle oral examination such as licking
Interaction with the handler—IH	Any behavior performed when interacting the handler, including active physical contact, sniffing, close visual inspection, and gentle oral examination such as licking
Interaction with the people—IP	Any behavior performed when interacting with the people in the room (child's parents, hospital staff), including active physical contact, sniffing, close visual inspection, and gentle oral examination such as licking
Withdrawal—WT	Avoiding interaction with the child by either moving away, very clearly turning away, or looking away
Panting—PT	Rapid shallow breathing (mouth open)
Frequency	
Yawning—YA	Yawning
Lip licking—LL	Part of tongue is shown and moved along the upper lip
Grooming—GR	The action of cleaning the body surface by licking, nibbling, picking, rubbing, scratching, etc., directed toward the animal's body (self-grooming)

their definitions. All 20 recorded AAT sessions were included in the behavior analysis. Videos were analyzed using the Solomon Coder (version: beta 15.11.19; ©2016 by András Péter). Interobserver and intraobserver reliability were assessed by means of independent coding of a random sample of videotaped sessions (10%) using percentage agreement: percentage agreement was always more than 92%.

A focal animal continuous recording method (Martin and Bateson, 1993) was used to describe the dog's activity. Some of the dog behaviors (exploration, passive, orientation to environment, panting, interaction with the child/handler/people, and withdrawal) were recorded in terms of duration of occurrence (states), and other behaviors (licking lips, yawning, and grooming) were recorded in terms of frequency (events). Children's interactions with the dog were recorded in terms of duration of occurrence (states). To describe duration and frequency for each behavior, a descriptive analysis was first performed.

Durations of states were calculated as percentage of total observation time, and events were expressed as frequencies. A bivariate correlation was used to verify the relationship between child-dog interactions and variables related to the dog's stress behaviors (licking lips, yawning, grooming, and withdrawal). Continuous recording of HRs was only available for 10 sessions. The remaining sessions could not be considered in the analysis because the recorded signal was either absent or incomplete. Mean (±standard deviation) HR values were calculated.

Results

Behavior

Analysis of dog behavior (Figure 1) on tape showed that she spent most of her time exhibiting panting behavior (panting [PT], 28.35% ± 18.09%) as opposed to avoiding interactions with the child or other people in the room (withdrawal [WT], 0.06% ± 0.15%). Most of her time she was oriented to the environment (OE, 23.22% ± 14.37%) or showed passive behavior (passive [PA], 6.58% ± 7.54%). The dog interacted more with the handler (interaction with the handler [IH], 8.61% ± 6.09%) than with the child (interaction with the child [IC], 4.93% ± 3.80%) or other people (interaction with the people [IP], 2.24% ± 3.03%). Exploration (EX, 3.48% ± 2.37%) was observed for very short periods especially during the early AAT sessions. Grooming (GR), lip licking (LL), and yawning (YA) were observed, respectively, for 1.65 ± 1.73, 5.65 ± 3.82, and 1.25 ± 0.97 (Figure 2). Children behaved differently with the dog, some never sought any interaction, whereas others interacted with the dog for most of the time (Figure 3). No correlation was found between dog stress–related behaviors (lip licking, yawning, grooming, panting, and avoidance) and children interactions.

Heart rate

HR was recorded every 5 seconds for only 10 therapy sessions. The dog's HR levels always remained within a range of normal values (basal metabolic rate, 60-110) (Santilli and Perego, 2009) as reported in Table 2.

Discussion

It is well known that humans benefit from interaction with therapy dogs; therefore, the behavioral and physiological health of the animal should be carefully reflected on (Stetina and Glenk, 2011). Dedicated research on animals in AAIs is limited and does not provide evidence on which standards can be issued regarding animal welfare (Beck and Katcher, 2003). In dog-assisted therapy, there are considerable differences between different programs with regard to the procedures in dog training, the AAI working schedule, time span between arrival at a facility and the start of the AAI, and quality assessment and quality assurance (Stetina and Glenk, 2011). Consequently, it is crucial to increase knowledge of which measurable variables reflect aspects of animal welfare and provide evidence on which standards should be achieved during AAT. This study explored whether a prepared dog exhibited behavioral or physiological signs of stress during AAT in pediatric surgery setting. Of the behaviors recorded, panting was most often exhibited. In addition to

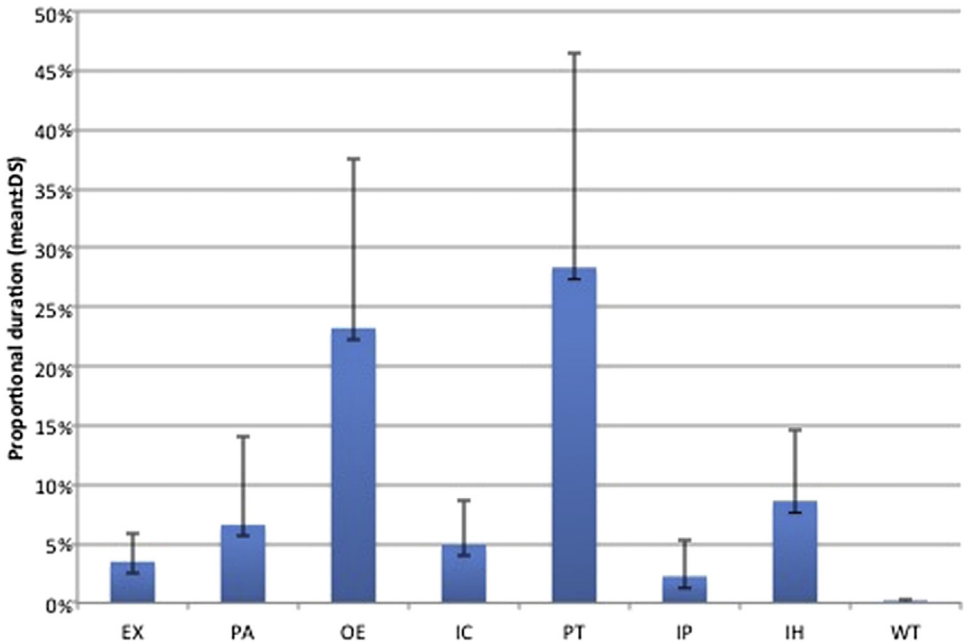

Figure 1. Proportional duration of behaviors of 20 animal-assisted therapy–working sessions of a therapy dog. EX, exploration; PA, passive; OE, oriented to environment; IC, interaction with the child; PT, panting; IP, interaction with the people; IH, interaction with the handler; WT, withdrawal.

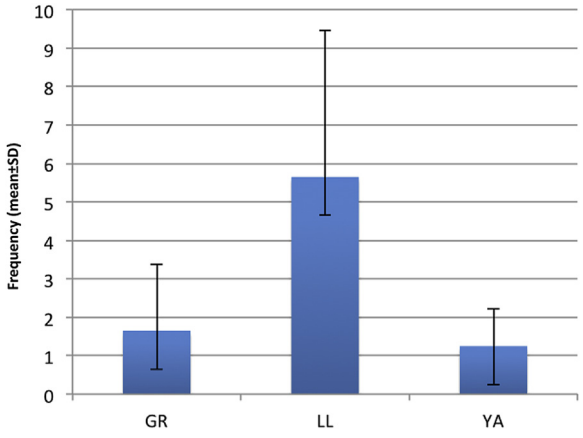

Figure 2. Proportional frequency of behaviors of 20 animal-assisted therapy–working sessions of a therapy dog. GR, grooming; LL, lip licking; YA, yawning.

being a response to heat, panting can be associated with negative stress (Godbout et al., 2007; Palestrini et al., 2010a) or with positive arousal, such as during anticipation of a desired reward (Ng et al., 2014). It must be noted, however, that the effect of room temperature on panting was probably substantial in this study because the temperature is maintained relatively high (22 ± 1) during postoperative awakening and remained constant between evaluations. No prior activity or stimulation was performed that could have influenced panting in the dog. The dog did not show noticeable signs of distress: she spent most of her time oriented to the environment or being passive. She never showed any withdrawal behavior and interacted both with the child and other people present in the room. The dog explored the environment especially during the early AAT sessions. The dog did not show more lip licking, yawning, grooming, or avoidance behavior during sessions where children interacted with the dog compared with sessions without any interaction. Lip licking, yawning, and grooming have been associated with fear or anxiety (Beerda et al., 1998; Frank et al., 2007; Cannas et al., 2010; Palestrini et al., 2010b) or as a possible displacement behavior indicative of conflict (Cannas et al., 2014). Lip licking and yawning have also been suspected to precede situations of social conflict in dogs (Voith and Borchelt, 1996). However, according to Rehn and Keeling (2011), lip licking may be communicative cues in dogs, which do not necessarily correspond to a stressful experience but, on the contrary, may help to manage stress. Recently, Shiverdecker et al. (2013) supported this assumption.

Not all dogs express stress-associated behavior in the same way because temperament and personality are influenced by many variables, including age, breed, and previous experience (Hiby et al., 2006; Passalacqua et al., 2013). Different dogs often have different responses and coping strategies to the same stimulus (Rooney et al., 2007). The brain and body develop coordinated biologic mechanisms in response to potent stressors to anticipate and recover from them in the future in an effort to maintain homeostasis (Karatsoreos and McEwen, 2011). Responses are also likely influenced by the type of interaction as it has been speculated that dogs may not exhibit stress-associated behavior in the context of human-animal interactions (Kuhne et al., 2012) despite being physiologically stressed (Ng et al., 2014). Therefore, it is necessary to assess behavior in conjunction with physiological parameters such as HR.

In our study, the 20-minute AAT sessions did not result in an increase in HR levels during the 10 AAT sessions for which heartbeat was measured. HR levels in the activity setting were no different from the normal range (basal metabolic rate, 60-110) (Santilli and Perego, 2009). HR responses were not related to whether the dog interacted with the child during the session. This may have been because interaction during the activity was safe and predictable. The inability to predict what will happen induces significant stress in humans (Henry and Stephens, 1977), and this likely occurs in dogs as well. An AAT, dog-handler team typically consists of a dog with a consistent, nonfearful, and nonaggressive temperament and a handler who is trained to minimize interactions that might be perceived as threatening by the dog (Ng et al., 2014). It must be noted that the therapy dog was specially prepared and chosen for the interactions, which were evaluated as suitable and performed together with the handler. The handler monitored the dog, tended to the dog's needs, and supervised each dog-child interaction.

AAT dogs are selected for this type of activity because of their temperament and are trained to remain calm and relaxed, even in stressful situations (Viau et al., 2010). Therefore, AAT dogs may not exhibit stress-associated behaviors typically demonstrated by the rest of the canine population when physiologically aroused. This underscores the importance of measuring behavior in conjunction with HR. Although single AAT sessions may not induce an acute stress response, it is not known to what extent the duration or frequency of AAT sessions may induce stress, which over time may

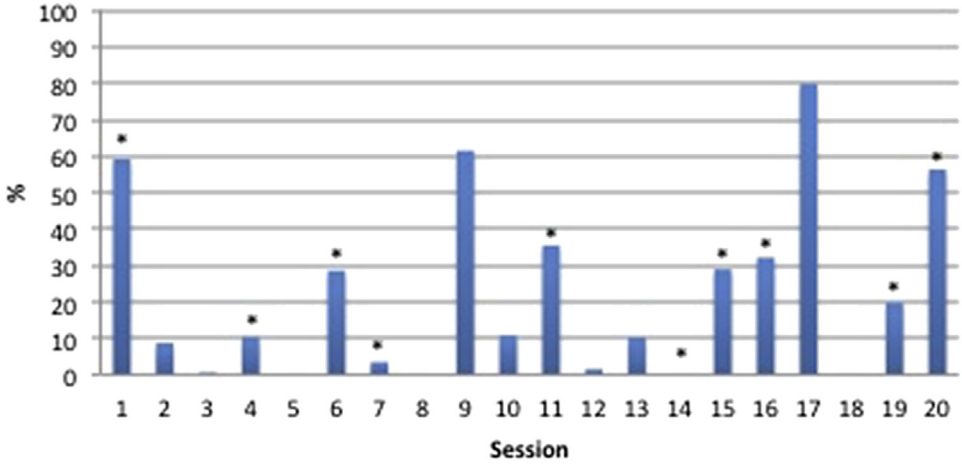

Figure 3. Proportional duration of children's interactions with the dog during 20 animal-assisted therapy sessions. The symbol * refers to sessions with corresponding heart rate measurements, as indicated in Table 2.

Table 2
Mean ± SD and minimum and maximum HR values for each recorded session

Sessions	HR (mean ± SD)	Minimum HR	Maximum HR
1	91 ± 15	70	121
4	140 ± 8	88	126
6	75 ± 3	71	138
7	93 ± 12	78	119
11	86 ± 8	75	134
14	100 ± 6	94	115
15	95 ± 18	77	132
16	85 ± 10	72	111
19	84 ± 10	69	127
20	104 ± 5	95	116

SD, standard deviation; HR, heart rate.

result in a disruption of homeostatic mechanisms and chronic stress (Karatsoreos and McEwen, 2011). Further studies are needed to investigate this limit. Although the dog in this study did not appear to be negatively affected by this particular AAT work, the welfare of AAT dogs should be continuously monitored. Until a gold standard measure of stress or distress is clearly established, behavioral observation remains a principal and practical method of evaluating stress and welfare in animals (Hekman, 2012). The handler must be rigorously trained on the prevention, recognition, and management of stress-associated behavior in his or her dog. It is particularly important that the handler understands normal dog behavior in the home environment to be able to recognize behavioral signs of stress when they occur (Ng et al., 2014).

The physical environment plays a role in dogs' stress response. An appropriately trained handler can influence the dog's perception of the environment and minimize the stress response by facilitating controlled and predictable interactions. Continuing education of AAT dogs, monitoring for behavioral signs of stress, and intervening with mental stimulation (training obedience commands or taking a break with a short time out from patient care areas) would be helpful. An optimal work shift achieved by monitoring behavioral signs of stress is mandatory to promote healthy interactions between the dogs and the people they serve. To date, there is no single validated model to test the effect of AAT on dogs because interventions vary greatly in intensity of interaction, duration, objectives, and demographics of recipients. Our study attempted to standardize these variables in a series of 20-minute AAT sessions in pediatric surgery. Its good feasibility and standardized data gathering techniques suggest that the technique we used could be successfully repeated with a number of dogs simultaneously. Our study has several weaknesses, one is the limited generalizability and another is the lack of baseline heat rate measurements for the dog involved in the study. Measurement of baseline HRs during stressful and nonstressful events would have allowed us to compare AAT-related measurements with baseline values during nonworking conditions (King et al., 2011). Working dogs need outlets for good behavioral health, particularly for AAT dogs because high performance is expected in unfamiliar and unknown working areas. AAT handler reports of dog stress were a valid indicator of physiological stress. Monitoring body language in the AAT dog will help in guiding the handler to intervene earlier if the dog is showing signs of stress (King et al., 2011).

Conclusions

AAT sessions of 20 minutes for children recovering from pediatric surgery, conducted in a safe and controlled manner, did not elicit observable stress-associated behaviors or an increase in HR and thus may not negatively impact the welfare of trained AAT dogs. This study may be considered as a first step toward further investigations on animal welfare in AAT. It proposes a straightforward and widely applicable approach to data collection that allows the synchronous recording of behavioral and HR data, which could be used to standardize exploration of the effects of different types of AAT on animal well-being. To provide consistent high quality in AAIs, it is essential to monitor and interpret physiological and behavioral parameters that are related to animal welfare. Future studies could be aimed at ascertaining the effects of different working conditions and environments by manipulating the therapy sessions and at validating the experimental methodology used in our study.

Ethics statement

The study was performed according to the Declaration of Helsinki. The ethics committee of the Fondazione IRCCS Policlinico S. Matteo and Department of Internal Medicine, University of Pavia, approved the study protocol on April 11, 2013. AAT was also approved on April 11, 2013, by the ethics committee of the Fondazione IRCCS Policlinico S. Matteo. No invasive intervention or drug experimentation on the dog was performed; therefore, the application of Decreto Legislativo 116/92, European Directives 86/609/EE for the protection of animals used in scientific and experimental studies and 2010-63UE was not required. The dog owner provided consent for its use in the study. Participants were recruited between September 1, 2013 and April 1, 2014. The study was registered at ClinicalTrials.gov (identifier: NCT02284100) after enrollment was initiated because AAT was considered a complementary treatment. The authors confirm that all ongoing and related trials for this drug/intervention are registered.

Conflict of interest

The authors declare no conflict of interest. All authors have approved the final article for submission.

References

Beck, A.M., Katcher, A.H., 2003. Future directions in human-animal bond research. Am. Behav. Sci. 47, 79–93.
Beerda, B., Schilder, M.B.H., van Hooff, J.A.R.A.M., de Vries, H.W., Mol, J.A., 1998. Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. Appl. Anim. Behav. Sci. 58, 365–381.
Beerda, B., Schilder, M.B.H., van Hooff, J.A.R.A.M., de Vries, H.W., 1997. Manifestations of chronic and acute stress in dogs. Appl. Anim. Behav. Sci. 52, 307–319.
Beerda, B., Schilder, M.B., Bernadina, W., van Hooff, J.A., de Vries, H.W., Mol, J.A., 1999. Chronic stress in dogs subjected to social and spatial restriction. Hormonal and immunological responses. Physiol. Behav. 66, 243–254.
Bernabei, V., De Ronchi, D., La Ferla, T., Moretti, F., Tonelli, L., Ferrari, B., Forlani, M., Atti, A.R., 2013. Animal-assisted interventions for elderly patients affected by dementia or psychiatric disorders: a review. J. Psychiatr. Res. 47, 762–773.
Calcaterra, V., Veggiotti, P., Palestrini, C., De Giorgis, V., Raschetti, R., Tumminelli, M., Mencherini, S., Papotti, F., Klersy, C., Albertini, R., Ostuni, S., Pellizzo, G., 2015. Post-operative benefits of animal-assisted therapy in pediatric surgery: a randomised study. PLoS One 6, e0125813.
Cannas, S., Frank, D., Minero, M., Aspesi, A., Benedetti, R., Palestrini, C., 2014. Video analysis of dogs suffering from anxiety when left home alone and treated with clomipramine. J. Vet. Behav.: Clin. Appl. Res. 9, 50–57.
Cannas, S., Frank, D., Minero, M., Godbout, M., Palestrini, C., 2010. Puppy behavior when left home alone: changes during the first few months after adoption. J. Vet. Behav. Clin.: Appl. Res. 5, 94–100.
Casey, R., 2003. Fear and stress. In: Horwitz, D., Mills, D., Heath, S. (Eds.), BSAVA Manual of Canine and Feline Behavioural Medicine. BSAVA, Gloucester, England, pp. 144–153.
Ferrara, M., Natoli, E., Fantini, C., 2004. Dog welfare during animal assisted activities and animal assisted therapy. Paper presented at the 10th International Conference of the IAHAIO, Glasgow, Scotland.
Frank, D., Minero, M., Cannas, S., Palestrini, C., 2007. Puppy behaviours when left home alone: a pilot study. Appl. Anim. Behav. Sci. 104, 61–70.
Glenk, L.M., Kothgassner, O.D., Stetina, B.U., Palme, R., Kepplinger, B., Baran, H., 2014. Salivary cortisol and behavior in therapy dogs during animal-assisted interventions: a pilot study. J. Vet. Behav.: Clin. Appl. Res. 9, 98–106.

Godbout, M., Beauchamp, G., Palestrini, C., Frank, D., 2007. Puppy behavior at the veterinary clinic: a pilot study. J. Vet. Behav.: Clin. Appl. Res. 2, 126–135.
Hekman, J.P., 2012. Salivary cortisol concentrations and behavior in a population of healthy dogs hospitalized for elective procedures. Appl. Anim. Behav. Sci. 141, 149–157.
Henry, J.P., Ely, D.L., 1976. Biologic correlates of psychosomatic illness. In: Grenell, R.G., Gabay, S. (Eds.), Biological Foundations of Psychiatry 2. Raven, New York, NY.
Henry, J., Stephens, P., 1977. Stress, Health, and the Social Environment: A Sociobiologic Approach to Medicine. Springer-Verlag, New York, NY.
Hiby, E.F., Rooney, N.J., Bradshaw, J.W., 2006. Behavioural and physiological responses of dogs entering re-homing kennels. Physiol. Behav. 89, 385–391.
Karatsoreos, I.N., McEwen, B.S., 2011. Psychobiological allostasis: resistance, resilience and vulnerability. Trends Cogn. Sci. 15, 576–584.
King, C., Watters, J., Mungre, S., 2011. Effect of a time-out session with working animal-assisted therapy dogs. J. Vet. Behav.: Clin. Appl. Res. 6, 232–238.
Kostarczyk, E., 1992. The use of dog–human interaction as reward in instrumental conditioning and its impact on dogs' cardiac regulation. In: Davis, H., Balford, D. (Eds.), The Inevitable Bond: Examining Scientist–Animal Interaction. Cambridge University Press, Cambridge, England.
Kruger, K.A., Serpell, J.A., 2010. Animal-assisted interventions in mental health: definitions and theoretical foundations. In: Fine, A. (Ed.), Handbook on Animal-Assisted Therapy: Theoretical Foundations and Guidelines for Practice. Academic Press, San Diego, CA, pp. 33–48.
Kuhne, F., Hößler, J.C., Struwe, R., 2012. Effects of human–dog familiarity on dogs' behavioural responses to petting. Appl. Anim. Behav. Sci. 142, 176–181.
Marcus, D.A., 2013. The science behind animal-assisted therapy. Curr. Pain. Headache Rep. 17, 322.
Martin, P., Bateson, P., 1993. Measuring Behaviour: An Introductory Guide, 2nd ed. Cambridge University Press, Cambridge, England, pp. 84–85.
McEwen, B.S., Wingfield, J.C., 2003. The concept of allostasis in biology and biomedicine. Horm. Behav. 43, 2–15.
Miklósi, Á., Topál, J., 2013. What does it take to become 'best friend'? Evolutionary changes in canine social competence. Trends Cogn. Sci. 17, 287–294.
Ng, Z.Y., Pierce, B.J., Otto, C.M., Buechner-Maxwell, V.A., Siracusa, C., Were, S.R., 2014. The effect of dog–human interaction on cortisol and behavior in registered animal-assisted activity dogs. Appl. Anim. Behav. Sci. 159, 69–81.
Palestrini, C., 2009. Situational sensitivities. In: Horwitz, D.F., Mills, D.S. (Eds.), BSAVA Manual of Canine and Feline Behavioural Medicine, 2nd ed. British Small Animal Veterinary Association, Gloucester, UK, pp. 169–181.
Palestrini, C., Minero, M., Cannas, S., Berteselli, G., Scaglia, E., Barbieri, S., Cavallone, E., Puricelli, M., Servida, F., Dall'Ara, P., 2010. Efficacy of a diet containing caseinate hydrolysate on 1 stress in dogs. J. Vet. Behav.: Clin. Appl. Res. 5, 309–317.
Palestrini, C., Minero, M., Cannas, S., Rossi, E., Frank, D., 2010. Video analysis of dogs with separation-related behaviors. Appl. Anim. Behav. Sci. 124, 61–67.
Palestrini, C., Prato Previde, E., Spiezio, C., Verga, M., 2005. Heart rate and behavioural responses in dogs in the Ainsworths situation: a pilot study. Appl. Anim. Behav. Sci. 94, 75–88.
Passalacqua, C., Marshall-Pescini, S., Merola, I., Palestrini, C., Prato Previde, E., 2013. Different problem-solving strategies in dogs diagnosed with anxiety-related disorders and control dogs in an unsolvable task paradigm. Appl. Anim. Behav. Sci. 147, 139–148.
Rehn, T., Keeling, L.J., 2011. The effect of time left alone at home on dog welfare. Appl. Anim. Behav. Sci. 129, 129–135.
Rooney, N.J., Gaines, S.A., Bradshaw, J.W., 2007. Behavioural and glucocorticoid responses of dogs (Canis familiaris) to kenneling: investigating mitigation of stress by prior habituation. Physiol. Behav. 92, 847–854.
Santilli, R.A., Perego, M., 2009. Manuale di elettrocardiografia del cane e del gatto. Genesi ed interpretazione del ritmo cardiaco [Manual of electrocardiography of dogs and cats. Genesis and interpretation of cardiac rhythm]. Elsevier, Milano, Italy, p. 173.
Shiverdecker, M.D., Schiml, P.A., Hennessy, M.B., 2013. Human interaction moderates plasma cortisol and behavioral responses of dogs to shelter housing. Physiol. Behav. 109, 75–79.
Stetina, B.U., Glenk, L.M., 2011. Ethische Grundfragen der Psychologie in der Mensch-Tier-Beziehung. In: Felnhofer, A., Kothgassner, O.D., Kryspin-Exner, I. (Eds.), Ethik in der Psychologie. UTB facultas.wuv [Ethical fundamental questions of psychology in the human-animal relationship], Wien, Austria, pp. 160–180.
Stiles, E.K., Palestrini, C., Beauchamp, G., Frank, D., 2011. Physiological and behavioral effects of dextroamphetamine on beagle dogs. J. Vet. Behav.: Clin. Appl. Res. 6, 328–336.
Viau, R., Arsenault-Lapierre, G., Fecteau, S., Champagne, N., Walker, C.D., Lupien, S., 2010. Effect of service dogs on salivary cortisol secretion in autistic children. Psychoneuroendocrinology 35, 1187–1193.
Vincent, I.C., Michell, A.R., 1992. Comparison of cortisol concentrations in saliva and plasma of dogs. Res. Vet. Sci. 53, 342–345.
Vincent, I.C., Leahy, R.A., 1997. Real-time non-invasive measurement of heart rate in working dogs: a technique with potential applications in the objective assessment of welfare problems. Vet. J. 153, 179–184.
Voith, V.L., Borchelt, P.L., 1996. Fears and phobias in companion animals. In: Voith, V.L., Borchelt, P.L. (Eds.), Readings in Companion Animal Behavior. Veterinary Learning Systems, Trenton, NJ, pp. 140–152.
von Holst, D., 1998. The concept of stress and its relevance for animal behavior. In: Slater, P., Møller, A., Manfred, M. (Eds.), Advances in the Study of Behavior. Academic Press, Waltham, MA, pp. 1–131.
Wilson, C.C., Barker, S.B., 2003. Challenges in designing human-animal interaction research. Am. Behav. Sci. 47, 16–28.