DIPLOMARBEIT

Effects of interaction style, attachment, relationship and personality on stress coping in human-dog dyads

angestrebter akademischer Grad

Magistra der Naturwissenschaften (Mag. rer. nat.)

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Wien, am 18.02.2009

Table of Contents

1. Zusammenfassung

Das Ziel meiner Diplomarbeit war, herauszufinden, ob und inwiefern der Interaktionsstil, Beziehung, Bindung, Persönlichkeit von Besitzer und Hund, und Stressmanagement sich gegenseitig beeinflussen. Dadurch, dass alle Wirbeltiere die gleichen sozialen Gehirnstrukturen und -funktionen teilen ist es möglich, dass auch zwischen Arten unterschiedlicher „Taxa", z.B. zwischen Menschen und Hunden „echte" soziale Beziehungen entstehen. Die Beziehung zwischen Besitzer und Hund scheint eine wichtige Rolle bei der Modulation von Hormonen zu spielen. „Stressmanagement" ist im Rahmen meiner Diplomarbeit als der verhaltensspezifische, sowie physiologische Aufwand, um eine Aufgabe zu lösen, definiert. Die Daten wurden innerhalb von drei Treffen mit 22 Besitzern, davon 10 männlich und 12 weiblich, zwischen 23 und 68 Jahren, und ihren mittelgroßen bis großen unkastrierten Rüden im Alter von 1,5 bis 6 Jahren, genommen. Das Verhalten von und Interaktionen zwischen Hund und Besitzer wurden während dreier Treffen, beim Besitzer daheim und in einem standardisiertem Raum, in verschiedenen Testsituationen beobachtet und gefilmt. Der Interaktionstil und die Performance während der Aufgaben, sowie die Persönlichkeit des Hundes wurden durch Beobachter-Beurteilung bewertet. Ein standardisierter Persönlichkeitsfragebogen, der NEO-FFI (Five-Factor Inventory) entwickelt von Costa und McCrae (1989), wurde verwendet, um die Persönlichkeit des Besitzer zu bestimmen. Ein Fragebogen bezüglich Bindung und Beziehung wurde von den Besitzern ausgefüllt. Weiters wurden für die Ermittlung von Kortisol von Besitzer und Hund Speichelproben in 20 Minuten Intervallen während der Treffen und während zwei Kontrolltagen genommen. Die Ergebnisse der Hormonanalysen zeigten, dass die Hunde während der ersten 20 Minuten des ersten Treffens gestresst waren. Somit scheint der soziale Stressor, in diesem Fall fremde Personen, die das Haus/die Wohnung betreten, ein beachtlicher Stressor zu sein. Weiters hatten z.B. Hunde von Mensch-Hund Dyaden, in denen sich Besitzer und Hund gegenseitig viel Aufmerksamkeit schenken und somit eine gute Beziehung haben, geringere Kortisolwerte, als jene, bei denen dies nicht der Fall war. Die Persönlichkeit des Hundes beeinflusste die Kortisolausschüttung des Besitzers, z.B. Besitzer mit einem vokalen und aggressiven Hund hatten höhere Kortisol Vormittags-Kontrollwerte. Weiters war Neurotizismus ein wichtiger Persönlichkeitsparameter, der nicht nur die Kortisolmodulation während des Alltages, sondern auch das Verhalten des Hundes während der Testsituationen beeinflusste. Der Interaktionsstil des Besitzers hatte nur einen geringen Einfluss auf das Stressmanagement in Mensch-Hund Dyaden. Folglich, wie Mensch-Hund

Dyaden Aufgaben meistern und wie diese miteinander interagieren, hängt mit deren Beziehung, Bindung und Persönlichkeit beider zusammen. Meine Diplomarbeit bietet Belege dafür, dass man bei der Arbeit/beim Training mit Menschen und deren Hunden auf die Beziehung, Bindung und Persönlichkeit von Besitzer und Hund und auf die Geschlechterkonstellation des Besitzers fokussieren sollte. Weiters gibt sie Anlass für weitere Untersuchungen unter Berücksichtigung dieser Parameter.

Schlagwörter: Mensch-Hund Beziehung, Stressmanagement, dyadische Interaktionen.

2. Abstract

The aim of my diploma thesis was to examine whether and how interaction style, relationship, attachment, owner and dog personality and stress coping influence each other. Since all vertebrates share the same basic social brain structures and functions, "truly" social relationships among different vertebrates, e.g. between humans and dogs, are possible. Particularly, the relationship between owner and dog seems to play an important role in modulating hormones. Within our frame stress coping is defined as the amount of behavioural and physiological effort to master challenge situations. Data were collected in three sessions with 22 humans, 10 male and 12 female owners aged 23-68, with their medium to large intact male dogs, 1.5 to 6 years of age. During one session at the owner's home and two in a standard test room, interactions of the owner-dog dyads were observed and video-taped in different challenge situations. Interaction style and performance of the challenges tasks and dog personality were rated by two observers. A standardised personality test, the NEO-FFI (Five-Factor Inventory) developed by Costa and McCrae (1989), was used to determine the personality type of the owner. Questionnaires concerning owner-dog relationship and attachment were used. Saliva samples for the analysis of cortisol and testosterone were taken before, during and after the sessions and during two control days. The results of the hormonal analysis showed that dogs were stressed during the first 20 minutes of our visit within the first session. Thus, the social stressor, i.e. strangers entering the home area, seemed to be a formidable stressor. It was found that relationship and attachment affects the dog's cortisol level during daily life, e.g. paying a lot of mutual attention within a human-dog dyad and respectively, a high quality relationship resulted in lower cortisol morning control values in dogs. Dog personality hardly affected the owner's cortisol secretion, e.g. owners with a vocal and aggressive dog had higher cortisol morning control values. Moreover neuroticism was an important personality parameter, not only affecting cortisol modulation in dogs during daily life, but also their behavioural reactions during challenges. In contrast, interaction style did not affect stress modulation in human-dog dyads as much as expected. To conclude, how an owner-dog dyad masters challenges and how they interact with each other is related to the attachment and relationship between the two and with the personality of both. Hence, when working/training with human-dog dyads, trainers should focus on those parameters and on the owner sex.

Keywords: Human-dog interactions, dyadic challenges, stress coping.

3. Introduction

All vertebrates conservatively share the same basic social brain structures and functions (Goodson 2005). Hence, their social systems are based on common physiological and psychological elements such as the two stress axes (hypothalamic-pituitary-adrenal axis and the sympathico-adrenomedullary system), socialisation, bonding, emotion and learning (Kotrschal 2005, McEwen & Wingfield 2003). Beyond this, similar personality axes are found within populations of different vertebrates (Gosling 2001), particularly within mammals. Such, a “four dimension model” of dog personality resembles the human “Five-Factor Model” (Gosling et al. 2003). These convergent mechanisms probably allow for “truly” social relationships among different vertebrate species and may also be regarded the base for the human ability to engage in social relationships with non-human animals (deVries et al. 2003, Goodson 2005, Panksepp 1998, Podberscek & Gosling 2000).

3.1. Why human-dog relationship?

Among domesticated animals dogs seem to be associated with humans for the longest period of time (Clutton-Brock, 1995). The oldest dog remains date back 14,000 years before present (Benecke 1995). Yet the oldest bones of wolves found in relation to hominids are up to 400,000 years old (Clutton-Brock, 1995). So, the companionship between hominids and canines seems to be quite ancient. Vila et al. (1997) suggested that the spilt between the wolf and the dog occurred 135,000 years before present, whereas Savolainen et al. (2002) date the dogs’ origin back to 15,000 years before present.

One expects that the long co-existence of (early-) humans and canines left traces in social skills of modern man. So it seems that humans developed their social skills not only with, but also through dogs (Lorenz 1983, Schleidt & Shalter 2003). Comparable to human social systems wolves live in clan systems with a division-of-labor system (Mech 1999). Furthermore, the ability of cooperation in all kinds of situations matches in wolves and humans (Schleidt & Shalter 2003). The first contacts between wolves and humans may have been mutualistic (Coppinger L. & R. 2003, Schleidt & Shalter 2003), and subsequent changes in both wolves and humans may best be understood as co-evolution (Schleidt & Shalter 2003), explaining why dogs play such an important role in our today’s society. They not only affect social interactions and social development in children (Kotrschal & Ortbauer 2003), but also may strongly affect human lifestyle (Hart 1995, Kotrschal et al. 2004), economics and society because of “acting” as “social grease and promoter” within family and society

(Kotrschal et al. 2004). However, caution is appropriate with regards to the “coevolution” hypothesis, because it is unclear how living with dogs would have affected the human genome and how this idea could be tested.

Dogs indeed, play an important and supportive part in their owners’ lives and are often regarded and treated at the same level as human family members (Allen et al. 2002, Allen 2003, Hart 1995). No other species of companion animals comes affectively as close to humans as dogs (Serpell 1995) and may be similarly able than human partners to provide active and passive social support (Scheiber et al. 2005); this may be mutual, resulting in well being, physiological effects and health benefits for the human partner (Serpell 1996 and 1991, Friedmann et al. 2000, Allen et al. 2002). Interestingly, the potential benefits dogs may gain from living together with humans, particularly with regards to social support, have never been investigated. Despite the close bond between humans and dogs little is known about the complex human-dog relationship, their interaction- and hormonal patterns.

3.2. Stress and coping styles

“Stress” is an often only negative associated term. This word is used in everyday life, but also professionals e.g. veterinarians and dog behaviour consulters, working with human dog-dyads talk about “stress” mostly with a negative connotation. But what exactly is meant by stress?

Selye (1950) termed the process of coping with stressors as “general adaptation syndrome”, including an alarm reaction, resistance and exhaustion. This stress response is a non-specific physiological and behavioural response to re-establish homeostasis (Selye 1950). Cannon (1929) formulated the “fight or flight” syndrome by concentrating on the adaptive aspects of the stress response through epinephrine secretion to stimulate the respiratory and cardiovascular system.

Physiologically, the stress response is a reaction to internal or external stimuli to adapt individuals to environmental (including social) perturbations and to ensure homeostasis. Hence, “stress” responses actually have an anti-stress function. Negative health and fitness consequences may be caused by perturbations which exceed an individual’s physiological and mental resources to cope. To avoid the overused and ambiguous term “stress”, the concept of “Allostasis” was proposed by McEwen & Wingfield (2003). “Allostatis” is defined as the adaptive process for actively maintaining stability through change. Glucocorticoids and catecholamines play important roles as mediators of allostasis. If an imbalance cannot be balanced through allostasis, cronic over–activation of neuroendocrine systems and deleterious health effects may result (Goldstein & Mc Ewen 2002, Koolhaas 1999, McEwen & Wingfield 2003, Sapolsky, 1994). These include cardiovascular, metabolic, reproductive, digestive, immune, anabolic and psychological consequences (Sapolsky 1994).

According to their behavioural and physiological reactions to stimuli individuals can be found along a continuum from proactive to reactive copers (Koolhaas et al. 1999), which is also manifest in hippocampal structure (Korte et al. 2005). Reactive individuals are more aware of their environment concerning danger; hence they are also at risk to develop anxiety disorders. Furthermore, reactive individuals are less mobile, are lower in aggression, have less circulating testosterone and show a more hypothalamic-pituitary-adrenal axis (HPA) activity in response to stressors than proactives; and their attendance to external information is well developed. Thus, reactives tend to be successful in unpredictable environment (Koolhaas et al. 1999). In contrast, proactive individuals are characterised by active behavioural responses to challenges, they have a higher hypothalamic-pituitary-gonadal-axis (HPG) activity and lower HPA-axis activity, resulting in higher testosterone levels and lower corticosteroid levels than rectives; hence they are more aggressive and bold, but less prone than reactives to monitor environmental changes in detail. Proactives easily develop routines and tend to be more successful than reactives under stable conditions (Koolhaas et al. 1999). Androgens will increase the likelihood of aggression however it does not cause it. HPA activation leads to high corticosteroid levels and negatively affects HPG axis, resulting in decreased testosterone levels, which may negatively affect activity and motivation (Korte et al. 2005).

In the frame of my diploma thesis stress coping is defined as the amount of behavioural and physiological effort to master challenge situations (after Koolhaas et al. 1999).

3.3. Hormones, relationship, attachment, personality and interaction

Hormones play an important role in intra-species-interactions by influencing behaviour and vice versa, the behaviour within inter-species-interactions seems to modulate hormone levels. For example, dogs of owners, who spent more time in affiliative behaviours (playing, petting the dog’s head, ears, neck or chin), had a lesser increase of cortisol after the loss of an agility competition, as compared with dogs which owners showed more punitive behaviour (physically pushing the dog, yelling at the dog). Also, male owners with a higher pre-competition testosterone level spent more time in punitive behaviour than in affiliative behaviour after loosing this competition (Jones & Josephs, 2006).

Particularly, the relationship between owner and dog seems to play an important role in modulating hormones. Such, children’s corticosteroid responses to fear-eliciting stimuli are related with the kind of parent-child bond. The cortisol levels of children with an insecure attachment to their parents tend to be higher after exposure to unknown stimuli than of children with a secure attachment to their parents (Gunnar, 1998). Dogs seem to fit the attachment system of parents and children (Voith 1985). Therefore, one would expect that the strength of the bond between the owner and the dog influences the reaction to stressful situations in dogs. Furthermore, Weaver and De Waal (2002) found that insecure relationships are more tense than secure bonds and fluctuating approach-avoidance behaviour can be observed. Insecurely attached dyads squabble and avoid each other more, but affiliative interactions occur as often as in securely attached ones. This kind of attachment is characterized by unpredictability (Weaver & De Waal 2002), which is one of the strongest causes of stress (Creel 2001).

Social relationship is also influenced by social interactions. Thus, responding tendencies to each other are influenced by social interactions; but through a conflict within the dyad the relationship can fail and the benefits from a relationship lost (Aureli et al. 2002). Indeed, O'Farrell (1995) found that owner personality and attitudes are associated with behaviour problems in dogs. The more a dog is considered as a family-member the more it tends to behave socially dependent; furthermore the owner´s behaviour seems to influence the dog's behaviour (Topal et al. 1997). Anthropomorphic involvement of the owner seems to further dominance behaviour in the dog; and anxiety in the owners correlates with over-excitement and displacement behaviour in the dog; also, anxious owners seemed to be more stressed by their dog's phobias (O'Farrell 1997).

Within social groups, elevated gluccorticoids are more often found in dominant individuals than in subordinates. In wolves high glucocrticoid levels, were unrelated with agonistic interactions. In this case glucocorticoid levels are probably related to behavioural state (e.g. position in the dominance rank) rather than their apparent behaviour (Sands & Creel 2004).

3.4. Hypothesis

Based on the general contingency of social behaviour and stress modulation a general relation between hormones and interactions in human-dog dyads and between attachment and behaviour of the owner and of the dog can be expected. However, little is known about potential links between personality, attachment, interactions and hormones in human-dog dyads. Thus, we decided to examine whether and how, those factors influence each other to obtain a first model to better understand within-species and between-species dyadic relationships.

We predict that personality, as well as the social relationship and attachment influences interaction style and thus, stress coping of human-dog dyads in challenge tasks. Since insecurely attached dyads show more aggressive interactions and are more unpredictable (Weaver & De Waal 2002), we anticipate that the quality of relationship and attachment relates to interaction style within human-dog dyads and to stress modulation in challenge situations. Furthermore, we assume that the relationship and interaction style influences the achievement in challenging tasks. Because different behavioural patterns are accompanied by different hormonal patterns (Koolhaas et al. 1999), we hypothesis that personality of the owner as well as of the dog affects stress coping in both. We predict that a harsh interaction style would cause up-modulation of cortisol in dogs (Beerda et al. 1997). And last but not least, we assume that those factors are influenced by owner sex, e.g. that female owners interact more with their dogs than male owners (Prato-Previde et al. 2006).

4. Methods

4.1. Subjects

Subjects for the observational and hormonal parts of this study were 22 human-dog dyads including 10 male and 12 female dog owners (aged 23 to 68 years), known as the primary attached person of their fertile male pet dogs (aged 1.5 to 6 years, weight between 11 and 55 kg). The dogs were adopted by their owners as pups, aged between 6 to 12 weeks. Four mixed breeds and 15 different dog breeds took part in the study (Bearded Collie, Belgian Shepherd Dog (Groenendael), Border Terrier, Bullterrier, Cocker Spaniel, Eurasier (2), Golden Retriever (3), Labrador Retriever, Parson Jack Russel Terrier, Pit Bull, Polish Lowland Sheepdog (Polski Owczarek Nizinny), Polish Tatra Sheepdog (Polski Owczarek Podhalanski), Rough Collie, Tibetan Terrier, White Shepherd Dog). The participants lived in or close to Vienna with no other dogs in the same household.

Further 18 dog owners (6 male, 12 female, aged 28 to 55) with their intact male pet dogs (aged 1.5 to 9, weight between 20 and 37 kg, adopted between 6 and 16 weeks of age, 11 different pure breeds and 5 mixed-breeds) completed our questionnaires.

4.2. Procedure

We looked for participants by inserting advertisements on different homepages, in veterinarian clinics, on dog places, in dog training centres and in newspapers. One of the experimenter assured on the phone whether a particular human-dog dyad meet our criteria, which were for the dog: intact male pet dog, only one dog in the household, adopted as pup (maximum 16 weeks), body weight 10 kg or more, age 1.5 to 6 years; and for the owner: aged 18 or older, main reference person of the dog, living in or close to Vienna). The criteria for the 18 dog owners just completing the questionnaires were the same excepting the dogs age which could be older than 6 years of age.

During this first conversation the owner was also informed about the general procedure, that saliva samples will be taken, data collection will be video-recorded and start immediately after entering the house/flat. In addition, the owner was told that no one else than the two experimenters, the dog and the owner should be present in the respective test room and that he/she should behave as he/she is used to in daily life. The owner was also asked to postpone the dog’s main meal to the time, when our first session will proceed. Furthermore the owner was explained that we will do some test situations, mostly situations known from daily life, but the exact procedure was not explained.

Data collection was carried out from January to Mai 2007 in a series of three sessions with an average of 7 days interval in between (range 4 to 27). The first session at the owner's home was conducted by two experimenters. Experimenter one (Iris Schöberl) interacted with the owner, guided the procedure, and explained the questionnaires; experimenter two (Manuela Wedl) video-taped dog and owner behaviour with a hand-held digital camcorder. The second and third sessions was scheduled in a 33 m² sized adapted test room at the University of Vienna and were guided by experimenter one. A table for the owner and the experimenter was placed in the left corner of the room, a dog blanked was forthcoming for the dog on the left side of the room, and a wire mesh bridge served as room divider, except during the situation "bridge" during the third session. The first and second sessions took approximately one hour each, and the third session took approximately 40 minutes.

Video recordings at the first session were obtained using a camcorder (Sony DCR-TRV 19E) with a wide-angle conversion lens (Sony VCL-0630 S) to expand the camcorder's field of view. For continuous videotaping during the second and third sessions another camcorder (Sony DCR-TRV 33E) with a wide-angel conversion lens (Hama, video objective HR 0.45 HTMC Compact (1)) was fixed on the roof of the test room left to the door via a ball head (Manfrotto Micro Ball Head 482).

4.2.1. Saliva samples

Throughout the three sessions saliva samples were taken in 20 minutes intervals from the owner and the dog by the owner her/himself for measuring the concentration of cortisol and testosterone. For that the human subjects chew sterile polypropylene gauze (Salivette, Sarstedt) for at least 30 seconds. At the same time the owner stimulated the salivation of the dog with food and took saliva out of the dog's mouth using a safety cotton bud for babies (Bellawa baby, Rauscher). The cotton part of the bud was put into a tube (Cliklok Microcentrifuge Tube, vol 1.5 ml, Firma Simport). Each saliva sample was refrigerated stored in a cool bag during the sessions and transport, and afterwards frozen until analysis.

The first saliva samples were taken at the beginning of each session, subsequent samples were taken after each 20-minute parts of the session. To maintain consistent 20 minute intervals between taking saliva samples, short breaks at the end of the parts occurred. The owner, the dog, and the experimenter were in the room during these breaks.

For reference values saliva samples of two control days were taken from the owner and the dog by the owner self at his/hers home. On those days five samples were taken in a morning and five samples in an afternoon session, at intervals of 20 minutes each. The owner was instructed to refrain from pronounced activities during these control days.

4.2.2. Questionnaires

We used a standardised personality test, the NEO-FFI (Five-Factor Inventory) developed by Costa and McCrae (1989), and translated into German by Borkenau and Ostendorf (1993) to determine the personality type of the owner. Our own basic questionnaire served to get background information about the owner's and the dog's daily life, including six different parts: 1. Personal data about the owner including administrative data; 2. Information about the lifestyle of the owner and the dog; 3. Further details about the relationship between the owner and the dog, including questions modified from the "Questionnaire for Anthropomorphic Attitudes" by Topal et al. (1997); 4. Information about the character of the dog; 5. Details about upbringing and training of the dog; 6. The attitude towards the dog scale translated and modified from "The Dog Attitude Scale" by Johannson (1999).

Furthermore within the sessions six short questionnaires were used to get a subjective statement from the owner about the different test situations. These six questionnaires were completed by the owner after the respective test situation (the feeding situation; the "veterinarian check"; the retention test; the "bridge " situation; the "threat with owner" situation and about taking saliva samples from the dog). At the end of each session (after the last saliva samples were taken) the owner was asked to complete a short questionnaire including just two questions about the subjective impression of their stress level.

4.2.3. Sessions

1.2.3.1. First Session:

During the first session the owner-dog interactions in daily life situations were observed. Another aim of this session was to become acquainted to the owner and the dog and to explain the procedure of the study, especially how to take saliva samples from the dog.

<u>Part 1:</u>

At the beginning, when the experimenters entered the owner's home, experimenter two documented the dog's reaction to strangers (the experimenters) and the owner-dog interactions during this so-called "entrance" situation. The first saliva samples were explained and taken. Subsequently, the owner was asked to fill in a registration form and to give consent to be videotaped during the study and to the dissemination of the results. The owner was subjected to the personality test, the NEO-FFI (Costa and McCrae, 1989; Borkenau and Ostendorf, 1993). Afterwards the procedure of taking saliva samples during two control days was explained to the owner. Saliva samples two were taken

<u>Part 2:</u>

The owner was asked to play with the dog in a way he/she usually does for a maximum of three minutes. Afterwards the owner was asked to feed the dog as always. While the dog was eating the owner was asked to touch it, then to step back and go again to the dog to take the food away for a few seconds. When the dog was finished with eating our basic questionnaire was given and explained to the owner with the demand to fill it in till the last session. Furthermore the owner was asked to complete a short questionnaire about the feeding situation. Saliva samples three were taken.

<u>Part 3:</u>

The owner was informed to take a muzzle and treats with him to the next session. Subsequent data collection was proceeded outside during a walk. A 10 to 15 minutes walk with the owner and the dog was observed. The behaviour of the owner and the dog during the walk was video-taped by experimenter two. Saliva samples four were taken outside at the end of the walk. The questionnaire after the session was completed by the owner.

1.2.3.2. Second session:

This session served to give evidence about the quality of the owner-dog relationship and to observe the human-dog interactions and behaviours during training sessions and an "ad lib" veterinarian check.

Part 1:

First, saliva samples were taken. At the beginning the owner was asked to look at 15 dog pictures placed on the wall and windows and to write down three words for each picture he/she associated with. The dog was allowed to run free in the room during this situation "picture". This task took 10 minutes time. During these 10 minutes no experimenter was in the room. Trough this "picture" test situation we had the possibility to record movement and orientation parameters in a standardized owner movement situation and especially how the dog relates to its distracted owner. After this situation the experimenter came back and made a short "ad-lib" interview with the owner about his/hers associations. The dog was allowed to run free in the room during this interview too.

At the end of this part, part 2 was explained to the owner: Two of 10 commands were chosen by the experimenter, depending on which of them were not known by the dog and were possible to do for the dog (considering back or hip problems of the dog). To evaluate which of these commands were not known by the dog, the experimenter interviewed the owner about commands they trained before. The 10 commands were: 1.) crawling on the ground, 2.) Spanish yard-ride-walk, 3.) making figure eight through the owners' legs, 4.) roll over, 5.) to sit up and beg, 6.) walking just on the hind legs, 7.) lying onto the side, 8.) give five, 9.) walking backwards and 10.) touching the closed hand of the owner with the nose. The first command was the preferred chosen by the experimenter, if known by the dog or if not possible to do for the dog, the experimenter asked if command two was known and possible to do and so on. This was done until two commands were found to be trained. The experimenter did not tell the owner, which command he/she would have to train his/hers dog during part 2. Salvia samples two were taken.

Part 2:

During this part the owner was asked to train the dog the two novel commands chosen at the end of part 1. The experimenter told the owner, shortly before the training session, the first command he/she should train to the dog within an eight minutes training session, and left the room for this time. The experimenter entered the room after the first training session and told the owner the second command to train, then the experimenter left the room again for eight minutes of training. After the second training session saliva samples three were taken.

Part 3:

At the beginning of this part the owner was asked to do a short performance test with the dog, featuring the two novel commands of part two within maximal three minutes for each command. The owner was told that he/she could abandon the test at any time. During this performance test the experimenter was in the room and recorded this situation with a check sheet. Afterwards the owner was asked not to practise these two novel commands until the next session.

After this, the experimenter did an “ad lib” veterinarian check. This test situation “vet check” was recorded with a check sheet. The owner was interviewed about the dog’s weight, age and race. Afterwards the experimenter placed the dog blanket in the middle of the room where the veterinarian check was practiced (Fig. 1). Within this situation the experimenter measured the dog size, length, waist circumference and chest circumference, looked into the mouth, ears and eyes of the dog and touched the whole body of the dog especially the paws. During this process the owner was present and was asked to behave as he/she wants to and as he/she feels comfortable and thinks that the dog feels comfortable. Afterwards the owner was asked to complete a short questionnaire about the veterinarian check. Saliva samples four were taken. The questionnaire after the session was completed by the owner.

1.2.3.3. Third session:

The aim of this session was to observe the owner’s and the dog’s reaction to two different stressors, a “threat” situation, once with and once without the owner present, and a “bridge” situation.

Part 1:

First, saliva samples were taken. The owner was asked to execute the two novel commands, which were trained during the second session, within maximal three minutes for each command. The owner was told that he/she could abandon the test at any time. During this retention test the experimenter was in the room and recorded this situation with a check sheet. Subsequent the owner was asked to complete a short questionnaire about this test.

After this the wire mesh bridge was prepared. The dog was allowed to run free while the experimenter assembled the wire mesh bridge. The owner was asked to lead the dog through the wire mesh bridge as good and secure as possible, within maximal eight minutes time (Fig. 1). The owner was told that he/she could abandon the test at any time. Afterwards the owner was asked to complete a short questionnaire about this "bridge" situation. Then, saliva samples were taken again.

Part 2:

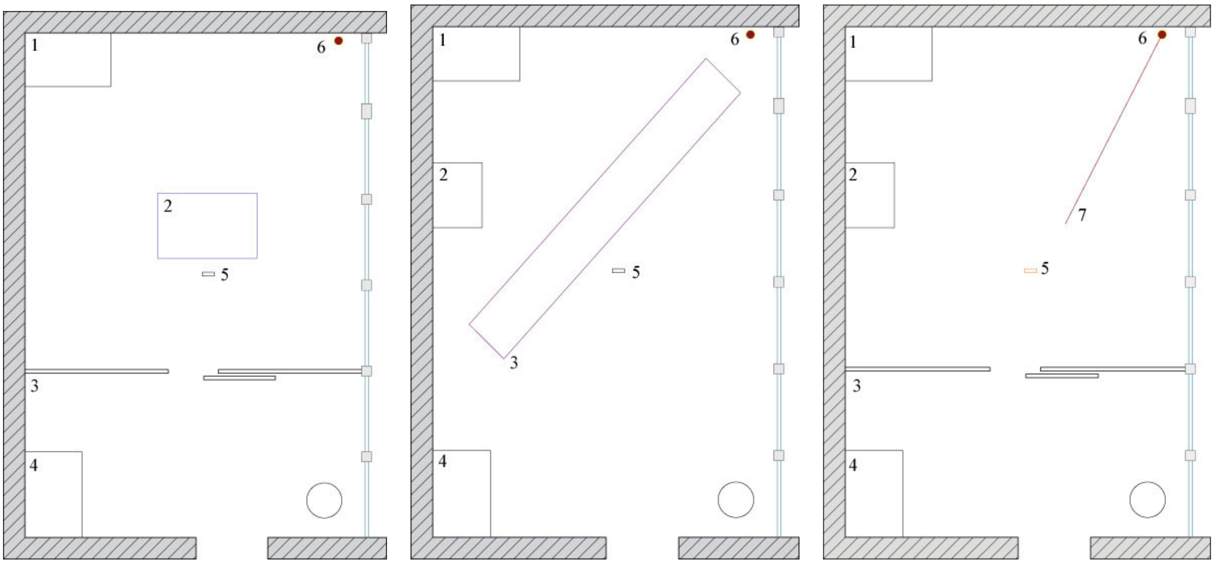
At the beginning of this part the experimenter dismantled the wire mesh bridge, the dog was again allowed to move free during this time.

Afterwards the experimenter prepared the owner and the dog for the situation "threat". The owner was asked to tether the dog, with an on the ground fixed leash, for security of the experimenter during the next test situation. The experimenter told that something will be done that the dog perhaps doesn't like, and that the owner should behave as he/she wants to and would do if something similar would happen during daily life. The experimenter did not explain what exactly happens during the situation "threat". The experimenter left the room to put on a black long coat with a hood, then entered the room again, closed the door and knocked onto the inside of the door to get the dog's attention. As soon as the dog looked into the experimenter's direction, the experimenter started to move ahead to the dog staring into the dog's eyes, or if not possible, because the dog avoided eye contact, staring at the dog's face. The experimenter stopped moving ahead to the dog at a marked point, so that the dog could not reach the experimenter (Fig. 1). From now on the experimenter stared approximately 30 seconds into the dog's eyes, or if not possible, because the dog avoided the eye contact, stared at the dogs face. Independent of the dog's reaction the experimenter averted her head after these 30 seconds and moved away from the marked point to the left corner of the room, which was the opposite of the corner, where the dog was fixed with the leash. While two minutes of waiting the next "threat" situation was explained to the owner.

After these two minutes of waiting, the owner was asked to leave the room with the experimenter and to wait quietly outside the room. The "threat" situation was repeated, but this time without the owner in the room. The experimenter repeated the steps from entering the room to staring at the dog for approximately 30 seconds. If the dog showed an aggressive reaction (barking and/or growling for more than four seconds and/or attacking the experimenter with moving ahead and/or stretching the leash (after Vas, 2005)) or an avoidance reaction (moving away from the experimenter into the back of the room and/or trying to hide) the experimenter moved away from the marked point to the left corner of the room, sat down onto the ground and looked away from the dog while waiting for two minutes.

If the dog showed a friendly reaction (neither aggressive, nor avoidance reaction) the experimenter turned away her head, crossed the marked point to get closer to the dog and squatted down to get in contact with the dog.

Then the experimenter left the room to get off the dress to go back to the room with the owner together. The experimenter invited the dog to play with her. After this the owner was allowed to let the dog off the leash. The owner was asked to complete a short questionnaire about the "threat with owner" situation and about taking saliva samples during the whole data collection. Saliva samples three were taken and the questionnaire after the session was completed by the owner. The owner was asked to sign a declaration of consent for using the videos for public lectures and publications. In the end the owner got a gift for participating.



A B C

Fig. 1: Floor plan of the 33 m² sized adapted test room during the different test situations. 1=Table, 2=dog-blanket, 3=wire mesh bridge converted as room-divider except during "bridge" situation (=B), 4=sink, 5=marker for the "threat" situations, 6=fixation for the leash for the "threat" situations. **A:** Test room during the veterinarian check. The dog-blanket (=2) was placed in the middle of the room to conduct the veterinarian check. **B:** Test room during the "bridge" situation. The wire mesh bridge (=3), across which the owner should lead the dog, was placed in the middle of the room. **C:** Test room during the "threat" situations. The dog was tethered with a leash (=7) that was fixed on the ground (=6), the experimenter walked ahead to the dog and stopped at a marked point (=5).

4.3. Video tape analysis

Video tapes were coded with THE OBSERVER Video Pro (Version 5.0) software by two observers (Iris Schöberl and Barbara Bauer). Within each of the coded test situations the human-dog dyads were distributed randomly among the two observers. The Inter- and intra-observer reliability of the duration of the observed behaviours was tested before, during, and after completion of coding and was generally better than 83%. Five test situations were coded via continuous recording: “threat with owner present”, “threat without owner present”, “bridge”, “veterinarian check” and “pictures”.

Additionally parameters were rated for owner-dog interaction style and owner-dog performance during the coded situations. The two observers rated all dyads independently from each other on a scale from 1 to 5. For statistical analysis the rated values within a parameter were partly grouped if the values did not significantly differ in the respective test situation. The parameters were:

1. synchrony between owner and dog (from opposite movements/moving to opposite directions - via seldom parallel movements including sitting-, lying down or standing up at the same time - to the point of periodic parallel movements including sitting-, lying down or standing up at the same time);
2. Reaction of the dog to an owner’s approach (from strongly avoidance behaviour including escape - via tolerant reaction, but no friendly reaction - to the point of friendly reaction including approaching the owner);
3. Qualitative interaction style (from just strict interaction with strict voice, less body contact and less friendly voice - via strict interaction as well as friendly interaction - to the point of just friendly interaction with friendly voice, stroking and praising);
4. Quantitative Interaction style (from very less interaction with mostly ignoring the dog - via sometimes interaction - to the point of a lot of interaction with the dog;
5. Reaction of dog to threat (from aggressive reaction with barking and/or growling for more than four seconds and/or attacking the experimenter with moving head and/or stretching the leash - via avoidance behaviour with potential barking and/or growling - to the point of friendly reaction including approach towards the experimenter without barking and/or growling);
6. Involvement of owner (from owner is involved most of the time with bodily reprehension, telling off, tugging the leash - via owner is less to not involved and ignores the dog most of the time - to the point of owner is involved most of the time with praising, becalming, talking to the dog);

7. Effort of owner for bridge (from owner tries to lead the dog across the bridge with mostly negative methods as telling off, prohibitions and bodily reprehension including tugging the dog across the bridge - via equally negative and positive methods - to the point of using mostly positive methods as praising, playing, treating and cajoling the dog into crossing the bridge);
8. Achievement for bridge (from dog did not cross the bridge and did not step on it - via dog did not cross the bridge, but did at least 2 steps on it - to the point of dog crossed the bridge fast and without hesitation).

4.4. Owner personality

The NEO-FFI (Five-Factor Inventory) developed by Costa and McCrae (1989), and translated into German by Borkenau and Ostendorf (1993) includes 60-items and was designed to measure normal adult personality in 5 domains: neuroticism, extroversion, openness, agreeableness, and conscientiousness. This is a well established and evaluated, empirical approach, which is highly practicable and fairly compatible with biological personality theory (Koolhaas et al., 1999).

4.5. Dog personality

After completion of video analyses, the dog's personality was scored on an observer rating scale (modified after Feaver et al. 1986) by ticking off along a line between opposing attributes. Inter- and Intra-observer agreement was tested before and after completion of rating and was generally better than 82 %. The two observers rated all dogs independently from each other after observing the dog's behaviour from video during selected situations (at the owners home: experimenters entering the house/flat, owner feeding the dog, owner playing with the dog; at the experimental room: picture, training two new commands and presenting them to the experimenter, veterinarian check, bridge, threat with owner and threat without owner). The position of each rating on a left-to-right scale was measured and transcribed for further analysis. The mean value from scorings of the two observers was used. A Principal component analysis was performed on the resulting values of 17 items ($n=22$, Bartlett-Test: KMO=0.673, Sphericity: $\chi^2=374.158$, $df=136$, $p<0.001$; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished). This resulted in 4 main axes (Appendix A): 1. sociable and active, 2. unconfident and anxious, 3. vocal and aggressive, 4. clever and attentive.

4.6. Analysis of Questionnaires

Out of the basic questionnaire a set of questions were used to characterize the quality of attachment and relationship. A principle component analysis (PCA) was calculated once for human - dog attachment and once for human - dog relationship.

For human-dog attachment the Principal Component Analysis (PCA; n=39, Bartlett-Test: KMO = 0.767; Sphericity: chi²=400.674, df=105, p<0.001; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished) performed with 15 attachment items revealed 4 main axes (Appendix B): 1. (dog as) social supporter, 2. (dog as) meaningful companion, 3. (dog as) social partner, 4. (dog as) understanding partner.

For human-dog relationship the Principal Component Analysis (n=39, Bartlett-Test: KMO=0.723, Sphericity: chi²=307.370, df=91, p<0.001; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished) performed with 14 owner-dog relationship items revealed 4 main axes (Appendix C): 1. time spent together, 2. responsibility taken, 3. mutual attention paid, 4. shared activities.

4.7. Analysis of Saliva samples

An enzyme immunoassay (EIA) was used to analyse the cortisol and testosterone concentrations of the owners' and the dogs' saliva samples. Cortisol and testosterone was determined at the Departement of Biochemistry at the University of Veterinary Medicine Vienna. Cortisol analysis was done as described by Palme and Möstl (1996); testosterone analysis by using the method as described by Palme and Möstl (1993).

The morning and afternoon cortisol control values differed in owners, so the morning values as well as the afternoon values were separately averaged for each owner as well as for each dog, to analyse with the same initial position. Because the sessions were scheduled to different times we used morning or afternoon control values adjusted to the corresponding time when the session was proceeded for comparison of control values with values from the sessions.

Testosterone morning and afternoon control values did not differ neither in owners nor in dogs, so those control values were averaged to one testosterone control value for each individual for comparison with testosterone values from the sessions. For correlations with cortisol control values also individually averaged morning and afternoon testosterone control values were used.

For hormonal analysis of the sessions, differences of cortisol, respectively testosterone values before and after the 20 minute parts were used. Therefore the hormone value before the part was subtracted from the value after the part. For hormonal analyses following four main test situations were adducted: “picture”, “vet check”, “bridge” and “threat”.

To analyse effects of personality, attachment and relationship on hormonal patterns, cortisol and testosterone differences were grouped into increase and decrease, and control values were grouped into higher and lower than group-mean value (if sex differences were found e.g. for testosterone separated mean values for men and women were calculated).
Two outlining single values of one dog during two sessions were excluded.

4.8. Statistical Analysis

Statistical analyses were preceded with SPSS (Version 11.5). All hormonal data were normally distributed so parametric tests (t-test, MANOVA, Pearson) were used as well as non parametric tests (Mann-Whitney-U, Wilcoxon, Kruskal-Wallis, Friedman, Spearman) were used when criteria for parametric test were not met. For the partly not normally distributed questionnaire data and for nominally-scaled data just non parametric tests were used.
All significances ($p<0.05$) are given two-tailed. Graphs were created with the software Sigma Plot 8.0.

5. Results

5.1. Analysis of hormones

5.1.1. Effects of owner sex on stress coping

During the first 20 minutes of session 1, the so-called entrance situation, male owners had a higher increase of cortisol than female owners (Mann Whitney-U: n=22, Z=-2.045, p=0.041; Fig. 2). Eight of 12 female owners even showed a decrease, while this was the case in just 3 of 10 male owners.

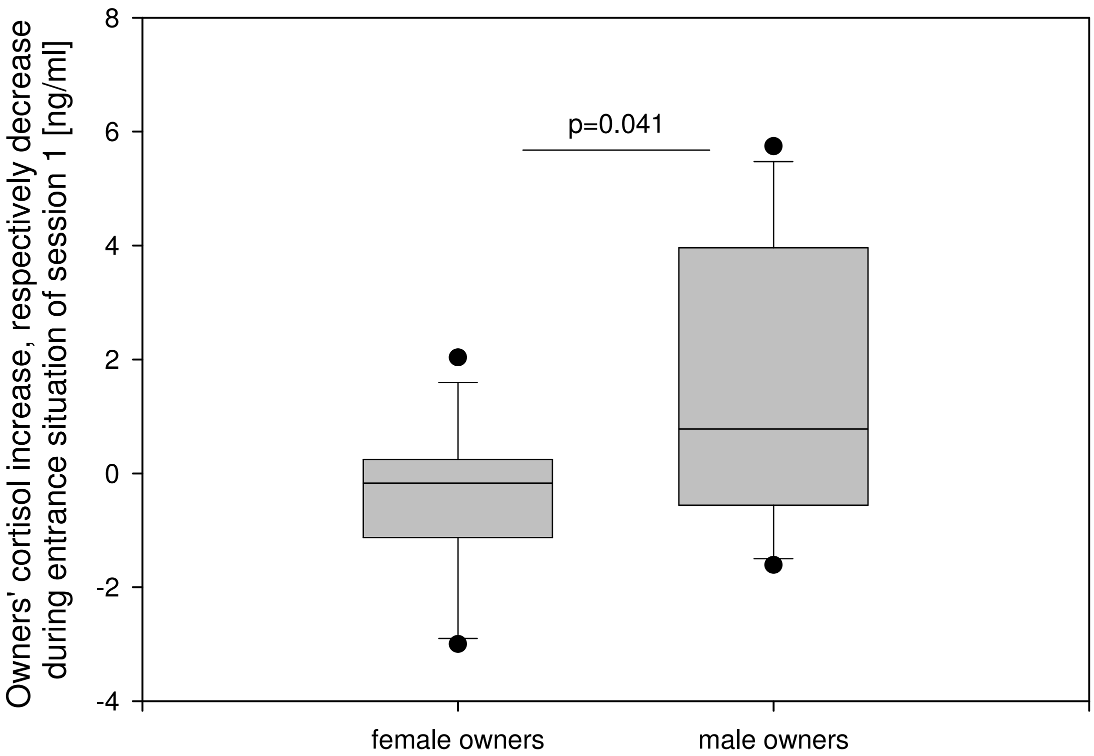


Fig. 2: Comparison of male and female owners' cortisol secretion during the entrance situation of session 1. Male owners (right hand side) had a higher cortisol increase during the first 20 minutes of session 1 than female owners (left hand side) (Mann-Whitney-U: n=22, Z=-2.045, p=0.041).

However owner sex had no effect on cortisol control values and on cortisol secretion during the four different main test situations in owners as well as in dogs (Tab. 1).

Tab.1: Male and female owner-dog-dyads did not differ in their cortisol secretion during control days and the four main test situations. For t-test t- and p-values are given, and when criteria for t-test were not met Mann-Whitney-U, given in Z- and p-values, was used.

	Cortisol morning control	Cortisol afternoon control	Test-situation "Picture"	Test-situation "Vet Check"	Test-situation "Bridge"	Test-situation "Threat"
Owners	n=22, t=-0.468, p=0.645	n=22, t=-1.205, p=0.242	n=22, Z=-0.462, p=0.644	n=22, t=1.953, p=0.065	n=22, Z=-0.627, p=0.531	n=22, t=0.201, p=0.843
Dogs	n=22, t=-1.393, p=0.179	n=22, t=-1.013, p=0.323	n=19, t=0.079, p=0.938	n=18, t=0.606, p=0.552	n=19, t=-0.015, p=0.988	n=18, t=0.148, p=0.884

5.1.2. Effects of challenges on cortisol secretion

Corresponding cortisol control values for the sessions did not differ from the first values of the sessions in owners as well as in dogs. (t-test: owner session 1: n=22, t=-0.169, df=21, p=0.867; dog session 1: n=21, t=0.208, df=20, p=0.837; owner session 2: n=22, t=-1.009, df=21, p=0.325; dog session 2: n=19, t=-1.412, df=18, p=0.175; owner session 3: n=22, t=-0.633, df=21, p=0.534; dog session 3: n=20, t=-0.885, df=19, p=0.387).

An in-detail analysis of the sessions showed for the first session a cortisol increase in dogs during part 1, i.e. the entrance situation, and during part 3, i.e. the walk situation, but a cortisol decrease during part 2 (MANOVA with repeated measurements: n=17, F=4.808, df=2, p=0.015; Fig. 3). During the other two sessions no differences in dogs' salivary cortisol were found. Owners showed no differences in cortisol secretion during any session.

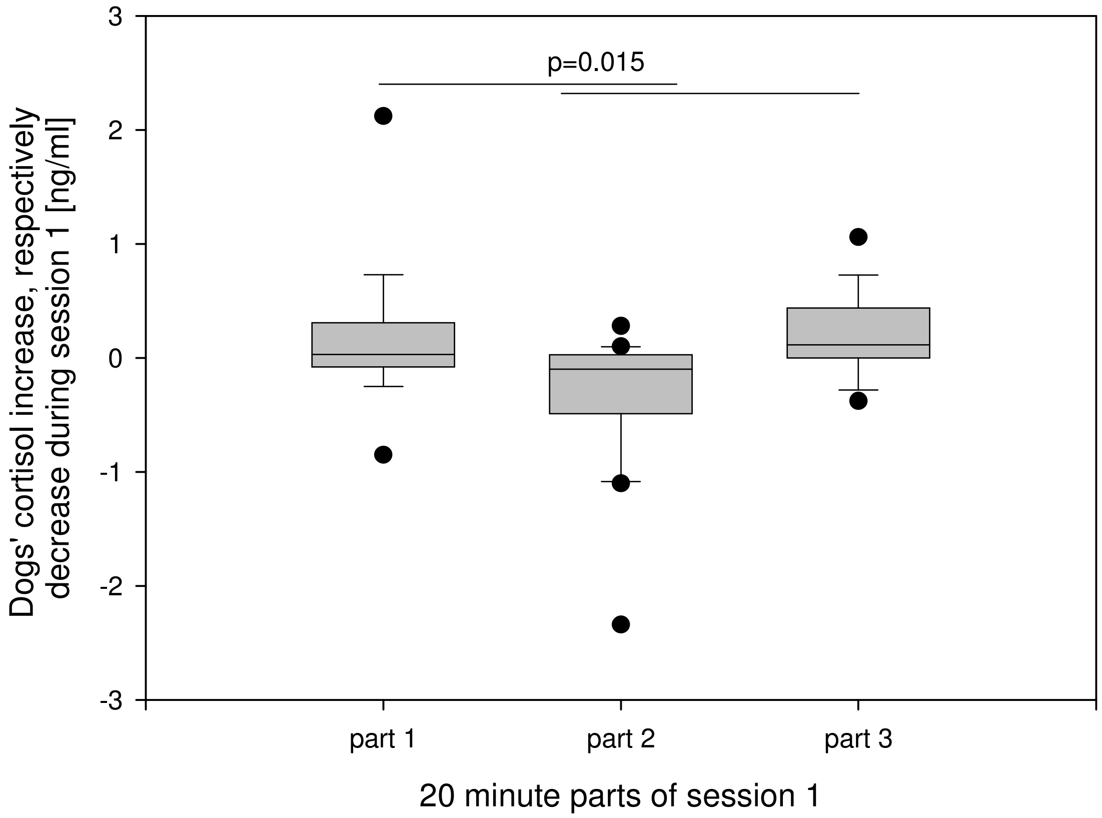


Fig. 3: During session 1 the dogs' cortisol secretion increased within part 1, the so-called entrance situation, decreased within part 2, and increased again within part 3, the walk situation (MANOVA with repeated measurements: n=17, F=4.808, df=2, p=0.015).

Comparing the four different main test situations "picture", "vet check", "bridge" and "threat" no differences in the cortisol secretion in owners as well as in dogs were found (Friedman: owners: n=22, Chi²=0.927, df=3, p=0.819, dogs: n=16, Chi² =1.226, df=3, p=0.747). Also owners and their dogs did not react differently to these four test situations (Mann-Whitney U: Session 2 "Pictures": n=41, Z=-0.444, p=0.657; Session 2 "Vet Check": n=42, Z=-0.013, p=0.990; Session 3 "Bridge": n=41, Z=-0.013, p=0.990; t-test: Session 3 "Threat": n=40, t=-0.406, p=0.687). But cortisol secretion in owners and dogs correlated positively during the situation "picture" (Pearsons: n=19, r_s=0.721, p<0.001; Fig. 4).

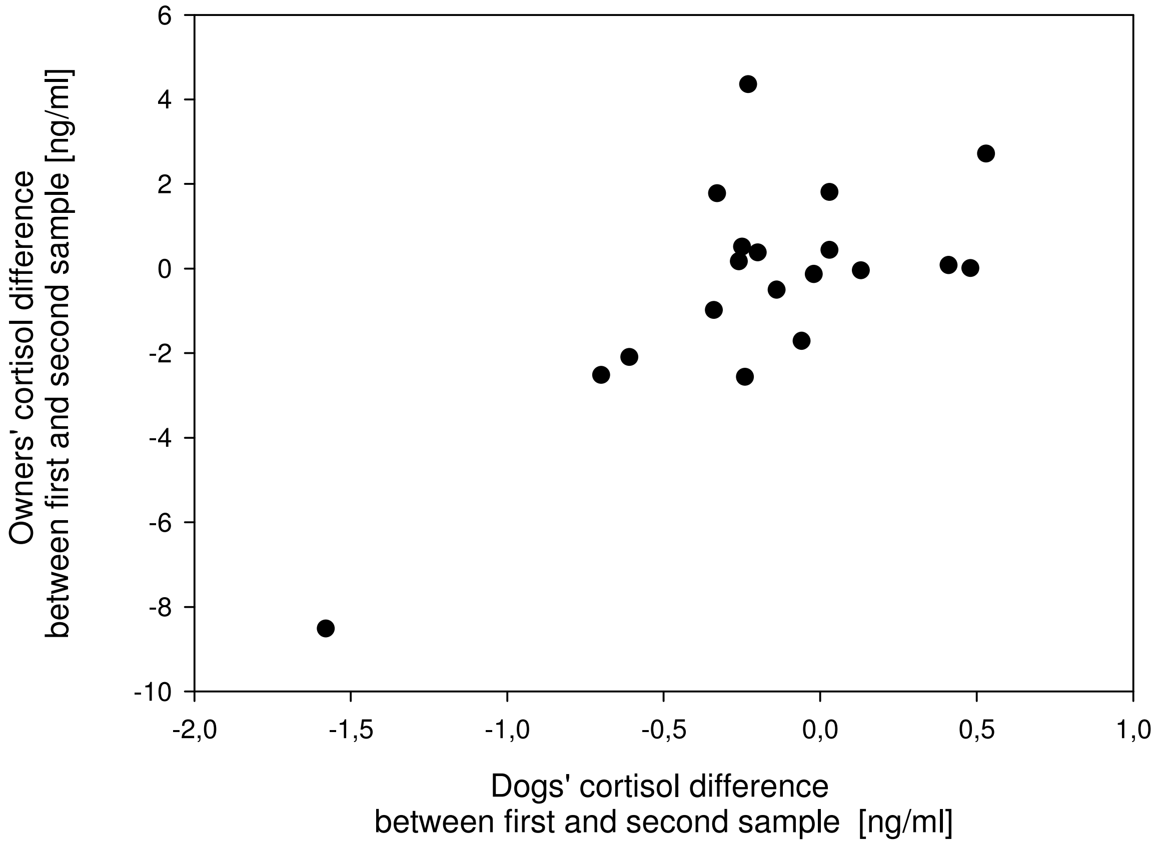


Fig. 4: Owners' and dogs' cortisol secretion during the situation picture. The cortisol increase and respectively decrease correlated positively in owners and their dogs (Pearsons: n=19, r_s=0.721, p<0.001).

Interestingly the cortisol secretion during the first 20 minutes correlated negatively with the cortisol secretion between the 20th and 40th minute during session 2 in owners as well as in dogs and during session 1 and 3 in dogs (Pearsons: dogs session 1: n=19, r=-0.836, p<0.001; dogs session 2: n=19, r=-0.575, p=0.010; owners session 2: n=22, r=-0.674, p=0.001; dogs session 3: n=18, r=-0.597, p=0.009). So it seems that at least in dogs during all three sessions a cortisol increase while the first 20 minutes signifies a cortisol decrease between the 20th and 40th minute and opposite (Fig. 5).

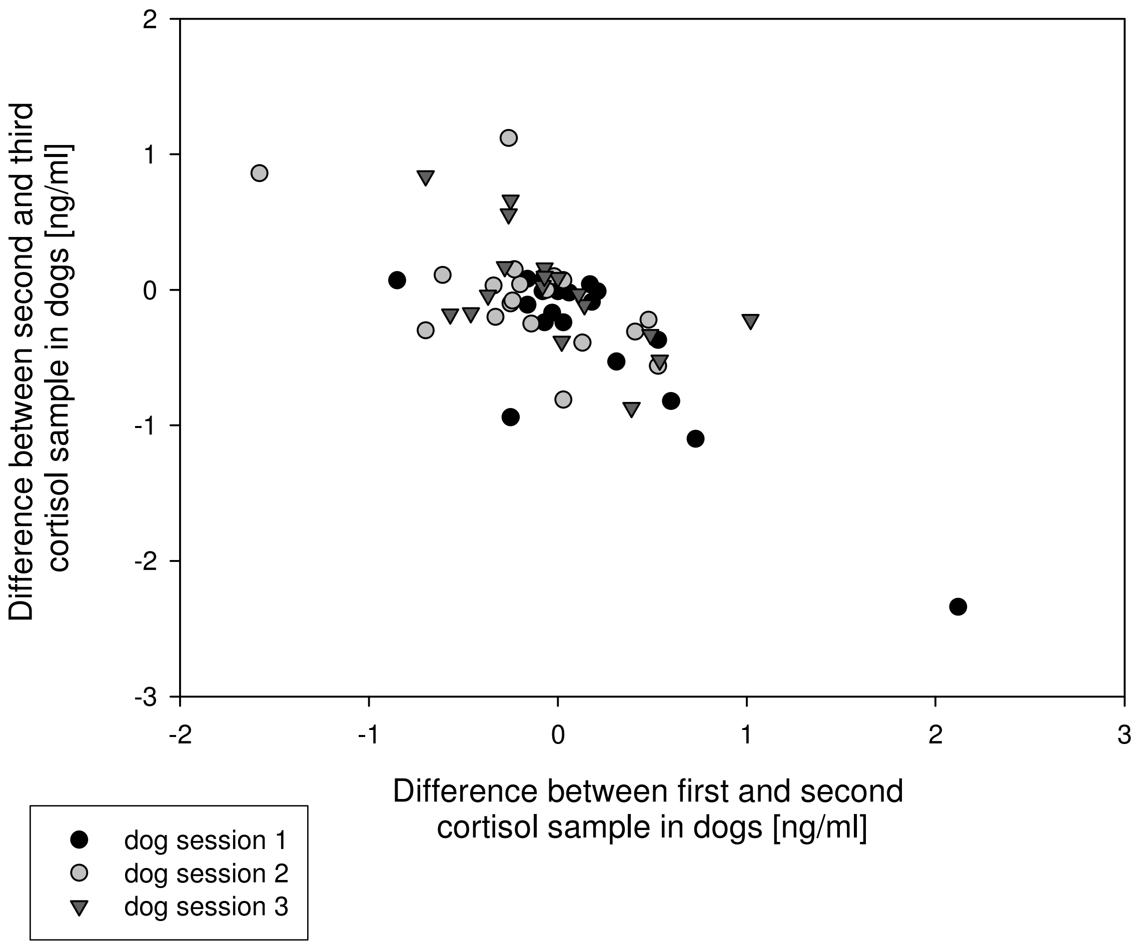


Fig. 5: Correlations of cortisol differences between sample 1 and 2, and sample 2 and 3 of all three sessions in dogs. The higher the increase during the first 20 minutes, the higher was the decrease during the 20th and 40th minutes of all three sessions, and opposite. (Pearsons: dogs session 1: n=19, r=-0.836, p<0.001; dogs session 2: n=19, r=-0.575, p=0.010; dogs session 3: n=18, r=-0.597, p=0.009).

5.1.3. Cortisol and testosterone correlations in owners and dogs

Cortisol and testosterone correlated positively in dogs during the control values (Pearsons: n=22, r=0.470, p=0.027). If one examines the cortisol and testosterone secretion during the test situation at least during the situation "bridge" of session 3 cortisol and testosterone increase correlated positively in dogs as well as in female owners (Pearsons: dogs: n=16, r=0.522, p=0.038; female owners: n=12, r=0.627, p=0.029).

Male owners' testosterone afternoon control values and their dogs' cortisol afternoon control values correlated positively (Pearsons: n=10, r=0.686, p=0.029). Also during the test situations "vet check" owners' testosterone increase and the dogs' cortisol increase correlated positively (Pearsons: n=20, r=0.457, p=0.043), and in the “threat” test, the owners’ cortisol and dogs’ testosterone increased in parallel too (Pearsons: n=17, r=0.577, p=0.015).

5.2. Effects of attachment, relationship and personality on steroid hormone secretion

Female and male owners differed in some aspects of attachment, relationship and personality. Male owners were higher on the extroversion axis (Neo-FFI dimension 2) and shared more activities with their dogs (PCA, Relationship axis 4; Mann-Whitney-U: extroversion: n=40, Z=-2.089, p=0.037; shared activities: n=39, Z=-2.741, p=0.006) than female owners. Dogs of male owners were more sociable and active (PCA, dog personality axis 1; Mann Whitney-U: n=22, Z=-2.176, p=0.030) and female owners considered their dogs by trend more as a social supporter (PCA, Attachment axis 1; Mann-Whitney-U: n=39, Z=-1.942, p=0.052).

The quality of attachment and relationship affected the owners’ and dogs’ cortisol secretion. Female owners with a high sense of responsibility for their dogs (PCA, Relationship axis 2) had dogs with higher cortisol afternoon control values than dogs of female owner low on this axis (Mann-Whitney-U: n=12, Z=-2.038, p=0.042). In contrast, during the situation “vet check”, dogs of male owners high on the responsibility axis (PCA, Relationship axis 2) showed a cortisol decrease (Mann-Whitney-U: n=10, Z=-2.193, p=0.028). Female owners who shared a lot of activities (PCA, Relationship axis 4) with their dogs, had dogs with higher cortisol afternoon control values (Mann-Whitney-U: n=12, Z=-2.038, p=0.042). Instead, dogs of female owners paying much mutual attention (PCA, Relationship axis 3) had lower morning cortisol control values (Mann-Whitney-U: n=12, Z=-2.378, p=0.017). Owners high on the relationship axis „mutual attention payed” (PCA, Relationship axis 3), showed a cortisol increase during the situation “picture” (Mann-Whitney-U: n=22, Z=-2.265, p=0.023), but a cortisol decrease during the situation “vet check” (Mann-Whitney-U: n=22, Z=-2.440, p=0.015), which indicates that the constrained attention towards their dog in the former, but not in the latter situation is stressful for such attentive owners. Owners who regarded their dogs as a “meaningful companion” (PCA, Attachment axis 2) showed a cortisol decrease during the situation “vet check” (Mann-Whitney-U: n=20, Z=-2.317, p=0.020), and dogs with an owner high on the attachment axis “dog as understanding partner” (PCA, Attachment axis 4) showed a cortisol decrease during the situation “threat” (Mann-Whitney-U: n=18, Z=-2.044, p=0.041).

Also, correlations between the owners' and their dogs' testosterone levels with attachment and relationship were found. Such, male owners of a dyad high in paying mutual attention (PCA, Relationship axis 3) had lower testosterone control values (Mann-Whitney-U: n=10, Z=-2.089, p=0.037) than male owners low on this axis. The same was found for dogs of female owners high on the axis "mutual attention paid" (PCA, Relationship axis3), those dogs had low testosterone control values too (Mann-Whitney-U: n=12, Z=-2.378, p=0.017). During the situation "vet check" female owners high on the relationship axis "mutual attention paid" (PCA, Relationship axis 3) showed a testosterone decrease (Mann-Whitney U: n=10, Z=-2.132, p=0.033). In contrast dogs of female owners, sharing a lot of activities with their dogs (PCA, Relationship axis 4) showed a testosterone increase during the situation "vet check" (Mann-Whitney U: n=8, Z=-2.236, p=0.025). Interestingly dogs of male owners high on the "taking responsibility for their dogs" axis (PCA, Relationship axis 2) showed a testosterone decrease during the situation "threat" (Mann-Whitney U: n=9, Z=-2.449, p=0.014). Male owners regarding their dog as social supporter (PCA, Attachment axis 1) had low testosterone control values (Mann-Whitney-U: n=10, Z=-2.089, p=0.037) as compared to dogs of male owners low on that axis, but showed a testosterone increase during the situation "bridge" (Mann-Whitney U: n=10, Z=-2.393, p=0.017). Male owners high on the attachment axis "dog as meaningful companion" (PCA, Attachment axis 2) had lower testosterone control values, than owners low on this axis (Mann-Whitney-U: n=10, Z=-2.089, p=0.037), but showed a testosterone increase during the situation "bridge" (Mann-Whitney U: n=10, Z=-2.393, p=0.017). Interestingly male owners regarding their dog as meaningful companion showed a testosterone decrease during the situation "threat" (Mann-Whitney U: n=9, Z=-2.205, p=0.027). For dogs of female owners considering them as meaningful companions (PCA, Attachment axis 2), a testosterone increase during the situation "threat" was found (Mann-Whitney U: n=8, Z=-2.000, p=0.046) and in female owners high on the attachment axis "dog as social partner" (PCA, Attachment axis 3) a testosterone decrease during this situation was found (Mann-Whitney U: n=11, Z=-2.191, p=0.028).

Moreover the owners' and the dogs' personality were related with their cortisol levels. Dogs of owners high in neuroticism (Neo-FFI dimension 1) had lower cortisol morning control values than dogs with an owner low on that dimension (Mann-Whitney-U: n=22, Z=-2.105, p=0.035). Also in female owners it was found that neurotic ones (Neo-FFI dimension 1) had lower cortisol morning control values (Mann-Whitney-U: n=12, Z=-2.278, p=0.023). Fitting these findings, neurotic owners (Neo-FFI dimension 1) showed a cortisol decrease during the situation “vet check” (Mann-Whitney U: n=22, Z=-2.246, p=0.025). Testosterone was also influenced by neuroticism. So the dogs’ testosterone control values of female owners were low, when their female owners were high in neuroticism (Neo-FFI dimension 1; Mann-Whitney-U: n=12, Z=-2.042, p=0.041). Extrovert (Neo-FFI dimension 2) and conscientious (Neo-FFI dimension 5) male owners had lower cortisol morning control values, than male owners low on these axes (Mann-Whitney-U: extroversion: n=10, Z=-2.155, p=0.031; conscientiousness: Z=-2.193, p=0.028). However, dogs of conscientious male owners (Neo-FFI dimension 5) showed a testosterone increase during the situation “bridge” (Mann-Whitney U: n=10, Z=-1.984, p=0.047). The same was found in dogs of highly agreeable owners (Neo-FFI dimension 4) for the situation “vet check”, those dogs showed a cortisol increase during this situation (Mann-Whitney U: n=20, Z=-2.055, p=0.040). As expected, owners with a “vocal and aggressive” dog (PCA, dog personality axis 3) had higher cortisol morning control values than owners of a dog low on this scale (Mann-Whitney-U: n=22, Z=-2.308, p=0.021). However female owners with an “unconfident and anxious” dog (PCA, dog personality axis 2) had lower cortisol morning control values (Mann-Whitney-U: n=12, Z=-2.335, p=0.019).

Male owners of anxious and unconfident dogs showed a testosterone decrease during the situation “vet check” and “picture” (Mann-Whitney-U: vet check: n=10, Z=-2.514, p=0.012, picture: n=9, Z=-1.960, p=0.050). In male-owner-dog-dyads, sociable and active dogs (PCA; dog personality axis 1) had higher Testosterone control values than dogs low on this axis (Mann-Whitney-U: n=10, Z=-2.393, p=0.017). Female owners of sociable and active dogs (PCA, dog personality axis 1) showed a testosterone increase during the situation “threat” (Mann-Whitney U: n=9, Z=-2.008, p=0.045). And a tendency was found that male owners with a “sociable and active dog” (PCA, dog personality axis 1) showed a testosterone increase during the situation “bridge” (Mann-Whitney U: n=10, Z=-1.937, p=0.053). Interestingly male owners with a “clever and attentive” dog (PCA, dog personality axis 4) had lower cortisol morning control values, than owners with a dog low on this axis (Mann-Whitney-U: n=10, Z=-2.611, p=0.009).

5.3. Effects of interaction style and performance during test situations on steroid hormone secretion

Female owners interacted more with their dogs and were more behaviourally synchronized with them during the situation “vet check” than male owners (Mann-Whitney-U: interaction: n=22, Z=-2.268, p=0.023, synchrony: Z=-2.278, p=0.023).

Interestingly owners with a highly positive interaction style showed a cortisol increase during the situation “vet check” (Mann-Whitney-U: n=22, Z=-2.965, p=0.003). This is due to a greater amount of empathy of these owners. The same was found for the situation “threat”, owners with a highly positive interaction style showed a cortisol increase during this situation (Mann-Whitney-U: n=19, Z=-2.106, p=0.035). However dogs that were synchronic with their owners showed a cortisol decrease during the situation “threat” (Mann-Whitney-U: n=18, Z=-2.140, p=0.032).

Also a relation between interaction style and salivary testosterone was found. Owners that interacted more positively with their dogs showed a testosterone increase during the situation “vet check” (Mann-Whitney U: n=19, Z=-2.167, p=0.030). A tendency was found that dogs of male owners that interacted positively with their dogs showed a testosterone decrease during the situation “vet check” (Mann-Whitney U: n=6, Z=-1.907, p=0.057). Furthermore male owners interacting more with their dogs during the situation “picture” showed a testosterone decrease during this (Mann-Whitney U: n=9, Z=-2.236, p=0.025).

There were generally just few results towards an effect of interaction style and performance during the test situations on hormonal patterns in human-dog-dyads. Attachment, relationship and the owner’s and dog’s personality seem to be the main influencing factors. Those parameters also strongly affected the human-dog-dyads’ interaction style, the dogs’ reaction to an owners approach and the dyads’ performance of test situations.

Owners’ interaction style during our test situation was related with dog personality, but not with attachment, relationship and owner personality. Owners that interacted only positively with their dogs through the situation “threat” had less vocal and aggressive dogs (PCA, dog personality axis 3), than owners that interacted positively as well as negatively with their dogs (Mann-Whitney U: n=19, Z=-2.982, p=0.003). Male owners with a more unconfident and anxious dog (PCA, dog personality axis 2) interacted more with their dogs during the situation “picture” (Mann-Whitney-U: n=10, Z=-2.132, p=0.033) than male owners with a dog low on the personality axis “unconfident and anxious” (PCA, dog personality axis

2). Interestingly, female owners that interacted mostly positively, but also sometimes negatively with their dogs during the situation “vet check” had more sociable and active dogs (PCA, dog personality axis 1), than female owners that interacted just positively with their dogs (Mann-Whitney-U: n=12, Z=-2.717, p=0.007).

The owner-dog relationship affected the dogs’ reaction to an owners’ approach. The higher the owners’ “sense of responsibility” for their dogs (PCA, Relationship axis 2) the more friendly their dogs reacted to an owner’s approach during the situation “bridge” (Spearmans: n=21, r_s=0.496, p=0.022). This was also found in dogs of male owners for the situation “threat”, the higher their owners’ “sense of responsibility” (PCA, Relationship axis 2) the more friendly their dogs reacted to an owner’s approach (Spearmans: n=7, r_s=0.797, p=0.032). In contrast, the more male owner-dog-dyads paid mutual attention (PCA, Relationship axis 3) the less friendly the dogs reacted to an owners approach during the situation “threat” (Spearmans: n=7, r_s=-0.797, p=0.032). When owned by females, dogs reacted less friendly to an owners approach during the situation “bridge” the higher their owners were on the attachment axis “dog as understanding partner” (PCA, Attachment axis 4; Spearmans: n=11, r_s=-0.626, p=0.039).

Also, owner and dog personality had an influence on the dogs’ reaction to an owners’ approach. Dogs that reacted friendly to an owners’ approach during the situation “threat” were more unconfident and anxious (PCA, dog personality axis 2) than dogs that just tolerated the approach (Mann-Whitney-U: n=18, Z=-3.110, p=0.003). Dogs with an owner low on the openness axis (Neo-FFI dimension 3) reacted friendly and went towards the owner, when the owner approached the dog through the situation “vet check” (Mann-Whitey-U: n=20, Z=-2.347, p=0.019). Furthermore dogs of highly neurotic female owners reacted more friendly to an owners approach than dogs of female owners low in neuroticism (Neo-FFI dimension 1) during the situation “vet check” (Mann-Whitney-U: n=12, Z=-2.603, p=0.009; Fig. 5). In dogs of male owners a tendency for the opposite was found: dogs of male owners’ high in neuroticism (Neo-FFI dimension 1) just tolerated the owner’s approach, but did not react friendly during the situation “vet check” (Mann-Whitney-U: n=10, Z=-1.919, p=0.055; Fig 5).

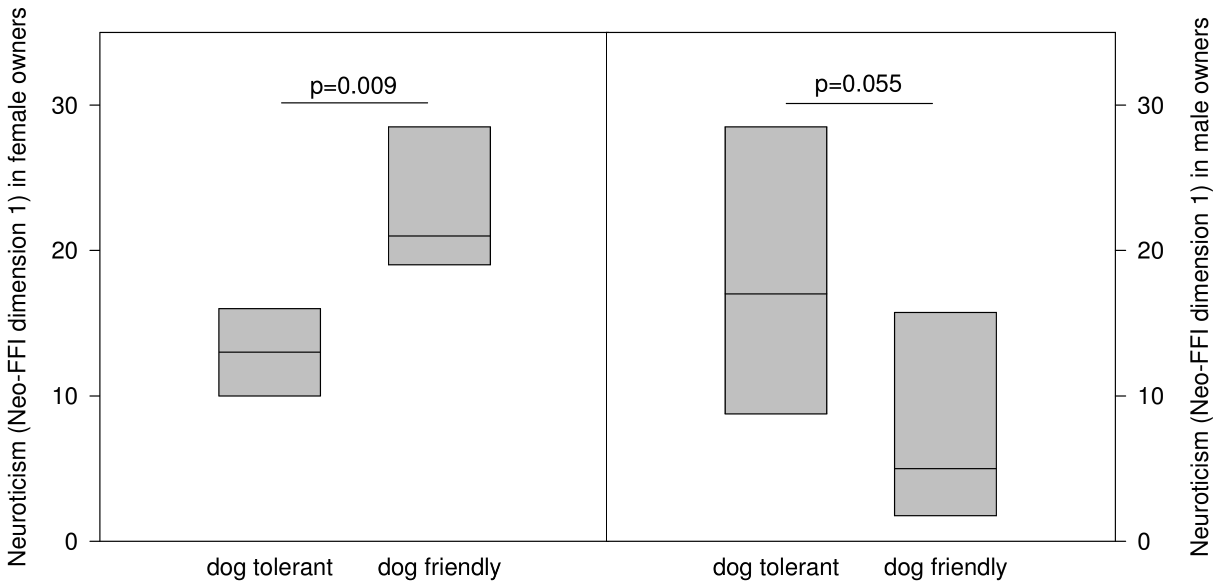


Fig. 5: Dogs of female (left hand side) and male (right hand side) owners high in neuroticism (Neo-FFI dimension 1) showed opposite reaction to an owners approach during the situation "vet check". Female owners significant: Mann-Whitney-U: n=12, Z=-2.603, p=0.009. Male owners by trend: Mann-Whitney-U: n=10, Z=-1.919, p=0.055.

Moreover, attachment and personality affected the performance of the human-dog dyad through the test situations "bridge" and "threat". The analysis indicated that dogs of owners who considered their dogs as "social partner" (PCA, Attachment axis 3) crossed the wire mesh bridge fast and without hesitating (Mann-Whitney-U: n=22, Z=-2.285, p=0.022). Also, dogs of male owners high in extroversion did so (Neo-FFI dimension 2; Mann-Whitney-U: n=10, Z=-1.999, p=0.049). In contrast, dogs of male owners high in neuroticism (Neo-FFI dimension 1) crossed the wire mesh bridge, if at all, only very hesitantly (Mann-Whitney-U: n=10, Z=-2.165, p=0.030), which was also true for dogs of male owners regarding their dogs as social supporter (PCA, Attachment axis 1; Mann-Whitney-U: n=10, Z=-1.937, p=0.053).

The more male owners considered their dogs as social partner (PCA, Attachment axis 3) the higher was the owners' effort for the situation "bridge", i.e. the owner tried to lead the dog through the wire mash bridge in a positive way (Spearmans: n=10, r_s=0.719, p=0.019). Dogs responding aggressively in the situation "threat" had owners lower on the attachment axis "dog as understanding partner" (PCA, Attachment axis 4) than dogs that showed little avoidance or friendly reaction (Kruskal-Wallies: n=22, Chi-Quadrat=9.451, df=3, p=0.024). Interestingly the more female owners considered their dogs as social partner (PCA, Attachment axis 3) the less frequently and the less friendly the female owners were involved during the situation “threat” (Spearmans: n=12, r_s=-0.622, p=0.031).

6. Discussion

With the relatively small sample size in mind, interpretation of our results needs to be conservative; nevertheless we could expand on previous studies concerning the major parameters affecting human-dog relationships on different levels.

First of all, most of our “challenges” were not sufficiently intense to trigger distinct stress responses in participants, neither for owners nor dogs. The initial cortisol values of the sessions did not differ from the control values and no different reactions to different challenges were found. Even cortisol decreases during the sessions were observed. An explanation for this could be, that just relaxed dyads participated, whereas owners of more extreme ones probably do not want to get filmed or documented. Our test situations could have happened during daily life, hence they may have been used to such situations. In fact, even difficult conditions may not provoke a physiological stress response unless they are unpredictable (Creel 2001). Probable our conditions were sufficiently predictable for owners as well as for dogs.

Interestingly, during the first sessions male owners appeared to be more tensed than female owners because of our visit. Indeed, most of the male owners showed a strong increase in cortisol, whereas most of the female owners showed a decrease within the first part of the first sessions. But during the challenge situations no sex differences were found. Maybe the presence of unknown female experimenters caused this initial response in men. Dogs showed a cortisol increase during the first 20 minutes, which was followed by a decrease during the next 20 minutes. Comparing this with the challenge situation, where no different reactions were found, the social stressor, i.e. strangers entering the home area, seemed to be a formidable stressor (McEwen &Wingfield 2003).

However, our results show that relationship and attachment affects the dog’s cortisol level during daily life, e.g. dogs of female owners with a high sense of responsibility for their dogs had higher cortisol afternoon control values. This agrees with O’Farrell’s (1997) results that an anthropomorphic involvement of the owner is related to dominance in dogs in connection with Sands’ and Creel’s (2004) finding of higher cortisol levels in dominant wolves. Our findings also support that a secure attachment is related to lower physiological stress responses (Gunnar 1998) and that good relationships provide social support (Scheiber et al. 2005), e.g. paying a lot of mutual attention within a human-dog dyad and respectively, a high quality relationship resulted in lower cortisol morning control values in dogs. Moreover, in our study securely attached dyads avoided each other less often, than insecurely attached dyads (Weaver & De Waal 2002). Thus, owners with a high sense of responsibility for their dogs had dogs that reacted more friendly and with less avoidance behaviour to an owners approach.

Owner personality affected cortisol secretion in owners but did less so in dogs. However, dog personality hardly affected the owner’s cortisol secretion, e.g. owners with a vocal and aggressive dog had higher cortisol morning control values. So one may assume, that beneficial effects for the human partner are strongly dependable from the specific relationship of any human-dog dyad. Interestingly female owners with an unconfident and anxious dog had low cortisol morning control values. Probably those dogs make less trouble than aggressive dogs. But one question will still remain: What was first, the stressed owner or the aggressive dog?

However neuroticism is an important personality parameter within stress coping in human-dog dyads, it not only affected cortisol modulation in dogs during daily life, but also their behavioural reactions during challenges. High neurotic owners had dogs with low cortisol morning control values and dogs of highly neurotic female owners reacted friendly to an owners approach, instead dogs of male owners’ high in neuroticism just tolerated the owner’s approach and they had problems to master the “bridge” task. This is consistent to the results that neuroticism is related to a close attachment and high mutual attention between owner and dog, but also with coming off badly during practical tasks (Kotrschal et al. submitted).

Within our study interaction style and performance in the task did not affect stress coping in human-dog dyads as much as expected. But interactions style and performance during challenge situations were strongly linked with attachment, relationship and owner and dog personality. Thus, we found relations between low aggression in dogs and an only positive interaction style; anxious dogs and male owners interacting a lot with them; and sociable and active dogs and female owners interacting mostly positive, but also sometimes negative with their dogs. These results are well fitting the point that social support (interacting positively), over-excitement (continuous interaction), and a non anthropomorphic involvement of the owner (setting boundaries) is related to dog behaviour or respectively, fits the behaviour of the individual involved (O’Farrell 1997, Scheiber et al. 2005). Social support was also helpfully for the owner as well as for the dog for bringing off the “bridge” task.

If, however, social support is missed, characterized by low quality attachment, dogs reacted aggressive during the “threat” task. Interestingly dogs that reacted friendly to an owners’ approach during this situation were more unconfident and anxious, which goes conform to an over-excitement of the owner (O’Farrell 1997), or it is just a simply submissive reaction, which is characterized by friendly approach behaviour on the part of the dog.

To conclude, how an owner-dog dyad mastered a challenging task and how they interacted with each other is affected by the attachment and the personalities of both. My study provides evidence that one should focus on those parameters and on the owner sex within working/training with human-dog dyads. Just regarding to interaction style and how they perform during challenge situations and not taking into account relationship and attachment, as well as owner and dog personality, will fall short in reaching an optimal training result.

7. Appendices

7.1. Appendix A

Dog personality factor loadings (axes 1-4, rotated matrix) resulted from the Principal Component Analysis (PCA) performed with 17 items (n=22, Bartlett-Test: KMO=0.673, Sphericity: chi²=374.158, df=136, p<0.001; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished).

Original Variables	PCA main axes for dog personality			
	sociable and active	unconfident and anxious	vocal and aggressive	clever and attentive
Sociable	**0,8784**	0,0936	-0,2983	-0,0517
Active	**0,8756**	0,3735	0,0333	0,0660
Gladsome	**0,8605**	0,2705	-0,3717	0,1033
Interested	**0,8524**	0,1930	0,2393	-0,0056
Playful	**0,8498**	0,1413	-0,2644	0,0234
calm and balanced	**-0,7680**	-0,4895	-0,1384	-0,0180
wild	**0,6025**	0,4029	0,4046	-0,1411
confident	-0,2520	**-0,9223**	-0,0023	-0,0385
anxious	0,0861	**0,9093**	0,1448	0,1397
Nervous	0,3833	**0,7917**	0,2309	-0,3242
dependable	-0,4867	**-0,7271**	-0,0216	0,3103
Vocal	0,0636	0,0345	**0,8555**	-0,2888
Aggressive	-0,1247	0,2339	**0,8046**	0,1379
Friendly	0,5543	0,0094	**-0,7635**	-0,0449
Excitable	0,4750	0,5253	**0,5280**	-0,2338
clever/smart	-0,0390	-0,1787	-0,1260	**0,9169**
Attentive	0,4615	0,4849	0,0877	**0,6137**

7.2. Appendix B

Factor loadings for human-dog attachment (axes 1-4, rotated matrix) resulted from the Principal Component Analysis (PCA) performed with 15 items (n=39, Bartlett-Test: KMO = 0.767; Sphericity: chi²=400.674, df=105, p<0.001; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished).

Original Variables	PCA main axes for owner-dog attachment			
	social supporter	meaningful companion	social partner	understanding partner
Just being with my dog makes me feel good.	**0,8664**	0,3201	0,1252	0,0195
My dog helps me to be balanced with myself.	**0,8076**	0,2720	0,1774	-0,1333
It makes me feel better to talk to my dog if I m sad, worried or angry.	**0,7637**	0,0491	0,0187	0,3928
I like taking care of my dog, the daily routines does not annoy me.	**0,6852**	0,0867	0,2839	0,4888
It feels good to talk to my dog.	**0,6625**	0,1195	0,4097	0,4951
If my dog were to get lost, sick, or hurt I would feel very sad.	0,1573	**0,8825**	0,0501	0,2629
I feel responsible for my dog, and that is good like that.	0,2439	**0,8512**	0,1314	0,1831
My dog means a lot to me.	0,1653	**0,7340**	0,5213	0,1315
My dog is a good buddy, or fiend.	0,2761	**0,5887**	0,5582	0,1813
My dog is a fully-fledged social partner/family member.	0,2210	0,2008	**0,8003**	-0,1905
I am having a conversation with my dog several times per day.	0,3968	-0,0319	**0,7019**	0,3187
My dog loves me unconditionally.	-0,0691	0,2492	**0,6858**	0,3726
My dog knows when I really feel sad, worried, or angry.	-0,0106	0,3373	-0,0647	**0,7433**
I think my dog understands me.	0,1550	0,0754	0,0940	**0,7115**
I miss my dog when we cannot be together.	0,1948	0,1796	0,2467	**0,6101**

7.3. Appendix C

Factor loadings for human-dog relationship (axes 1-4, rotated matrix) resulted from the Principal Component Analysis (PCA) performed with 14 items (n=39, Bartlett-Test: KMO=0.723, Sphericity: chi²=307.370, df=91, p<0.001; Varimax-rotation, Kaiser-normalization; M. Wedl, unpublished).

Original Variables	PCA main axes for owner-dog relationship			
	(spend) time together	(take) responsibility	(pay) attention	(shared) activity
I make a point of spending time with my dog.	**0,9250**	0,1025	0,1564	0,0593
I spend quite a bit of time with my dog.	**0,8298**	0,2682	0,1781	0,1463
I like cuddling with my dog.	**0,8150**	0,0019	0,0940	-0,1827
I am going for a long walk with my dog or train/play with my dog several times per week.	**0,7091**	0,2332	0,0004	0,1780
Sometimes, the things my dog does makes me laugh	**0,6412**	0,4722	0,1810	-0,0085
I make sure my dog has fresh water all the time.	**0,5138**	0,5010	0,2270	-0,4110
I am responsible for feeding my dog on a daily basis.	0,1313	**0,8990**	0,1827	-0,1575
Even if other family members are around, my dog lets me know when he/she wants to go outdoors.	0,1615	**0,7929**	-0,2277	0,0475
I am the person in my family who usually walks my dog.	0,2485	**0,7363**	0,2248	0,2067
My dog often wants attention from me.	0,1392	0,2197	**0,7701**	-0,1031
I am sometimes looking for my dog when I actually need to be doing something else.	0,1701	-0,1860	**0,6965**	0,0213
I play with my dog several times per day.	0,0041	0,1059	**0,5296**	0,1306
I am always taking my dog with me (e.g. to my workplace, hobbies, holidays, excursions, shopping…).	0,4734	0,2126	0,1243	**0,7591**
I like to just 'hang out' and to relax with my dog.	0,5684	0,2365	-0,1022	**-0,6062**

8. Acknowledgement

First of all, I would like to thank my supervisor Ao. Univ.-Prof. Mag. Dr. Kurt Kotrschal for giving me this wonderful opportunity to work out my diploma thesis with dogs, my professional as well as private passion; and for advancing my scientific development.

Special thanks to Mag. Manuela Wedl, who helped me so much with so many thinks, that I cannot count them anymore. Without her productive input and critical view my diploma thesis would be just half as good.

Not to forget MMag. Barbara Bauer, who spent her precious time to help us with coding the videos and for being a kind of social supporter when I got stressed about my diploma thesis.

I am also very grateful for the help my family provided. Especially my mother was the person, who bolstered me through my studies and supported me in any possible way.

I would like to thank my friends and especially my partner, who always believed in me and supported me too.

Finally, I have to mention my dogs, Jorunn, who inspired me to work with dogs more than 10 years ago, and Ekhaya, who teach me each day from anew how important and well-doing animals as social supporters are.

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Schöberl I, Bauer B, Dittami J, Möstl E, Wedl M und Kotrschal K: Interaktionsstil und Stressmanagement in Mensch-Hund Dyaden.

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