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Research

Behavioral and cardiac responses by dogs to physical human–dog contact

Franziska Kuhne [a,*], Johanna C. Hößler [b], Rainer Struwe [b]

[a] Division of Animal Welfare and Ethology, Department of Veterinary Clinical Sciences, Justus-Liebig-University Giessen, Giessen
[b] Veterinary Department, Institute of Animal Welfare and Behaviour, FU Berlin, Berlin

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ABSTRACT

Measures of behavioral responses and cardiovascular parameters to evaluate and assess animal well-being are well established. A major aspect of companion animal well-being seems to originate from direct human–animal interaction. For pet dogs, the manner in which they obtain and respond to petting and hugs could interfere with the development of a pleasant human–dog companionship. Therefore, the purpose of this study was to evaluate cardiovascular responses by dogs to physical human–dog contact and to assess these physiological responses in relation to the dogs' behavioral responses. Noninvasive measurements of privately owned dogs' ($N = 28$) cardiovascular parameters and behavioral responses were carried out during 9 physical human–dog interactions (e.g., petting the dog on its back, holding a forepaw of the dog). The behavioral responses were grouped in categories, for example, redirected behavior, displacement activity, and appeasement gesture. The mean heart rate (HR) and 2 cardiac activity parameters, standard deviation of normal-to-normal R–R intervals (SDNN) and root mean square of successive heartbeat interval differences/SDNN (RMSSD/SDNN) ratio, differed significantly among the human–dog interactions. Petting and holding the dog around the head was associated with an increased SDNN. An increased vagal tone was the dogs' responses to being petted at the chest. Displacement activities correlated negatively with all cardiovascular parameters (HR, SDNN, RMSSD, and RMSSD/SDNN ratio). Appeasement gestures were positively correlated with HR and occurred less under an increased vagal tone. The behavioral strategies, that is, freezing (standing motionless with all legs on the floor) and withdrawal (moving backward without any agonistic display) were negatively associated with the cardiac activity parameters, RMSSD and RMSSD/SDNN ratio. The dogs' behavioral and physiological responses suggest that some common physical human–dog interactions perceived as unpleasant by dogs. Emphasis on human signaling in human–dog interactions encourages development of recommendations for pleasant and safe human–dog contact to enhance dogs' well-being and the human–dog relationship.

Introduction

Measures of behavioral responses and cardiovascular parameters to evaluate and assess animal well-being in husbandry are well established (Mohr et al., 2002; Hagen et al., 2005; von Borell et al., 2007; Zebunke et al., 2011). In the last decades, increasing attention has been paid on the well-being of companion animals. A major aspect of companion animal well-being seems to originate from human–animal interaction (Jagoe and Serpell, 1996; Patronek et al., 1996; Hausberger et al., 2008; Bergamasco et al., 2010; Sankey et al., 2010; Ramos et al., 2012). For pet dogs, the manner in which they obtain and respond to human–dog interactions is highly variable and dependent on many factors (Hennessy et al., 1998; Palestrini et al., 2005; Kuhne et al., 2012a). Dogs, living in a human–dog relationship, which is characterized by unpleasant human–dog contact or by an uncontrollable environment and unpredictable stimuli, may develop chronic or recurrent frustration or stress. Physiological and behavioral responses associated with frustration and stress will occur. For dogs, such responses include, for example, activation of the autonomic nervous system (ANS), immune activation, proinflammatory cytokine release, displacement, and redirected behaviors (Raison and Miller, 2003; Pastore et al., 2011; Kuhne et al., 2012b). A disturbed human–dog relationship is the

* Address for reprint requests and correspondence: Franziska Kuhne, Animal Welfare and Ethology, Department of Veterinary Clinical Sciences, Justus-Liebig-University Giessen, Frankfurter Strasse 104, D-35392 Giessen. Tel: +49-641-9938754; Fax: +49-641-9938789.
E-mail address: franziska.kuhne@vetmed.uni-giessen.de (F. Kuhne).

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leading cause of behavior problems and relinquishment of dogs to a shelter (Arkow, 1985; Marston and Bennett, 2003).

Previous studies have discovered that humans experience significant changes in blood pressure, heart rate (HR), oxytocin release, and immune defense as a result of petting a dog (Baun et al., 1984; Vormbrock and Grossberg, 1988; Charnetski et al., 2004). In these studies, cardiovascular changes in humans were measured while the human was petting a dog. The dog's behavioral and cardiovascular responses to petting, the body part of the dog that was petted, the human–dog familiarity, and individual differences in dogs' responses have partly been evaluated (Hennessy et al., 1998; McGreevy et al., 2005). Behavioral data of previous studies, for example, dogs' showing submissive gestures, displacement activities, or redirected behaviors, provide evidence that dogs signaling in some physical human–dog interactions relevant stress-related responses (Haug, 2008; Luescher and Reisner, 2008; Kuhne et al., 2012b). Noninvasive measurements of physiological parameters in dogs exposed to different activities and environmental challenges mainly comprise salivary levels of cortisol, blood pressure, respiratory rate, or HR (Ogburn et al., 1998; King et al., 2003; Kuhne et al., 2009; Pastore et al., 2011) and seldom heart rate variability (HRV) (Maros et al., 2008). Measurements of changes of dogs' HR and HRV in response to being petted on different parts of the body may serve as a key factor in the assessment of physical human–dog contact.

Subtle behavioral indicators of stress are seldom recognized by owners, and only some specific stressful situations will be identified (Mariti et al., 2012) suggesting that a comprehensive evaluation of dogs' stress, that is, a correct interpretation of physiological and behavioral stages associated with adaptive challenges in dogs is necessary to evaluate the human–dog relationship. Furthermore, beside this evaluation of physiological and behavioral aspects, the identification of specific human–dog interactions that might prove dangerous for humans or that might disturb the dog's well-being is important to consider (Overall and Love, 2001). Therefore, the purpose of this study was to evaluate the interplay of cardiovascular and behavioral responses in dogs to petting and mild forms of constraint by humans. It is worth mentioning that noninvasive measurements of physiological and behavioral parameters are necessary to receive reliable information.

Materials and methods

Animals

Privately owned dogs of different breeds, life history, and obedience training state, participated in this study (N = 28). The participating dogs were of both sexes with a mean age of 4.78 years (standard deviation, 2.64). A dog's participation in this study depended on the willingness of its owner. The dog owners were recruited through contacts to dog schools. Information about the life history of each dog, for example, age obtained, previous owner, dermatological and current behavioral problems, was previously revealed by a questionnaire and the dog's physical condition by a clinical examination. Fortunately, no preliminary exclusion of a dog was necessary. The dog owners were fully aware of the testing procedure and that the whole test will be videotaped. All dog owners were asked to give a written consent for their pet's participation. The testing procedure and dog handling were approved by the institutional animal welfare officer.

Testing procedure

Each dog was tested individually in a normal office setting. The office (6 × 4.20 × 2.40 m) was the same room for all dogs and was located at the Institute of Animal Welfare and Behaviour of the Veterinary Department at Freie Universität Berlin. All dogs were visiting the testing room for the first time and were accustomed to that room for at least 15 minutes.

We carried out 9 different human–dog interactions that were applied consecutively. Each human–dog interaction was performed for a period of 30 seconds with an intertrial interval of 60 seconds. The 9 test sequences were as follows (abbreviations in parentheses):

1. Petting the dog on its shoulder (shoulder)
2. Petting the dog on the lateral side of the chest (chest)
3. Petting the dog on the ventral part of the neck (neck)
4. Petting and holding the lying dog on the ground (ground)
5. Holding a forepaw of the dog (paw)
6. Petting the dog on the top of the head (head)
7. Scratching the dog at the base of the tail (tail)
8. Holding the dog on its collar (collar)
9. Covering the dog's muzzle with 1 hand (muzzle).

The order of these different human–dog interactions was randomized for each dog. The dog testing was carried out by an unfamiliar person. This person was trained always to behave in exactly the same way during the test sequences and ignored the dog completely during the intertrial interval. The dogs' owners stayed throughout the testing in the room and were instructed to ignore their dog. The dogs were not leashed or muzzled during the handling. The test procedure used in this study is described in detail by Kuhne et al. (2012a, b).

Data acquisition

The dogs' behavior was video recorded and analyzed frame by frame (25 frames per second) using the INTERACT 8.1 (Mangold International, Arnstorf, Germany) software to determine the frequency and duration of each behavioral response. The behavioral responses were grouped in categories: redirected- and social approach behavior, displacement activity, and appeasement gesture. Kuhne et al. (2012a, b) have previously described these behavior categories. In brief, behavioral responses grouped as redirected behavior were, for example, sniffing/licking on the floor or playing with inanimate objects, grouped as displacement activity were yawning or stretching, and grouped as appeasement gesture were flicking tongue or lifting a paw. Furthermore, the behavioral responses, freezing, which is a passive behavioral response to an uncomfortable situation, and withdrawal, which is an active behavioral response without any agonistic display, were recorded.

The telemetric system RS 810 Polar-Systems (Polar Electro Öy, Kempele, Finland) was used for noninvasive real-time measurement of HR and HRV in the dogs (Jonckheer-Sheehy et al., 2012). The measuring system, a Wear link strap with 2 electrodes, was applied on the dog's chest using electrode gel to improve the electrode-to-skin contact. The watch-like data logger, which stores the HR parameters automatically, was attached on the dog's collar. Thereafter, before testing, the dogs were accustomed to wear the Polar-Systems and were allowed to freely explore the office for 15 minutes.

Statistical analysis

Preliminary analysis involved the identification of any anomalous beats using the Polar software (Polar Electro Öy, Kempele, Finland). We analyzed the mean frequency of HR and the frequency domains of HRV using Kubios HRV, version 2.0 (Jonckheer-Sheehy et al., 2012). The mean frequency of HR was calculated for each test sequence of 30 seconds. The frequency domains of HRV, the standard deviation of normal-to-normal R–R intervals (SDNN)